PART 3

Sources of motion and the Varigear speed drive unit

PART 3

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Chapter 16

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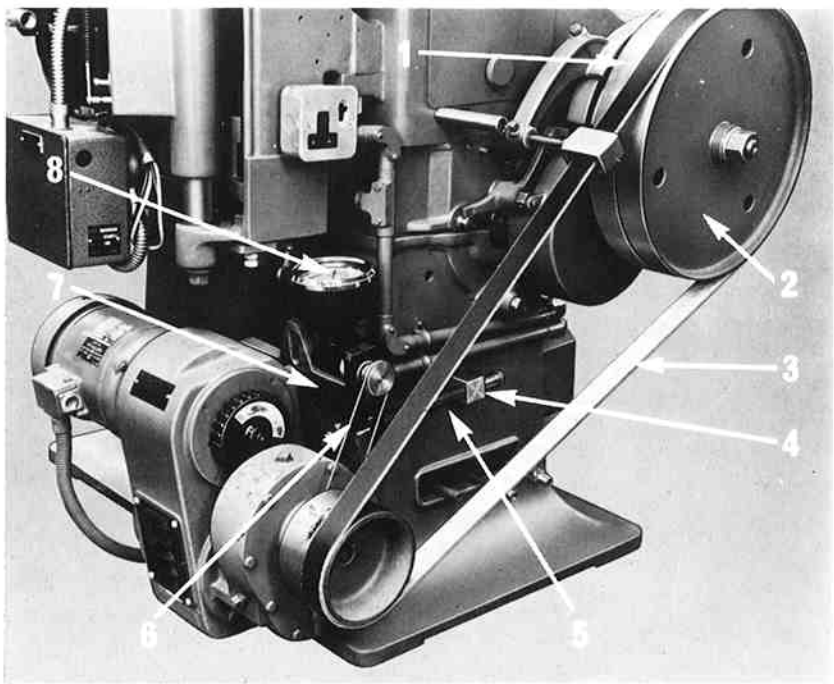
CHAPTER 16

The Varigear unit and gear box

Power for the Super caster, derived from an integral electric motor, is transmitted via a variable speed drive to a gear box (by belt drive) and thence to a pair of coupled shafts housed in the camshaft stand, which carry five pairs of complementary cams. (A sixth pair, which control the cutter cam lever, is housed alongside the camshaft stand, close by the camshaft handwheel.) Between each pair of cams runs a roller follower which is carried at the lower end of a vertical lever. The oscillation of the cam levers, influenced by the movement of the cams, provides the basis for all the integrated continuous movements involved in the casting cycle, embraced in one complete revolution of the camshaft through 360°.

A 'Monotype' Varigear speed drive unit, complete with a $\frac{3}{4}$ h.p. (560 W) motor, is mounted on a base plate (7) hinged to the right-hand side of the machine base, which is held in position (and maintained under constant tension when running) by means of a combined base tension spring rod (5) and spring. The rod and spring secure the motor base plate to the machine base via an anchor block (4).

The Varigear drive is carried direct to the fast (2) and loose (1) pulleys by a nylon cord belt (3) which, due to the spring rod mounting, is kept at an even tension at all speeds. The transmission is thereby maintained at a constant torque; in consequence of which, low running speeds can be constantly sustained



without belt slip, and consequent loss of power. The drive thus imparted to the fast pulley is in turn transmitted to the cams through a gear system which offers a selection of three speed ratios, two of which in effect reduce the revolutions transferred, whilst the third increases them. The output drive from the gear box is meshed with the camshaft drive; the speed range selected being controlled by means of three control selector handles which can be set for A, 2–10 r.p.m.; B, 10–60 r.p.m. and C, 60–160 r.p.m.

The Varigear is itself controlled by a regulator, which, by determining the output speed that is passed through the pulleys to the selected gear, can dictate the drive speed that is in consequence delivered to the camshaft. The influence of the Varigear regulator is displayed on the speed indicator, which registers the camshaft speed, the indicator being linked by a small tubular belt (6) to the output shaft of the Varigear speed control unit, whilst the dial is marked with three colour-distinguished scales, one for each of the three speed ranges available.

It will thus be seen that the constant drive of the $\frac{3}{4}$ h.p. electric motor, which is regulated as required by the Varigear speed control unit (and checked on the speed indicator) is passed through the selected gear to produce precisely the required speed at the camshaft as dictated by the size and nature of the product being cast. The diagrams which illustrate the gear positions for the three speed ranges will show how the drive from the pulley is delivered to the camshaft in each case.

We will now make a detailed examination of the Super caster speed-changing mechanisms provided by the Varigear unit and the gear box.

