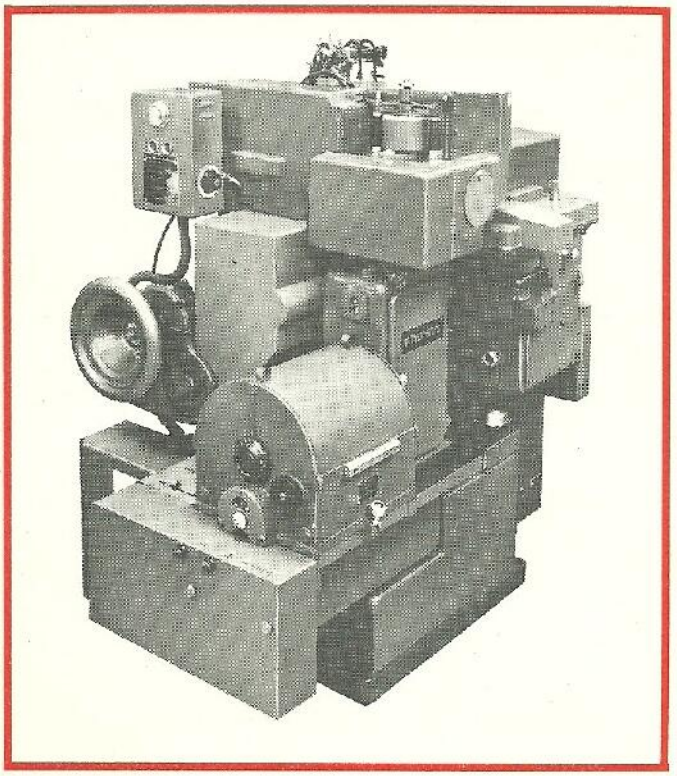
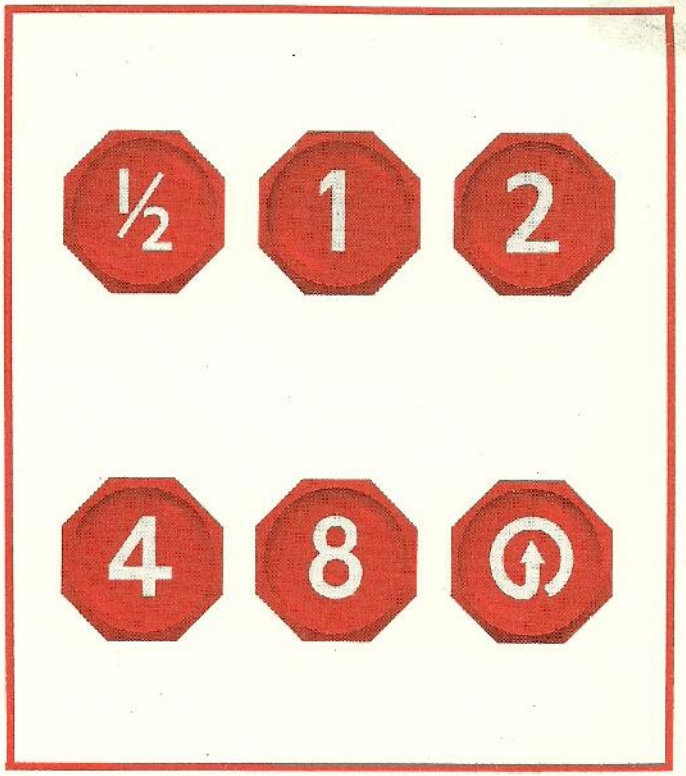
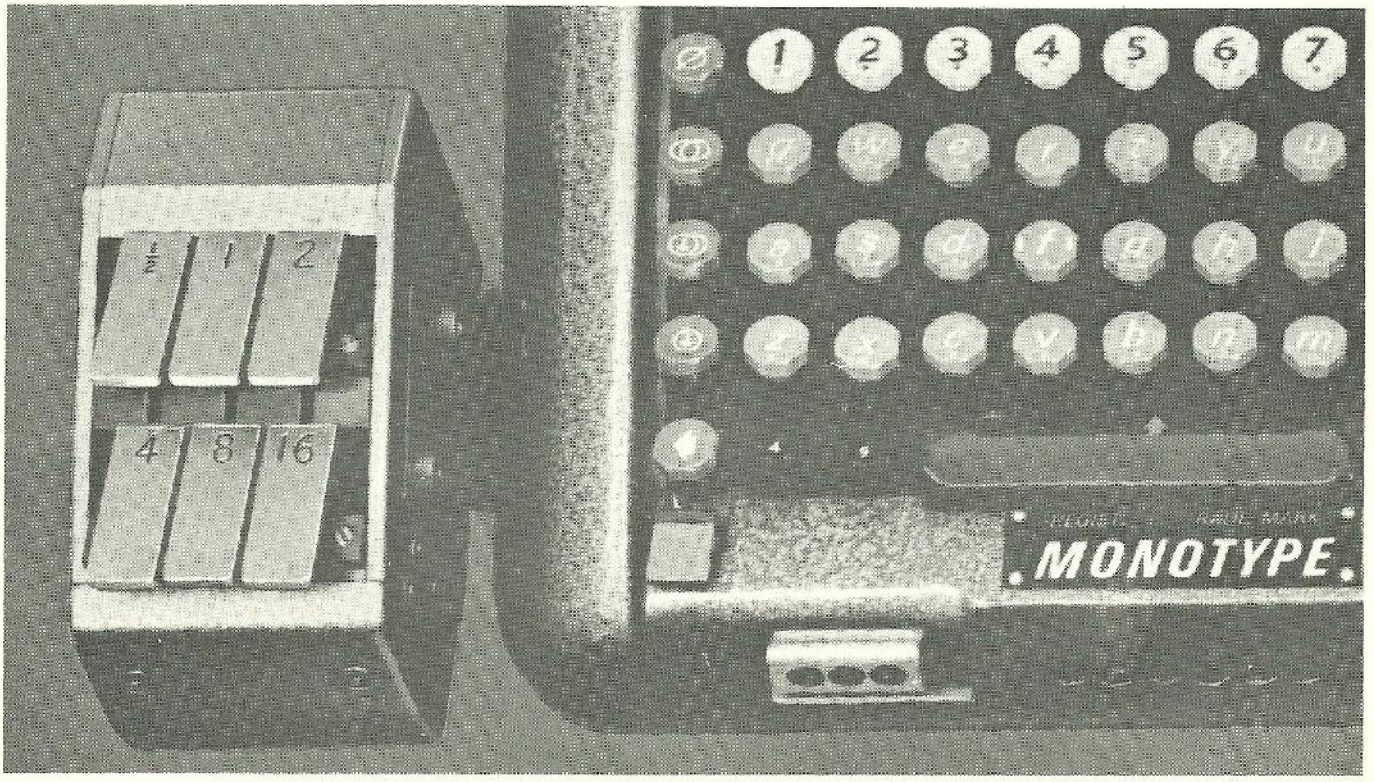
The new Mark 5 'Monophoto' filmsetter