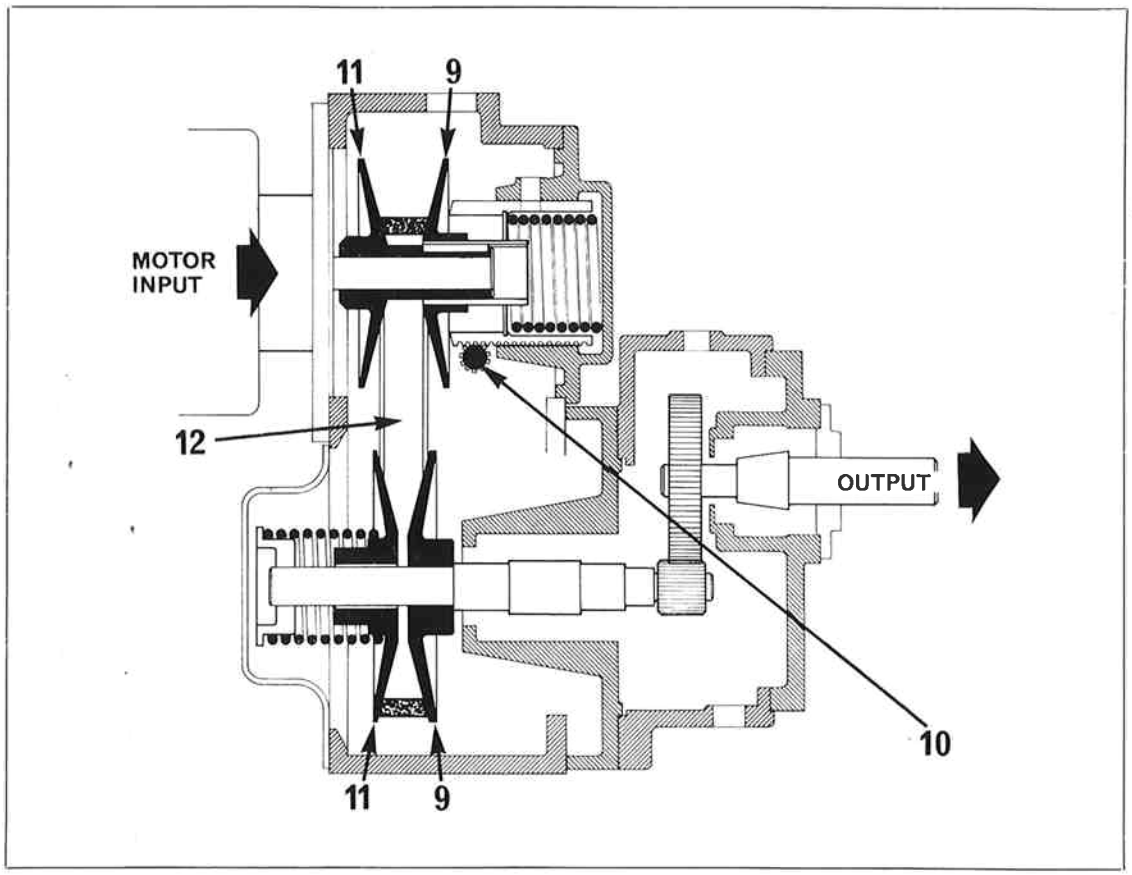
16.1 Speed changing mechanisms

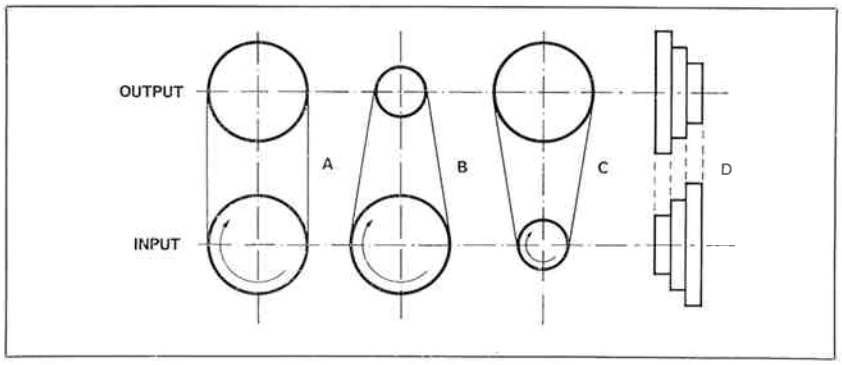
The Varigear unit: The main advantage of the Varigear unit as used in the Super caster lies in its ability to provide a stepless speed variation between its upper and lower limits, which permits its controlled output to be passed direct to the Super caster pulley at varying speeds, by means of a flat nylon cord belt. The drive thus transmitted, in consequence (on being passed through the gear box), results in controlled output at the camshaft – and specific speeds for casting to meet all requirements and conditions.

Close study of the diagrams will reveal the basic simplicity of the principles involved; but first some brief remarks on those fundamentals of belt transmission which pertain to shaft speed ratios and the effects of pulley size on these relationships. When power is transmitted by belt from one pulley to another of the same diameter, the speed of both remains the same (A). Where the driving pulley is half the diameter of the driven, the latter will revolve at only half speed (C), and where the driver is twice the size of the driven, the speed at the driven pulley will be twice that of the driver (B); i.e. differential speeds vary directly with pulley size.

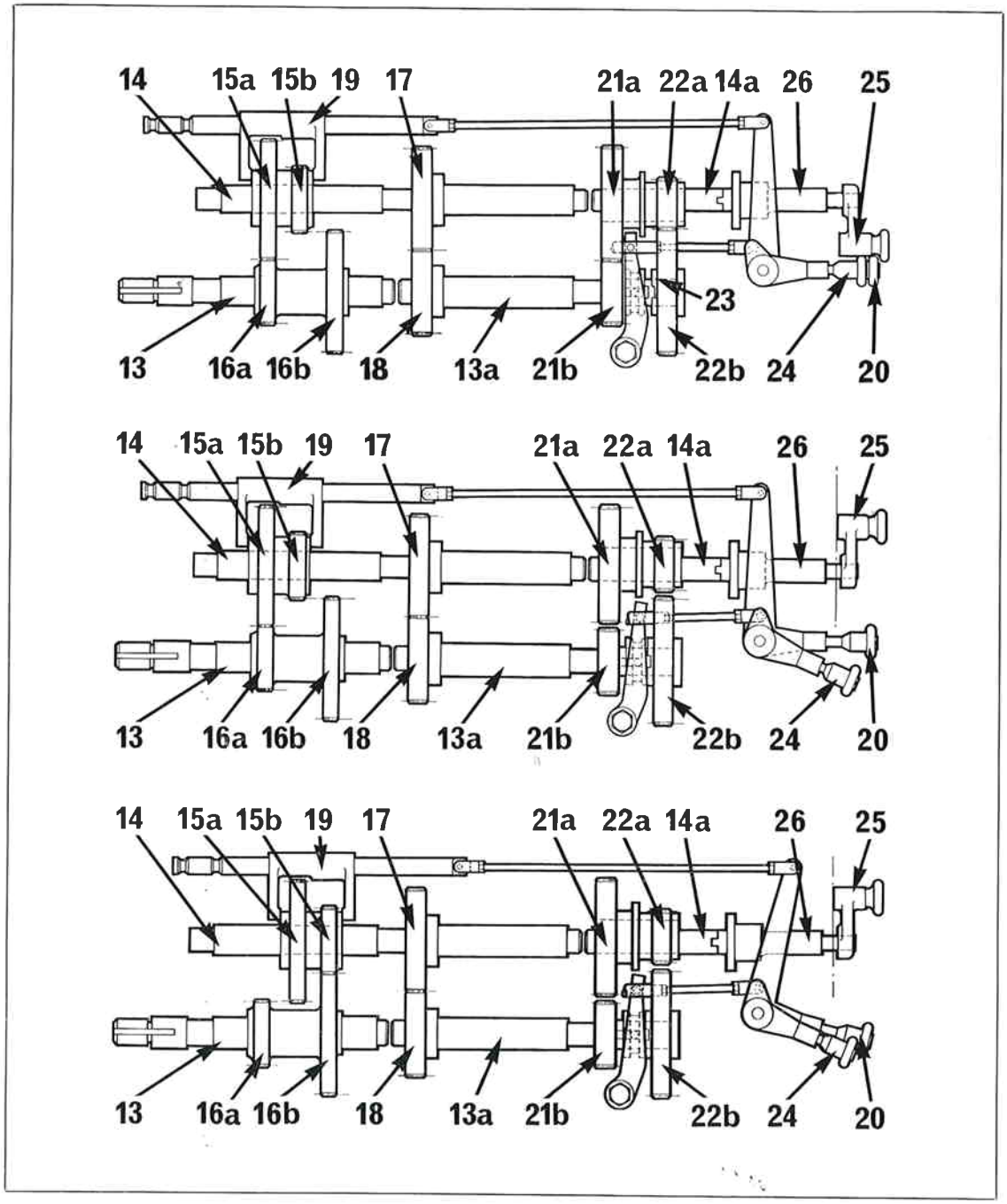
If conical pulleys are arranged in the manner shown in (D) the three conditions obtaining in A, B, C can be produced by moving the belt across the pulleys so as to regulate their effective diameters. This is the principle employed in the Varigear. The vee belt (12) runs between two pairs of split flange pulleys (to support the belt on both sides) mounted one above the other. Each pulley consists of one fixed (9) and one spring-loaded flange (11), whilst a graduated control (10) connected to the upper movable flange determines its degree of separation from the fixed member. This in turn governs the radius about the pulley axis at which the vee belt will ride.

The tension of the belt causes the movable flange of the lower (driven)





pulley to take up an appropriate corresponding position. Consequently when the flanges of the driving pulley are set wide apart, the belt will run on the bottom of its vee groove, and the slack in the belt will be taken up as shown by the lower pulley contracting under spring pressure. This will cause the belt to ride near the periphery of the driven pulley, giving its shaft a reduced speed. Conversely, when the control causes the moving flange of the driving pulley to approach its fixed flange, the belt is driven towards the periphery, while the driven pulley is expanded (against the spring pressure) by the resultant increase in belt tension. The belt therefore rides low in the driven pulley, giving its shaft increased speed.



The gear box: The gear box is located behind the camshafts and is made up of two sets of two shafts running parallel to each other and to the camshafts. On the gearbox diagram, the two sets of shafts are shown as (13/13a) and (14/14a). Each set of shafts carries two double gears and one single gear; one pair of double gears (15a/15b) and (16a/16b) being at the rear (nearer to the pulleys) whilst the other is close to the front of the machine. The whole collectively comprises two separate gear systems which are interconnected by the constantly meshed single gears (17) and (18).

The rear double gear (15a/15b) may be moved along the shaft (14) by means of a yoke (19), which is connected by a rod and lever to a control handle (20) at the front of the machine.