'Monophoto' filmsetter Mark 5



One way of employing the leading keys in the limited method



The comprehensive keyboard arrangement with an auxiliary keybank

The new Mark 5 'Monophoto' filmsetter

Since the first 'Monophoto' filmsetter was introduced in 1955, successive models have greatly increased the machine's versatility and productivity. With the new Mark 5 filmsetter, further important improvements have been made which once again extend the machine's capacity for handling complex work and also increase its flexibility of operation.

The improvements concern the facilities of line-feeds and leading variations, as follows:

1) The range of line-feeds is from $\frac{1}{2}$ to $31\frac{1}{2}$ point in $\frac{1}{2}$-point increments.

2) Selection of line-feeds can be made either at a specially equipped keyboard or (as with earlier models) at the filmsetter.

3) The range of leading variations is from $\frac{1}{2}$ to $31\frac{1}{2}$ point, and these are signalled from the keyboard.

4) All leading variations may be carried out in any part of a line. For example, a variation can be effected of the same value as a line-feed, so that vertical rules may be composed both up and down the page in a similar manner to horizontal rules.

5) The line-feeds and leading variations can be made in either a backward or forward direction. One particular asset of the reverse function is the ability to compose such diverse languages as English and Arabic on the same film drum.

The filmsetter

The whole film drum platform with its mirror carriage has been modified so that the film feeds at the ends of lines, as well as variable leading increments, are produced by one mechanism. This mechanism comprises six air pistons, each applying one movement in the range $\frac{1}{2}$, 1, 2, 4, 8 and 16 points; so that, when selectively signalled, any film feed in the range from $\frac{1}{2}$ to $31\frac{1}{2}$ points in $\frac{1}{2}$-point steps can be obtained. For the purpose of end-of-line feeds, the movements are automatically signalled as part of the justification process, and for leading they are manually signalled at the keyboard. A reverse signal enables the increments to be made in the reverse direction (i.e. subtractive), if required.

Consequent upon these alterations, the opportunity has been taken to redesign components associated with the mirrors, in order to improve the safeguards for excluding dust and to make the cleaning of the mirrors simpler.

The keyboard (limited method)

If control of the line-feeds is not required at the keyboard, no modification to the keyboard is necessary: the filmsetter operative will continue to make manual adjustments on the filmsetter according to written instructions from the keyboard operator.

To utilise the new leading variations, the six existing key-buttons and keybars are replaced, and there is a choice of several different ways of employing them. One is to nominate them as follows: $\frac{1}{2}$, 1, 2, 4 and 8 point, and reverse; by tapping any one key or combination of keys, a maximum of $15\frac{1}{2}$ points movement can be obtained, either backwards or forwards, and this can be added to or subtracted from the pre-selected line-feed. Another way is to nominate the keys for commonly used leadings: e.g. $1\frac{1}{2}$, 2, 3, 4 and 6 point, and reverse. It would also be possible to utilise more than six leading keys in the case of special work such as mathematics or vertical ruling.

In a mixed Mark 4 and Mark 5 installation, compatability is possible on the condition that the operator specifies which machine before he starts.

The keyboard (comprehensive method)

The limited method, described above, is entirely adequate for a wide variety of work. However, in some kinds of work, such as mathematical and textbook setting, it may be necessary to change the line-feed for several lines, as well as the introduction of leading variations. For this purpose an auxiliary keybank can be added to the left of the normal keybank (see illustration). It contains six keys for signalling line-feeds of $\frac{1}{2}$, 1, 2, 4, 8 and 16 points.

In this way, the keyboard operator can establish the line-feed on the filmsetter and yet make frequent changes to it as may be necessary for special work, e.g. quoted passages in books requiring less line spacing than the actual text; mathematics with the text in 12 point and the formulae in multiples of 6 point.

The Monotype Corporation Limited
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MONOTYPE

'Monophoto' Filmsetters

Marks 3, 4 and 5

Operating and Maintenance Instructions

The Monotype Corporation Limited

'Monophoto' Filmsetters Marks 3, 4 and 5

Operating and Maintenance Instructions

Please note that with the exception of the wiring diagram, these proofs contain no illustrations. Any figure references contained in the text should therefore be disregarded.

The Monotype Corporation Limited

Registered Trade Marks: Monotype, Monophoto

SECTION 1

Introduction

01.01.00 General

.01 In this manual, we have tried to assemble all the information that we think the operative of a 'Monophoto' filmsetter Mark 4 is likely to want. While much of the descriptive matter will be found applicable to earlier machines also, the reader should not expect agreement in several of the details.

.02 In many cases, elementary information has been included. To the experienced operative, this may seem 'nursery-talk', but it is possible that the reminder may refresh his memory on some long-forgotten reason or detail. Such items are intended principally for the guidance of the student or novice who may not have fully absorbed the content of the lectures and demonstrations he attended; even if he did, the 'refresher course' afforded by a recapitulation of basic facts and methods should help him on towards a fuller and speedier proficiency.

.03 Previous manuals have been intended for use in conjunction with the volume dealing with 'Monotype' composition casters; however, the latest edition of this is an expensive publication and the greater part of its contents, relating solely to hot-metal working, is therefore inappropriate. This manual you hold deals only with the filmsetter.

.04 The reader may have had no previous experience in working this type of machine. Nevertheless, we anticipate that he will quickly realise that the routine is simple and that the mechanism, despite its numerous sub-units, can be resolved into a series of straightforward and logical motions. Provided he conscientiously attends to the maintenance requirements, steady and gratifying production should continue indefinitely.

.05 Because a 'Monophoto' filmsetter is essentially a mechanised camera, the importance of cleanliness cannot be overstressed. Inferior results are bound to be obtained if the normal intensity of the light is reduced by dust and/or oil film on the lenses or reflecting surfaces; these must be kept immaculate. Routine calls on customers by our Staff reveal the significant fact that continuous trouble-free operation occurs most consistently in those establishments where the filmsetters are maintained in the state of cleanliness normally associated with surgery.

.06 In case some unexpected difficulty should arise, the fault-tracing section (17.00.00) will give a very useful lead. Should unsatisfactory results continue, a representative from one of our Depots (or abroad, from our nearest Agent) will bring expert knowledge to bear on the problem.

.07 ⚠ Where this symbol introduces a paragraph, the information it contains is intended solely for the use of a qualified engineer or electrician, as the work is not considered to be within the scope of an operative who has not had such specialised training. However well intentioned, unpractised hands could easily add to existing difficulties and, on the electrical side in particular, might produce very serious results.

01.02.00 Principles

.01 By the use of 'Monotype' and 'Monophoto' equipment, manuscript or typescript matter is converted into direct- or reverse-reading film or paper positives, for litho, gravure or letterpress working.

.02 Composition can take the form of continuous body matter or display (in sizes from 6 pt to 24 pt), mathematical expressions of the most complex kind and diagrammatic chemical formulae – anything that can be composed in hot metal and many things that can't, as, for example, overlapping characters or extremely narrow spaces.

.03 Two machines, independently operated, are required. The first is a keyboard which is the subject of a separate manual and therefore need not be described in detail here. Keys, similar to those of a typewriter, are tapped to produce, not a legible script, but a punched paper ribbon with 31 tracks in addition to the 2 rows of continuous marginal perforations by which the ribbon is fed through the machine. Combinations of perforations (regarded in a single line across the ribbon) form signals for selecting the characters to be reproduced and for transmitting other controlling instructions to the second machine.

.04 The second machine is a 'Monophoto' filmsetter, the particular model with which this manual deals being the Mark 4. This is powered by an electric motor and controlled by the paper ribbon which is placed in position on the air tower.

.05 It is important to remember constantly (if the operations are to be fully understood) that the paper ribbon passes through the filmsetter *in the reverse order* to that in which it was perforated. That is to say, the last signal tapped will be the first to reach the filmsetter; when the keyboard operator completed the composition of a line, he then tapped the justification signals. These, therefore, will arrive at the filmsetter *before* the signals for the characters and spaces, so causing the correct space-widths to be established and 'in stock' before they are required for use in the line. When the filmsetter has dealt with that line, fresh justification signals will be transmitted in anticipation of the needs of the following line.

.06 Up to 340 characters are available for use at any one time, enabling foreign (accented) letters, floating accents, mathematical signs and a variety of other symbols, in addition to the seven basic alphabets to be selected and used at the rate of 190 per minute, without any manual re-arrangement.

.07 Every character is provided in the form of a negative film contained in a protective open-ended box generally measuring 0·2 in × 0·2 in (5·08 mm × 5·08 mm). These original characters, either direct- or reverse-reading, are of

approximately 8 pt size, and from them optical reductions (to 6 pt) or enlargements (to 24 pt) are made by quick and accurate adjustments at the beginning of a job. To maintain typographic standards, it is advantageous for an 'A' set of matrices to be used for 6 pt and 7 pt working and a 'B' set for 8 pt to 24 pt (see 13.01.02). In addition, provision can be made for some larger characters to reproduce 2-line mathematical or other signs; the casings of these measure 0·4 in × 0·2 in (10·16 mm × 5·08 mm) and one of them can be substituted, in certain cases and to meet special needs, for two of the smaller pattern before the work that needs them is started. All these photographic originals with their protective surrounds are termed film matrices and they are retained as a complete (but manually variable) set in a film matrix case that, as mentioned, holds 340 of the standard size.

.08 For convenient reference, the 31 tracks of the paper-ribbon perforations (see 01.02.03) are designated *1,2,3,4 ... 15* on the right and *A,B,C,D ... N*, plus *Q* and *S*, on the left, reading outwards from the centre which is the position allotted to *Q*. The currents of air they admit bear the same designations (e.g. *C* air, or 5 air) as do also the pistons or air pins that they cause to move. Basically, the columns (lettered) and rows (numbered) of matrices in the matrix case are similarly referenced, though as there are insufficient single letters for requirements (it not being practicable to extend the width of the ribbon) some compound references, such as *BJ*, are introduced. These require an additional perforation each, but that is automatically provided by the keyboard when the key is struck.

.09 The effect of this is that when, for example, perforations *C* and 5 arrive simultaneously at the air tower, they regulate motion that selects the film matrix in column *C* and row 5 of the matrix case, by moving the case so as to bring this matrix into the operative position.

.10 The operative position is where a beam of light will fall on it for approximately one fiftieth of a second. The matrix forms the photographic object of a lens which will bring the beam to sharp focus on a piece of light-sensitive film, where the brief exposure is sufficient to leave a permanent image. This image, however, is invisible (a latent image) until it is chemically developed in the darkroom. After an exposure has been made, automatic movement of a pair of mirrors arranges that the next image shall fall beside the first – not on the same spot – so that a line of character-images is built up. At a later stage, these and further lines of images will be transferred to a plate for printing the text which has been tapped out on the keyboard.

01.03.00 Unit system

.01 Printers using hot-metal material recognise that a piece of type has three dimensions. Of these, the height-to-paper does not concern us, as film is virtually a two-dimensional substance. It has been assumed (01.02.02) that readers are familiar with the point-measurement – height as seen up and down a page. A point is approximately $\frac{1}{72}$ of an inch, or 0·01383 in (0·3513 mm). The corresponding Didot point, used in many countries, is 0·0148 in (0·376 mm).