The two elements (21b) and (22b) of the outer gear system of the front speed reduction pair can be separated by the withdrawal of a dog-clutch (23) operated by a lever connected to a second control handle (24). Finally, the double gears (21a) and (22a) can be moved into and out of mesh with (21a) and (22b) by a third control handle (25) and a shaft (26) which actuates an eccentric in which are mounted the inner gears (21a) and (22a).

The gear box diagram shows the control lever handle settings for each of the three speed ranges. The settings are also indicated on a plate which is affixed to the machine. What follows explains how the drive imparted by the fast pulley to the driving shaft (13) is diverted through the gears, via shaft (13a) to gear (21b) and thence to the camshaft, in each speed range: Range A: 2–10 r.p.m. The rear pair of double gears are meshed as indicated (15a with 16a), the single gears (17 and 18) are in constant mesh; the clutch (23) of the gear in the front speed reduction unit is out, and the drive therefore passes through the four gears (21a–21b–22a–22b) to the camshaft (not shown). Range B: 10–60 r.p.m. The rear double gears and the single gears remain meshed as before, the front speed reduction unit gears (21a and 22a) are taken out of mesh with (21b and 22b) and the dog of this gear system is moved 'in', so that the drive is carried direct to its front component and through it to the camshaft drive gear. Range C: 60–160 r.p.m. In this, the highest speed range, the rear movable double gear (on the inner shaft) is shifted by control lever handle (20), to secure a different mesh (15b with 16b), with the outer double gear giving the alternative ratio. The single gears remain in mesh, the clutch dog on the front speed reduction unit remains 'in' and again the drive is transmitted through the outer front component to the camshaft drive gear.

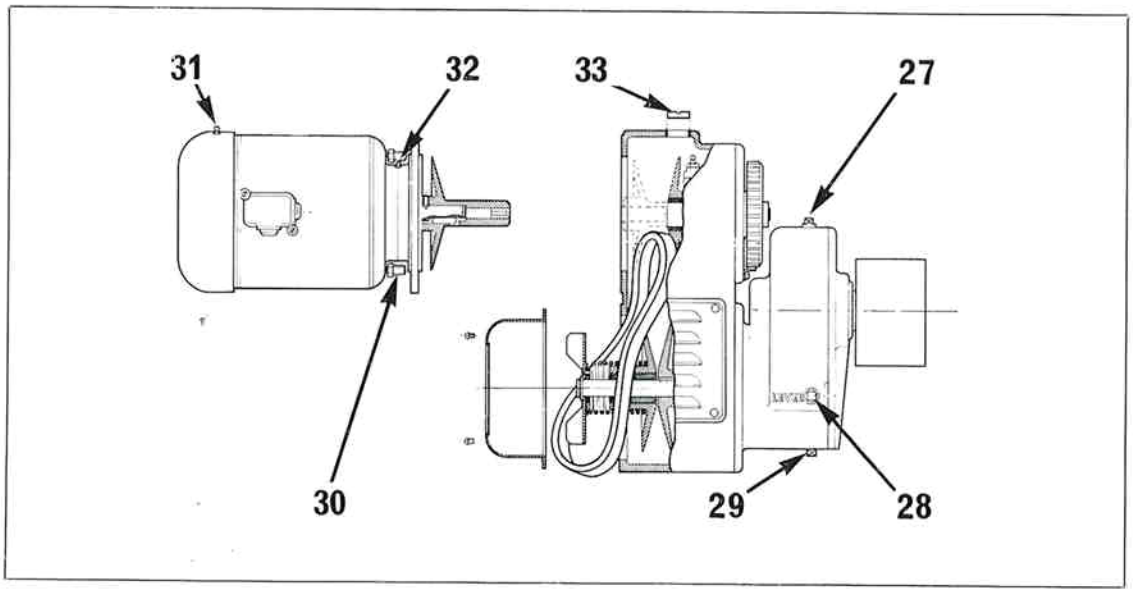
16.2 Starting procedure

After the gearbox control selector handles have been set for the required speed range, and the motor has been started, the camshaft output speed (the revolutions per minute) must be checked on the speed indicator dial (8), and the Varigear regulator adjusted accordingly, until the needle indicates the desired speed on the scale applicable to the gear box speed range setting.

Note: The speed range selected will largely depend on the figures given in the 'Product Information Table'. The figures quoted for each class and size of product constitute a general guide and are those which will allow the machine to operate most efficiently under average conditions. Conditions, however, will not always be average and you will possibly be called upon to use discretion at times in this respect. Moreover the proportions of the metals of which the type metal is composed may vary, or a particular typeface may demand special treatment. You will learn by experience to make such careful checks as are necessary and to take account of your observations and adjust the machine speed accordingly. It is emphasised, however, that the recommended speeds should be adhered to unless there is some good reason to vary them intelligently.

16.3 Care and maintenance

The motor bearings: The motor bearings must be greased at intervals of approximately 500 running hours. Access to the greasing points is facilitated by swinging the melting pot away from the main stand. There are two points of application, one on the main cowling (31), the other on the neck of the



motor mounting flange (32). Each of these two nipples requires three shots from the grease gun at the stated periods.