.02 There remains the width from side to side, and this varies according to the shape of the letter – compare 'i' with 'W'. This also is measured in points, distinguished by being termed 'set points' and usually abbreviated to 'set'.

.03 A 12 pt quad of any given fount is a square if it is 12 points high and 12 set points wide. It is briefly described as '12 pt, 12-set'. A fount of 'condensed' (i.e. narrow) face might be 10 pt, $8\frac{1}{4}$-set. The quad (again, of any size) is, for 'Monotype' or 'Monophoto' machine purposes, assumed to be divisible into 18 units of set. To obtain a measurement of width, it is therefore essential to know the set being considered as well as the number of units; '9 units of set' conveys nothing more than '9 pieces of string' does. But *9 units of 12 set* ('9 pieces of string each 12 ft long') gives a measured width of $\frac{9}{18}$ in × $\frac{12}{72}$ in = $\frac{1}{12}$ in (2·117 mm).

.04 Consequently, all 'Monotype' or 'Monophoto' faces are designed with character widths of specified units; the machines are geared to count these and provide the corresponding accommodation based on the set size of the fount. When finer steps are required, as in justification, provision is made for spaces to be graded in units and fifteenths of units of whatever set-size of fount is being employed.

.05 This spacing in units and fifteenths of those units is known as 'proportional justification' and differs from the principle used in 'Monotype' hot-metal machines and many earlier 'Monophoto' filmsetters, where spacing is in steps of 0·0075 in and 0·0005 in.

01.04.00 Power

.01 Some parts of the mechanism of a 'Monophoto' filmsetter are operated from a pair of camshafts (usually driven by a small electric motor mounted at the left side of the machine), and others by compressed air at 17 lbf/in^2 (1·12 kgf/cm^2)*. A constant supply of this is maintained by a separate electrically driven unit, with piped connections to both keyboard and filmsetter.

.02 In many cases, it will be noted that the power is used for the compression of springs, and the act of releasing them. The 'useful work' is then done by the resistance of the spring to distortion, or by its subsequent reversion to normal size.

The application of spring pressure, in place of 'positive motion' is a safeguard against disaster resulting from an incorrect adjustment or the accidental presence of a 'foreign body' causing an obstruction.

*See 12.04.01 for explanation.

SECTION 2

Installation

02.01.00 Accommodation

.01 A 'Monophoto' filmsetter Mark 4 weighs 15 cwt 1 lb (764 kg) and occupies a projected floor area of 3ft 9in × 3ft 0in (115 cm × 92 cm). It should have a minimum working area of 9ft × 9ft (275 cm × 275 cm) to enable adjustments and cleaning to be carried out efficiently.

.02 The room in which the filmsetter stands should not be used for other purposes, as the creation and/or disturbance of dust can be very damaging to the product; it is particularly undesirable that the room should be used as a means of access to any other part of the building. In non-temperate climates, the room should be air-conditioned, but, where this does not apply, a dust-cover should be put on the machine when it is idle. Cleaning of the room should be done with a suction machine rather than by sweeping. *Unauthorised handling of the machine or any part of its equipment should be prevented at all times.*

.03 Preferably, the filmsetter room should be conveniently close to the keyboarding room and the photographic dark room to maintain liaison of personnel, and so that a fresh film can be readily substituted for the exposed one on the drum which is detachable for this purpose.

.04 Provision should be made (drawers, cupboards and a bench with a vice which may be occasionally necessary) for housing the filmsetter's equipment, including tools and cleaning material, and spare parts, and for such work as the changing of individual matrices. In the planning of these, dust-exclusion should have high priority. The services of a technical representative are available in most countries to advise on the layout of plant to obtain the most effective use of space.

.05 The equipment supplied with the machine includes:

Two film drums (point or Didot as required).

Optical test rig and sighting lens (in case).

Focusing bars (in case) (point or Didot as required), most conveniently kept on an inclined wall-shelf opposite the gearbox and 12 in (300 mm) from the floor.

Set-change gears in box (as per specification), most conveniently attached to a wall at the rear of the machine, opposite the belt-guard.

Film matrix case in box (as per specification).

Unit selectors (as per specification).

Unit selector assembly stand (initial installation only).

Complete kit of tools.

Dust cover.

02.02.00 Services

.01 Moisture free compressed air at 17 lbf/in^2 (1·20 kgf/cm^2) is required. It is strongly recommended that a tapping be taken from the high-pressure supply pipe to feed a flexible hose with a controlled nozzle near the bench for air-drying machine components after cleaning. Note that the machine is fitted with a combined air-filter and oil mist lubrication system which requires only periodic replenishment and cleaning after having been connected to the main air-supply (12.10.01).

.02 The electric mains should provide an AC supply of 1·4 kVA. The machine circuits are wired to suit the requirements of the local supply which must be quoted by the customer – for details, see 14.05.01.

.03 As heat is not involved in filmsetting, this machine does not require cooling water nor drain, but see also 02.03.03.

02.03.00 Air compressor unit

.01 More fully detailed in 12.01.00, air compressors are supplied in four sizes, according to the requirements of the establishment. Their brief particulars are:

Model	*Keyboard & filmsetters*	*Power*	*Speed r.p.m.*	*Weight*	*Lenght*	*Width*	*Height*
HP12	10 machines	3 H.P.	300	7¼ cwt (369 kg)	6′ 2″ (1880 mm)	2′ 6″ (762 mm)	4′ 0″ (1220 mm)
HP22	18 machines	5 H.P.	265	8¼ cwt (420 kg)	6′ 2″ (1880 mm)	2′ 6″ (762 mm)	4′ 2″ (1270 mm)
HP33	28 machines	10 H.P.	300	14¼ cwt (724 kg)	7′ 4″ (2236 mm)	3′ 0″ (916 mm)	5′ 0″ (1524 mm)
HP44	36 machines	10 H.P.	365	14¼ cwt (724 kg)	7′ 4″ (2236 mm)	3′ 0″ (916 mm)	5′ 0″ (1524 mm)

.02 The compressor can be placed in any convenient location, preferably where the sound of its operation will not be disturbing. It should be bolted to the floor so that the right hand end (as seen from the side opposite to the driving side) is at least one inch (25 mm) lower than the left-hand end; the difference in heights of the supports assumes a level floor. Adequate ventilation must be available to dissipate the heat resulting from the air compression.

.03 Because cooling is an essential feature of the air-drying process, a controlled water-supply must be fed (conveniently, through plastic tubing) to the right hand end of the heat-exchanger, and the warm out-flow from its left hand

end must be led to a drain. The effluents of condensate and oil/water mixture from the drain cock (driven out under pressure) can be collected in independent containers or they, too, should be led to a drain.

.04 If the air surrounding the compressor is polluted by dust or anti-set-off sprays etc., the air-induction must be taken from the purest possible source – e.g. by plastic tubing from outside the building. This will also help to reduce noise. An efficient silencer is fitted to the discharge from the unloader valve, but sound can be still further reduced by carrying the pipe-line through to the open air.

02.04.00 Preliminaries

.01 Before any attempt is made to start a new filmsetter on regular production, a set procedure should be followed for the adjustment of the machine to suit the conditions and standards of quality that efficient operation requires. Operatives should therefore see that all the conditions described under the headings 'Light output control' (08.03.00), 'Calibration' (08.04.00) and, if appropriate, 'Standardising several machines' (08.03.00 to 08.05.00), are fulfilled.

SECTION 3

Operational procedure

03.01.00 Essential data

.01 When the paper ribbon comes from the keyboarding section, it will carry the data which are necessary for setting-up the filmsetter. Such information may well be written on an adhesive label similar in form to the one illustrated.

.02 The keyboard operator will have knowledge of the actual number of lines tapped and this, together with the feed, will indicate the length of film required, and the measure will indicate its width. One inch (25 mm) of clear space should be allowed in each of the two directions. In addition, the Production Manager will probably have inserted other required particulars.

03.02.00 Loading film or paper

.01 Except where otherwise stated, 'film' is understood to refer equally to a paper original.

.02 All operations involving the handling of the film prior to development must be undertaken in subdued safe-light in the darkroom (refer to the film-manufacturer's instructions).

.03 To prepare a length of film (see also 15.01.00) for mounting on the film drum, cut it to the length and width required, and prepare two strips of one-inch-wide (25 mm) adhesive tape about one inch (25 mm) shorter than the width of the film to be used. Lay the film on the bench, emulsion side up if a reverse-reading product is required, and so apply one strip of tape that half its width adheres to one end of the film, but it must allow a clearance of about $\frac{5}{8}$ inch (15 mm) from one side to avoid contact with the locating pin (03.02.05) when placed on the film drum. Similarly apply the other strip to the other end but here there will be no pin to be avoided.

.04 Remove the film drum housing cover by pressing inwards the two spring clips and lifting the cover upwards, using the spring clips as handles. This exposes the top half of the film drum which presents about 15 inches (380 mm) of its circumference.

.05 The film is located lengthwise against the lip of the gear end of the drum; the end location of the film is approximately one inch (25 mm) from the air-gap shutter, the end of the film lying on the scribed line and abutting against the front of the pin. Note that, with the drum controls towards the operative, film for direct-reading is laid to the right of the air-gap shutter, and film for reverse-reading to the left. Different drums are obtainable, according to the end-product required.

.06 For a reverse-reading product, lay the film, its emulsion side uppermost, on the drum, positioned as above, and press one adhesive tape on to the drum.

.07 Using the main-scale control wheel, turn the drum (counter-clockwise for direct-reading, or clockwise for reverse-reading) and proceed to lay the film round the drum circumference, away from the air gap shutter, ensuring that throughout its entire length the edge of the film is constantly in contact with the locating lip of the drum. Attach the other end of the film by means of the second tape, and check that the film is perfectly smooth round the drum and that both the tapes are secure.

.08 For a direct-reading product, follow the above procedure, except that the emulsion side of the film, which, for ease of subsequent operations, should be of the thin-base type (about 0·0025 in or 0·06 mm thick) has to be downwards. The images will then be shot through the film and its anti halation backing, which will absorb a certain amount of light; the loss can be made good either by opening the iris diaphragm (03.06.05) about two stops above the specified setting, or by raising the setting of the variable resistor control knob on the right-hand side of the upper control panel box.

.09 When the cover has been replaced and secured by the spring clips, its side fitting properly into the light-excluding slots, the drum is rotated to the 'Shutter' (closed) position and the assembly is then ready for mounting on the machine (03.03.01).

.10 Next, see if the spool label has any instruction regarding signalled extra line-feed, as this must be arranged before the film box is put on the machine. If this addition is needed, refer to 11.07.01.

03.03.00 Fitting film drum housing

.01 Before mounting the film drum housing on the machine, it is essential to check that the feed-and-lock rack is in its lower position, i.e. as when the film drum housing is removed. Then turn the dust cover to lie flat on the mirror bracket housing, exposing the slot. Lower the film drum housing into position, when its four feet will give approximate positioning; the dowels provide accurate location. When the housing is correctly seated, swing the spring-loaded retaining knobs into position.

.02 Rotate the film drum from the 'Shutter' (closed) to the film-start position (on the main and point scales), bring the feed-and-lock rack into position by raising its locking nut from the lower to the upper location; secure it by turning clockwise until the rack is held in engagement with the film-drum gear wheel (see 11.06.04). The zeros on both scales should now be finally checked; if correct, the drum is ready for use.

.03 It is possible to re-position accurately the film drum, and therefore the film throughout its entire length. For special

work, such as column, paging etc., the drum may be re positioned to any predetermined setting by stopping the machine after the justification period, releasing the feed-and-lock rack, manually rotating the drum to the required position (indicated by means of the joint readings of the main and point scales), and restoring the feed-and-lock rack.

Note: When re-starting, make allowance for the drum-feed during justification

.04 For further details of the film drum housing and drum, see 11.09.00.