The Varigear bearings: First, position the melting pot under the main stand and begin by removing the screwed plug (33) from the top of the belt case; then start the motor (with the gear box positioned for the highest speed range) and set the Varigear control regulator to the position which indicates the highest speed on the dial. This will bring the moving flange of the upper pulley towards the fixed flange, and position its shaft lubricator immediately below the lubricating post. Stop the motor, remove the flat machine belt, release the motor base plate and swing away from the machine. Insert the stem of the grease gun through the aperture, locate its nose on the nipple and apply three shots, which will suffice for some 250 running hours.

To assist lubrication and to ensure that grease reaches all the appropriate parts, you should make a point of operating the Varigear through each of the three speed ranges at least once every day.

Varigear gearbox: The gearbox has three plugs: a filler (27), a drain plug (29) and an oil level plug (28). To charge the gearbox, remove the plugs (27) and (28) and pour in oil until overflow is observed at the level plug hole. Before replacing the filler plug, set the Varigear in motion with the speed adjusted to the upper range (at 160 r.p.m.) and inspect to see that oil splash or surge can be observed through the filler plug aperture. If such is not the case, add oil in small quantities until the desired condition is obtained; then replace the plugs.

On a new unit, the oil should be drained off from the plug (29) and renewed after 100 hours of running; thereafter an oil change every 5000 running hours will be adequate. Not that the gearbox can be ignored during the interval: at least once every 100 running hours, remove the filler plug, check that visible oil surge is maintained and make good any minor oil losses. Heavy loss of lubricant is an indication of serious wear in the oil seals, the replacement of which requires the services of an experienced mechanic.

Changing the Varigear belt: It will become necessary to replace the vee belt in due course of time, as some stretching and wear will inevitably occur after constant use over a considerable period, and this will result in belt slip which will be most conspicuous towards the upper end of the speed range: it will be remembered that in this condition, power is transmitted from the major effective diameter of the driving pulley to the smallest diameter of the driven, i.e. where mechanical advantage is minimal. The best method of estimating the extent of belt stretch and of ascertaining the need for replacement is therefore to adjust the gears and the regulator to produce top speed, to run the Varigear under load, and to verify that full power is being transmitted. If such is the case, 1600 r.p.m. will be registered on the dial of the speed indicator. If this value is unattainable it may be taken as a fair indication of the need for belt replacement.

To remove the existing belt, set the gears for the lowest speed range, start the motor and adjust the Varigear control regulator to the lowest speed. Then stop the motor, remove the four screws (30) in the motor mounting flange and withdraw the motor from the transmission case. Take care to support the full weight of the motor during withdrawal in order to avoid distortion of the spindle. The fixed flange of the driving pulley will come away with the motor, and the movable flange will remain positioned in the belt housing, as a result of which the belt will fall to the bottom of its case.

Next remove the eight screws which secure the spring cover and the louvred side cover, both of which must be taken off. This presents two points of access to the lower pulley and, using both, the belt can be manipulated from under the pulley, clear of the spring shaft and cooling fan, and drawn out through the spring cover aperture.

Fitting the new belt is substantially the reverse of the foregoing procedure: feed in one loop of the belt beneath the lower pulley and ease the other upward through the opening. To raise the upper loop to a height more convenient for fitting the motor and the top pulley spindle, give the belt a firm upward pull. This will part the flanges of the lower pulley and provide ample slack at the top. When the motor has been remounted, switch on and operate the Varigear through its full speed range through each of the three gears before replacing the spring cover.

16.4 Recommended lubricating oils and greases

Manufacturer	*Gear oil*	*Grease*
Shell Mex and B.P. Ltd	Vitrea 79	Alvania 3 or RA
Castrol Industrial Ltd	Alpha 817	Spheerol AP3
Alexander Duckham Ltd	Galrex 10	Admax L3
Esso Petroleum Co. Ltd	Teresso 140	Beacon 3
Mobil Oil Co.	600W Super Cyl Oil	Mobilux 3

CHAPTER 17

The cams

In order to provide the cyclic sequence of movements required for the operation of the machine (each movement occurring once each camshaft revolution) six separate motions are required. Each of these motions, accurately controlled in respect of timing, direction, speed and distance, originate from the driving camshaft (13), the rotation of which, through the cams and cam levers, is converted into the necessary linear movement required of the rods and levers concerned in the control of the several parts involved in the production and delivery of the wide range of products the Super caster is designed to produce.

Power from the Varigear is imparted by belt drive to the driving pulley (15). The pulley is keyed to the rear driving shaft of the three-speed gear box, the output from which is duly delivered via the front driving shaft to a constantly meshed gearwheel (25) that drives the camshaft which carries the six cams. The gearwheel that drives the cams is meshed with an intermediate gear, which in turn engages a third gearwheel mounted on the driven camshaft, which results in both camshafts rotating in the same direction – clockwise, as seen from the gearwheel end, at the front of the machine.