03.04.00 Fitting matrix case

.01 Select the matrix case with the Matrix Negative Arrangement (MNA) specified on the spool label, and examine the film matrices to make sure that no dirt – i.e. dust or oil – is liable to interfere with the free passage of light. Never neglect a check on the tightness of the cover screws when ever fitting the case. For full details of the care and handling of film matrices, see Section 13.00.00.

.02 Ensure that there is a thin film of grease on the working surfaces of the matrix case – the supporting flanges, the guiding tenons and the hook. On a long run, this lubricant must be renewed daily.

.03 (To facilitate the identification of parts, references are given in this paragraph to the illustrations in Section 07.00.00.) To place the matrix case in position, first turn the camshafts to between 100° and 180° so that the bridge lever (15) is in its uppermost position; then take out its pin (16). Pull the fibre stop (25) forward to allow the bridge lever to reach its maximum height, so that the hook of the matrix case (27) will be able to ride over the front of the cross slide. Holding the matrix case so that its grooves and the hook of its tail are downwards, slide the hook into the groove in the lower face of the sliding frame (10) and push it right back so that the hook contacts the rear of the cross slide. To engage the hook with the cross slide, depress the bridge lever and replace its pin. Check that the matrix case is correctly held, by lifting its front with a forefinger and trying to draw it forward; it should remain firmly held by the cross slide.

03.05.00 Film drum feed

.01 A label-instruction reading 'SIZE/FEED 10/12' indicates that although the size of the character is to be 10 pt, a 12 pt line-feed is required, giving the effect of 2 pt leading. It is therefore necessary to arrange that before a new line is started, the film drum must be turned so that the film on its periphery is moved by 12 points. The mechanism for effecting this is described in 11.00.00.

.02 The operative is, at the moment, only concerned with achieving the scheduled results. At the front of the machine is the stroke adjustment knob (9). Pull this outwards and turn it till the arrow points downwards. The knob can now be slightly lowered and moved along till the required point-size is indicated on the line feed scale, which is graduated in half-points. Now raise the knob and simply turn it so that the arrow points upwards.

.03 If the text requires extra interlinear spacing (the equivalent of leading) at irregular intervals, as, for example, between paragraphs, this can be automatically provided by a signal (see 12.19.02-3) tapped by the keyboard operator. The additional amount will be in steps of 1 pt either from $\frac{1}{2}$ pt to $5\frac{1}{2}$ pt or from 1 pt to 6 pt; which of the alternative ranges is required must be stated on the label. To obtain the desired effect, remove the film drum housing and lower the control box plunger (to avoid damaging it) by creating a *D* signal at the air tower (05.02.02); then use a suitable screwdriver to turn the eccentric setting button (see 8) through 180° to show the $\frac{1}{2}$ pt or 1 pt range as required; this button is visible through an aperture in the front cover of the mirror bracket housing. The knurled stroke-setting knob must register the same figure; immediately after, and before running the machine, press the knob to the rear and turn it also through 180°; see that it springs forward again into its locked position after the adjustment is made. Full details of the mechanism concerned are given in 11.07.00 where the button at (8) and eccentric pin carrying the knob (4) are clearly shown.

03.06.00 Setting the optical system

.01 It is essential that there should be no accidental loss of light before the beam reaches the film. Care should therefore be taken, before a job is started, to ensure that the lamp (Section 08.00.00), as well as the condenser lens, optical flat, prism-faces, projection lens and travelling mirrors (Section 09.02.02–09.16.06) are all in perfect working condition. Make a regular practice of testing the light-intensity (08.04.07–11 and 08.04.16) twice every day to detect any reduction before it is sufficient to cause a defect.

.02 For reverse-reading work on machines numbered up to and including 91083 (except numbers 91061 and 91062), the screw (1) in the shutter housing cover must be in the position shown, and the change-over block (5) must display the letter R on its outer face. For direct-reading work, insert the screw in the alternative position, further to the right, and turn the change-over block (after withdrawing its spring-clip retainer) through 180° so that the letter D is visible. In the case of machines numbered 91061, 91062, 91084 and upwards, shutter housing covers of different designs are incorporated for reverse- and direct-reading work respectively.

.03 Assuming that the face-size of the next job is different from that of the last, it will be necessary to change the focusing bars. Open the prism box and turn the handgrip nut for the right-hand prism clockwise; this raises the prism, allowing its focusing bar to be lifted out. Remove the focusing bar of the left-hand prism in the same way, except that the nut is turned counter-clockwise. Turning the lens handgrip nut also counter-clockwise releases the third focusing bar. Each is clearly lettered and has its own place of safety in the box provided. See also 09.09.03.

.04 For 6–12pt working (6–11D), the lens must be in its left-hand position and for 14–24pt (12–24D), in its right-hand position. To effect a change-over, move the left prism fully up and the right prism fully down; then, with the lens in approximately the middle of its rack, the spring-loaded plunger in the lever above the prism box may be pulled out and the lens swung over to the new position, without fouling either prism. Check that the plunger is safely re seated. From the set of focusing bars, select those required for the new job and place each carefully in its appointed position, with its adjustment at the top, and the wider face towards the vertical slide. Make sure that the spigot at the foot is fully 'home' in its socket, and when the lens or a prism is resting on top of it, that the adjoining faces are making clean metal-to-metal contact.

.05 Refer to the table inside the prism box door, noting the settings needed by the iris diaphragm and the mirror bar stop. The knurled ring on the lens can be turned to regulate the diaphragm and, as soon as this is done, the door should be closed to exclude dust. For further information, see 09.10.02.

03.07.00 Mirror bar stop

.01 Set the mirror bar micrometer stop according to the code figure obtained from the table in the prism box door (see 03.06.05 above). Each of the 50 milled notches on the disc represents ·02in; each complete revolution is therefore 1·00in, which is indicated by the exposure of a white ring (there are two of these) on the spindle carrying the disc. See also 10.18.06, or, for multi column work, 10.18.07.

03.08.00 Optical flat

.01 Adjustment of the optical flat, so that the low-alignment signal gives the required amount of displacement, is effected by slackening the lock screw and turning the control ring; this is marked off in 60 divisions, with a scale to indicate up to 6 revolutions. The required position is read from the table inside the prism box door. For example, in the case of 10pt setting, to obtain a displacement of 6pt (i.e. 60%), turn the ring to give a reading of 3 on the vertical scale and 34 on the ring itself, but the figures will vary from machine to machine. Retighten the lock screw.

.02 This adjustment should not be made at an earlier stage so as to avoid the risk of oily fingers leaving traces on parts that should be dry and clean.

03.09.00 Set gears

.01 At the rear of the machine, open the door of the set gear housing and slacken off the two handgrip nuts. Swing the intermediate gear out of mesh with both the set gear and the reversible double gear, so that the correct set gear can be substituted, and the double gear re-positioned if necessary; the 48-tooth periphery is required for 13¼ set and over, and the 64-tooth for smaller sizes. Each of the gears slides on its keyed shaft and is retained by a boss on the door when it is closed.

.02 Press the intermediate gear fully into mesh with both of the others and tighten the handgrip nuts. Finally, check that the intermediate gear is still fully engaged and shut the door firmly. When set gears of over 27 set are used, smaller nuts (provided) must be employed.

03.10.00 Unit selector assembly

.01 It is usual for a unit selector assembly to be available, complete, to match every Matrix Negative Arrangement, but should it be necessary to build one up to meet special requirements, refer to 03.18.00. Before starting a job, check that the correct assembly is in position; verify the unit-allocation with that of the MNA. It may be convenient to paint reference numbers on permanent assemblies.

.02 To remove a unit selector assembly already in the working position, turn the camshafts to 120°–140° so that the bridge lever is at the top of its stroke; this position must be retained until after the change-over operation is complete, or damage will result. Open the access door to the gearbox, and hold the selector assembly with the left hand. With the right, press in the spring catch at the top of the unit selector shaft (above the gearbox) and lift the shaft till the key is clear of the keyway. Turn the shaft slightly, and it will remain raised. Withdraw the selector assembly from the yoke, pulling it towards you and to your right. Place it in a tin box or other convenient receptacle to keep it clean.

.03 Insertion of the new assembly, provided that it is perfectly clean, is a reversal of the foregoing. After the shaft has entered the assembly, this must be turned as required to register the key in its keyway, but do not slide the shaft up and down, as this action might damage the key. Press the shaft fully home so that its securing catch retains it, and close the access door.

.04 As the unit selector is plentifully lubricated, the operative

should 'clean up' after this procedure, to ensure that oily fingers do not lower the normal high standard of cleanliness applicable to the machine and its accessories. He should also wipe the displaced selector assembly carefully before it is stored.

03.11.00 Fitting paper ribbon (If necessary, parts may be identified in the illustrations to 05.01.01 and 05.09.01.)

.01 When a machine has been standing unused for several hours, there is a chance that an air pin may rise sluggishly. Before starting work, therefore, it is necessary to know that no such mishap will occur. Press the air bar on to the crossgirt (see 05.02.01) without any paper ribbon inserted; all the air pins will immediately rise. Any pin that does not fall again when the air pressure is withdrawn by the air bar being released should be once more supported by air pressure; then rotate it a few times with an Allen key inserted into the socket provided for the purpose in the head of each pin.

.02 As the operative will be standing at the rear of the machine, the words 'right', 'left', 'clockwise' etc are used here in the sense of 'as seen by him', and not in the usual sense of 'as seen from the front of the machine'.

.03 Place the roll of paper in the recess in the machine cover half-way up the left-hand side of the air tower, so that, when an end is drawn upwards, it unwinds in a clockwise direction. With the connecting rod hook disengaged, swing the air bar lever counter-clockwise, leaving a clear path over the crossgirt. While the fingers of one hand hold the paper clear of the paper-feed pins so that they cannot tear it, pass a convenient length over the crossgirt down to the winding spool. Position the first signal (usually *GII*) on the crossgirt apertures and return the air bar lever to its normal position, thus restraining the paper.

.04 The winding spool rotates counter-clockwise; fold the end of the paper round the flange spring of the spool and spin this gently to take up the slack. When the hook has been re-engaged, and the paper feed locking lever has been raised to its uppermost position, the air tower is ready to start work.

.05 At the end of a run, withdraw, and twist through 90°, the button at the side of the spool-supporting arm. This will release both ends of the spool which should be replaced after the coil of paper has been slid off.

03.12.00 Starting the machine

.01 Make a final check (see 03.15.01) that all the fittings and adjustments appropriate to the job have been dealt with correctly.

.02 Rotate the film drum from the 'shutter closed' to the film-start position (0 on the main and point scales), bring the feed-and-lock rack (11.07.02) into operation by raising its locking nut from the lower to the upper location, and secure the nut in this position (11.06.04). The zeros on both scales should now be finally checked; if correct, the drum is ready for use. Make certain that it is direct- or reverse reading, as required.

.03 Verify that the paper feed locking lever is up, the air bar hook is connected and that the quadder control plates are not responsible for holding the paper locking pawl engaged with the pin wheel ratchet (05.06.02). Check that the air cock is on.

.04 See that the isolator switch (mounted independently of the machine) and the constant-voltage transformer switch (in the upper right-hand corner of the control panel below the handwheel) are ON. This will be shown by the red light on the control panel above the handwheel, which also indicates that the machine circuits are in good order. Turn the rotatable control switch on this panel to OFF.

.05 Press the START (green) button, and, while holding it depressed, give the handwheel a flick to help the motor overcome the initial inertia of the machine. Watch the knob of the line-feed mechanism; as soon as this moves, turn the control switch smartly to CLUTCH & LAMP. Release the start button and filmsetting will continue.

03.13.00 Restarting

.01 If the machine has come to an emergency stop due to over-load, turn the hand wheel one revolution, press the STOP & RESET button on the lower control panel and repeat the motions detailed in 03.12.04.

.02 If the preceding action fails to restore normal running, investigate the cause of the overloading.

.03 Other incidental stoppages may be due to failure of current (general or local), lamp break-down or mirror bar over-run. Turn the camshafts at once to the 'free' position (120°–140°), disconnect the air bar connecting hook and turn down the paper feed locking lever. Operating the film feed by hand, turn the drum so as to clear the partly exposed line. Then rewind the paper ribbon until the preceding line end signal has been passed; restore the connecting hook and locking lever, and, as soon as the cause of the trouble has been put right, the starting routine of 03.12.05 may be repeated.