The cams on the driving camshaft are numbered from 1 to 6, starting from the front of the machine. The cams and their functions are:

1. Cutter 2. Type carrier 3. Matrix 4. Type pusher 5. Pump 6. Mould blade.

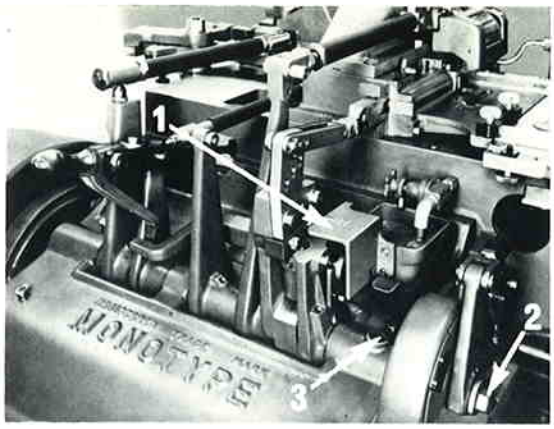
Each of the cams on the driving camshaft is complemented by another cam bearing the same number (in a square recess) mounted on the driven camshaft. Where one cam of each complementary pair is convex in shape, the other is concave; in consequence of which, each of the cam lever rollers (which ride between the cams) receive positive motion both backwards and forwards, in conformity with the degree of movement the cam lever is required to perform.

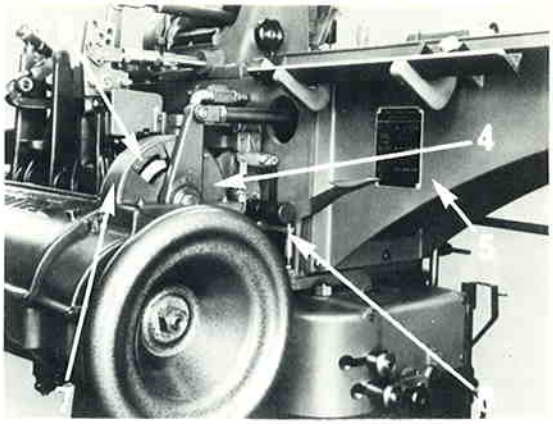
To facilitate checking of the timing of the various machine operations, the circumference of the intermediate (graduated) gear is marked at intervals of 20°; a fixed vernier scale (8) on the gear guard (7) indicating the intervals in degrees. This intermediate graduated gear is also marked with an arrow which indicates the point of mesh with a corresponding mark on the driven camshaft gear (11). Two arrow marks similarly indicate the correct engagement between the intermediate and driving gears.

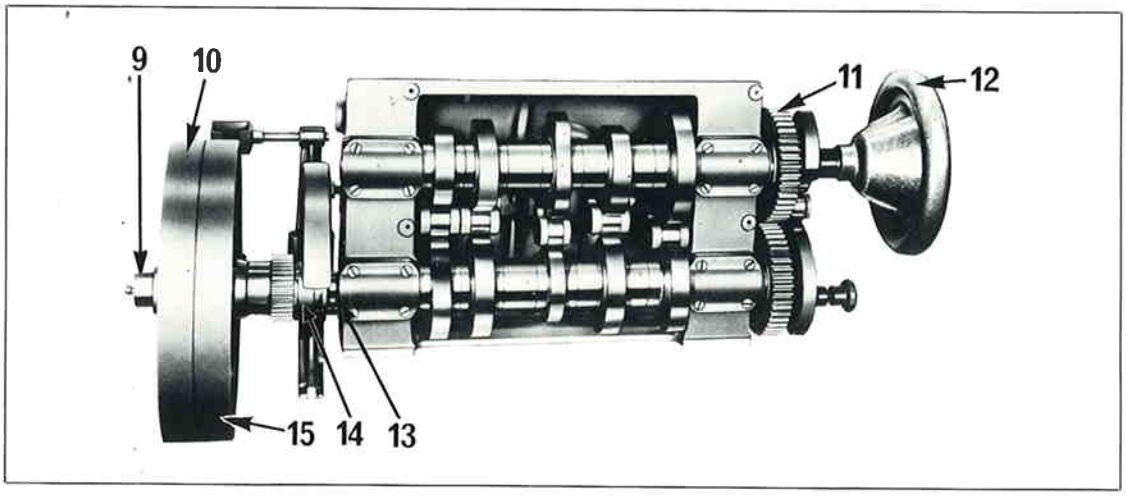
The handwheel (12), carried on an extension of the driven camshaft, in front of the driven camshaft gear wheel, enables the machine to be set by hand to any required position. It must always be rotated anti-clockwise. The handwheel provides a useful means for checking the machine movements in slow motion. It is also vitally important when you require to set the machine in any given 'degree' position, both when setting up for casting and when checking and adjusting the various machine parts.

17.1 Removing the cam levers

Should you ever require to replace one of the cam follower rollers, the complete cam lever must be carefully removed and returned to the nearest Monotype depot. Removal procedure is as follows:







Switch off the electrical power to the motor. Remove the driving camshaft nut (9) and washer. Slide off the loose pulley (10), the driving pulley (15) and the driving pulley clutch (14). Take off the belt shifter ring rod end (24) and allow the belt shifter ring to move down.

Turn the machine to 360°. Remove the two type carrier cam lever guard screws and take off the type carrier cam lever guard (1). Remove the two bracket screws from the belt shifter ring rod latch (6), and the bracket screw (23), (which is also the trip fulcrum) and take off the automatic stop mechanism complete.

Disconnect all cam lever connections, dealing with the pump cam lever (21) as follows; loosen the pump driving rod yoke lock nut (18) and the link lock nut (20) located at either end of the rod; disconnect the counter actuating rod eye (19), unscrew the pump driving rod and remove it.

Turn the machine to approximately 100°. Remove the front gear guard cover plate (4) by releasing the three screws. Release the two screws and remove the front gear guard (7).

Finally, remove the hexagon-headed cam lever shaft screw (2), together with the washer; then release the cam lever shaft retaining screw (3) and the cam lever shaft can be removed (to the rear); the cutter cam being removed first, and the others in sequence.

17.2 Removing the camshaft stand and camshafts

First turn off the water supply at the main valve.

Disconnect the water pipe drain and supply assemblies.

Remove the two water service bracket screws and the water service bracket. Take the oil trough from the base column by releasing the two screws.

Now remove the oil pan (26) by loosening the two long screws and the two short screws which pass through to the camshaft stand. Take out the two screws and remove the rear driving shaft sliding gear guard situated at the front of the driving pulley.

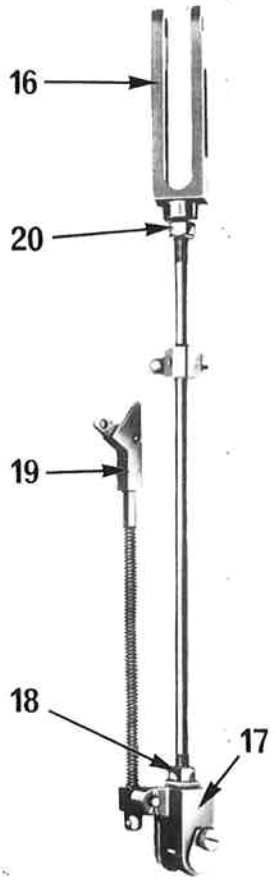
Remove the two long camshaft stand screws from inside the main stand. You now need someone to assist you whilst you take out the three short camshaft stand screws from the camshaft stand. The camshaft stand can now be lifted off, whilst taking care that adjacent parts are not damaged.

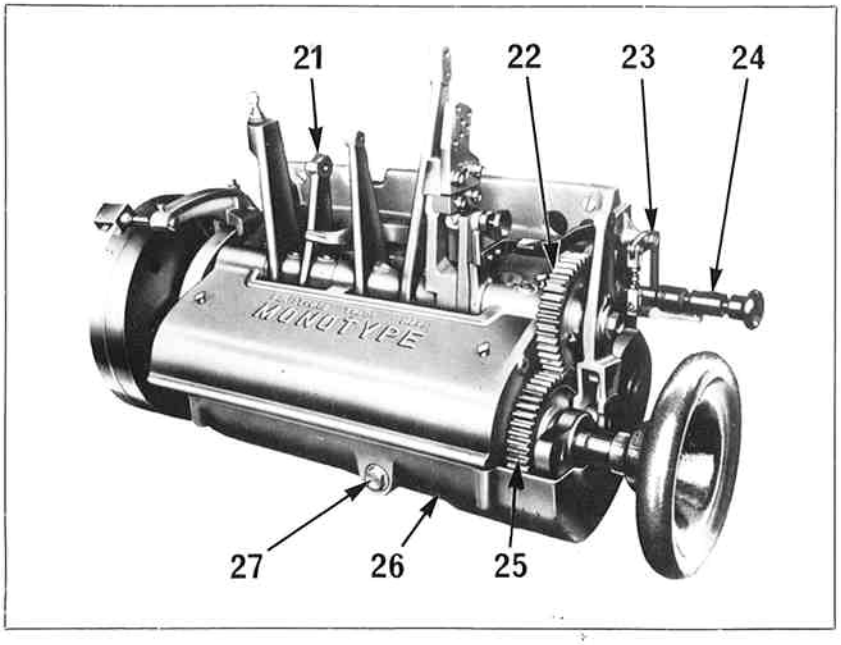
The camshafts can now be removed. Take off the camshaft stand caps, and the shafts complete with the cams can be carefully lifted out.

17.3 Removing the galley bracket

Remove the two matrix box tray screws and the hexagon screw which secures the tray to the galley bracket (5); and take the matrix box tray off the galley plate. Now remove the length gauge by releasing the two screws which secure it to the galley; then release the lead stacker connecting rod eye lock nuts and unscrew the connecting rod. Loosen the air pipe union and take off the air pipe.

Finally, remove the galley bracket screws which secure the bracket to the main stand, and the screw which also serves as a support for the air nozzle holder. You will need assistance on doing this, as, on the withdrawal of the screws, the galley bracket can be removed complete.





17.4 Removing the pump bracket

Take off the ingot feeder attachment.

Remove the pump body and piston from the metal pot. Turn off the power at the main switch and empty the metal from the pot as quickly as possible (the heater elements in the pot should not be exposed whilst the power is on).

Remove the mains leads from the connecting box.

Disconnect the pump driving rod yoke (17), by removing the driving rod yoke pin screw and withdrawing the pump driving rod yoke pin.

Wind the metal pot down and remove the swing frame post screws.

Now wind the metal pot up into position again and, with someone to assist you, remove the hexagon screw, whereupon the pump bracket can be lifted off the main stand.

17.5 Removing the main stand and speed bracket assembly

Remove the main stand inside cover. Take out the main stand locating screw, the two screws fixing the main stand to the speed bracket, and the two screws fixing the main stand to the column. You can now, with assistance, lift off the main stand.

Finally, remove the three screws and remove the gear box assembly complete.

17.6 Assembling the speed bracket and the main stand

First obtain assistance, and place the gear box on the column; then assemble and tighten up the three speed bracket screws.

Now locate the main stand in position on the gear box, replace and secure the main stand locating screw and the two screws which fix the main stand to the speed bracket. Replace and secure the two column screws at either end of the right-hand side of the main stand, and replace the main stand cover.

17.7 Assembling camshaft stand, camshafts and cam levers

Ensure that all bearings and caps are clean. The camshafts can then be lubricated and placed in position in the camshaft stand.

Assemble all the caps and screws, whilst making sure that the caps are assembled correctly as indicated by the numbers stamped upon them.

Obtain assistance again, place the assembly into position on the main stand, and secure with the three short camshaft stand screws. Replace the two long camshaft stand screws inside the main stand. Replace the cam lever shaft gear (22) and the cutter cam lever, whilst making certain that the zero marks on the gears coincide. Slide in the cam lever shaft to temporarily engage the cutter cam lever and the gear; then turn the machine to approximately 100° and replace the other cam levers in the following order;

a) The matrix cam lever.

b) The type carrier cam lever.

c) The type pusher cam lever.

d) The pump cam lever.

e) The mould blade cam lever.

Locate the cam lever shaft finally in position and fix with the cam lever retaining screw (3). Then replace and secure the hexagon screw (2) and washer.

Replace the oil trough and secure with the two screws.

Replace the water service bracket and secure with the two water service bracket screws. Couple up the water pipe drain assembly and the water pipe supply assembly.

Now turn the machine to approximately 350° and replace first the front gear guard (7), securing with the two screws, and then the gear guard cover plate (4), using the three screws.

Replace the automatic stop mechanism and secure the two bracket screws and the trip fulcrum bracket screw (23). The oil pan (26) must now be replaced, using the two long screws and the two short screws which secure it to the camshaft stand.

Assemble the type carrier cam lever guard (1) and, finally, replace the starting handle, the clutch (14), the driving pulley (15) and the loose pulley (10); then tighten with the large hexagon nut (9) and washer.

17.8 Assembling the pump bracket

Assemble the pump driving rod into the yoke (17) (left-hand thread) and the link (16), attached to the pump cam lever (21), then couple the actuating rod to the actuating rod housing, using the actuating rod eye pin.

With assistance, replace the pump bracket and melting pot on to the edge of the column, and fix with the swing frame post screws and the hexagon screw.

Connect up the pump driving rod yoke (17) inserting the pump driving rod yoke pin into the upper hole of the bell crank, and secure with the knurled yoke pin screw. Complete the assembly by attaching the mains leads to the connecting box, replacing the ingot feeder and the pump body and piston.

17.9 Assembling the galley bracket

Place the galley bracket (5) on the main stand and secure with the two galley bracket screws, and the screw which supports the air nozzle holder.

Screw in the lead stacker connecting rod, securing with the lock nuts.

Replace the length gauge, connect the air pipe union and replace the matrix box tray, together with the two screws and also the hexagon screw which secures it to the galley bracket.

Finally, connect the cutter actuating block link yoke to the cutter cam lever with the link yoke pin.

17.10 Lubrication of the cams and gears

The oil pan (26) is designed to provide a constant supply of oil to the cams and cam rollers, the camshaft gears and the speed regulating gears, and to prevent oil overflow.

There are two oil pan compartments. The larger one, which is for the cams and rollers, has a series of sub-compartments and an oil scraper; the smaller one is for the camshaft gears.

The cams and cam lever rollers are splash lubricated, oil being picked up by the driven cams from the sump in the larger compartment.

The camshaft gears are lubricated by oil transferred from the back gear clutch gear to the camshaft gear. An oil scraper is fitted, and excess oil is thrown off into the smaller compartment of the oil pan and led by means of a channel, to the trough, and thence to the sump located in the column.

The column is also divided into two compartments, the larger for the main speed regulating gears, and the smaller for the back gears, the clutch gear and the back gear clutch pinion. These two compartments are connected by a small hole which regulates a supply of oil to the camshaft gears, by means of the clutch gear.

17.11 Oiling the cams and cam lever rollers

Pour 1 quart of gear oil through the aperture marked 'cams'. Allow about 30 minutes for the oil to spread evenly over the oil pan, then remove the oil level plug (27) and ensure that the oil will flow from the plug hole. Frequent checks should be made to ensure that this level is maintained.

17.12 Oiling the camshaft gears and speed regulating gears

Fill the sump through the aperture marked 'gears' until oil reaches the bottom of the countersink in the oil level gauge on the rear of the column. Replace the camshaft stand oil hole cover.

Make a weekly check to ensure the oil is maintained at the correct level in the oil level gauge and, if necessary, transfer surplus oil from the gauge to the oil pan.

17.13 Recommended lubricating oils

Manufacturer	*Oil*
Castrol Industrial Ltd	Cresta SHS
Alexander Duckham Ltd	Q.2280 Oil
Shell Mex and B.P. Ltd	Nassa J.85
Mobil Oil Co.	Extra Hecla Super Cyl Oil (Mineral)
Power Petroleum Ltd	B.P. Energol DC.1200
Gulf Oil (GB) Ltd	Security 205 or Endurance 217
Esso Petroleum Co. Ltd	Cylesso 220