03.14.00 Stopping

.01 The machine may be stopped at any moment by pressing the STOP (red) button. The use of this should be followed by the restarting routine detailed in 03.13.03.

.02 Stopping is normally effected by a signal (*GHN*). Because the paper travels through the machine in the reverse order to that in which it was perforated, this is the first one to be tapped by the keyboard operator. He follows it with a line kill (*BC*) and three film-feed signals, the latter ensuring that there is clean film adjacent to the copy. The *GHN* signal causes a piston to operate an electric switch that cuts off the electrical power. When this has occurred, turn the camshafts to the 'free' position (bridge lever fully up), disengage the air bar connecting hook and engage the paper feed locking lever.

.03 Before attempting to remove the film drum housing, release the knob of the feed-and-lock rack so that this is unmeshed from the driving gear wheel (see illustration to 03.05.02). Be sure to turn the shutter to CLOSED, or the film will be spoilt. Unclip the film box from the machine and, as soon as it has been lifted off, close the dust flap above the travelling mirrors. If possible, the film should be processed at once, to ensure that the result is satisfactory, so that errors are not repeated unnecessarily.

03.15.00 Re-cap

.01 The full routine for operation, with stress on the details of starting and stopping, has been set down with explanations; consequently, it appears lengthy and complicated. It is like giving instructions, without gestures, on how to tie a shoe lace – easy and quick to do, when once the procedure has been mastered. We therefore list briefly the sequence for setting up and operating the filmsetter; these are the recommended rules, though experience may make some alternative order preferable to a thoroughly practised operative.

03.01.00 Read the spool label data.
03.02.00 Load the appropriate film on to the drum.
03.03.00 Fit the film drum housing.
03.04.00 Select and fit the matrix case.
03.05.00 Adjust the line feed.
03.06.00 Set the lens, prisms and iris diaphragm correctly.
03.07.00 Position the mirror bar stop.
03.08.00 Adjust (if necessary) the optical flat.
03.09.00 Select and fit the set gears.
03.10.00 Fit the unit selector that matches the MNA.
03.11.00 Fit the paper to the air tower.
03.12.00 Start.

03.16.00 Removing film drum housing

.01 The feed-and-lock rack of the line-feed mechanism must be disengaged (by freeing its locking wheel and dropping this to its lower location), and the air-gap shutter returned to the SHUTTER (closed) position before any attempt is made to remove the film drum housing.

.02 Release the film drum housing clamps by raising them against their spring pressure and swinging them clear, when the housing can be lifted from the machine by its side ledges; do not use the cover spring-clips for raising it. The dust cover on the mirror box housing must be turned over to protect the mirrors, and the film drum housing transported by its carrying handles to the darkroom for unloading, which is effected by removing the film box cover and carefully stripping the tape and film from the drum.

03.17.00 Rewind

.01 Remember that the free end of the paper ribbon is the part that was tapped first. If there is any likelihood of the text being run again, rewind the ribbon so that it is ready for instant use the next time it is wanted. Check by noting the presence of the large (*C*) perforation in the justification signal; this will precede the text when the paper is correct for fitting to the filmsetter. Re-attach the label.

03.18.00 Building a unit selector assembly

.01 By study of the train of mechanism (10.02.01–03) from the matrix case and unit rack to the selector assembly (disregarding for the moment the question of Unit Shift), it will be seen that the rotation of the selector assembly is directly proportional to the number of the corresponding row in the matrix case (13.01.08). This is not the same thing as the amount of feed transmitted by the vertical movement of the selector assembly (i.e. by the height of the selected lug from the anvil) which is directly proportional to the number of units allocated to the characters in that row; there may be more than one row with the same unit-allocation. There may also be several unit-values (such as 2,3,13,17) which are not required. With these points in mind, the build-up of a selector assembly to suit any MNA is a logical process, but cleanliness is essential; all components must be clean and dry on every face before their assembly is begun.

.02 First, to dismantle the existing assembly. To obtain a firm grip, slide it on to the assembling fixture, the post of which has a key that fits the internal keyway of the splined sleeve. With an Allen key, slacken the three lock screws (10) in the knurled flanged bush nut (1) sufficiently to clear the thread of the splined sleeve. Unscrew the nut (using a C-spanner) and lift off both the washer below it and the flanged bush (3); wipe its underside clean. Slide off all the individual selectors and clean them if necessary.

.03 Note the A stamped on the flange of the splined sleeve; this registers with one of the splines and the internal key-way, and marks the starting position. That is to say, this position will align with the anvil when the matrix case has been located to expose a character in row *1* of the matrix assembly.

.04 See what is the lowest number of units the matrix arrangement will require – this will probably be 1 unit and, in the example shown, it is the allocation (subject to Unit Shift) for row 6. Thread a single-lug selector on to the splined sleeve, with the notch that is aligned with the lug 6 notches to the left of the notch for spline A, counting both the first and the last of these notches. If the lowest allocation of units had been 2, a plain (lugless) selector (12) would have been used as the first, because each rise of 1 layer in the assembly represents an increase of 1 unit.

.05 As there is no allocation of 2, 3 or 4 units in our example, three lugless selectors come next.

.06 The fifth layer (i.e. 5 units) requires a lug to represent the first row; this lug therefore aligns with spline A. The sixth, seventh and eighth layers (which represent 6, 7 and 8 units) respectively (or rows 2, 3 and 4), being a smooth progression of both units and rows, give a continuous spiral of lugs.

.07 Next, it will be noticed that 9-unit characters occupy three rows, the fifth, seventh and sixteenth. This means that three lugs are required at the same height, i.e. on the same selector. There must be a gap of one lug-width between the first two lugs, to give vertical access to the 1-unit selector which was first positioned, and also a gap equal to eight lugs between the second and the third lugs to leave a clear path when other unit values are needed. Selectors with a variety of multiple-lug arrangements are available to meet such cases

.08 The next layer, representing 10 units, is required for rows 8 and 9 – a selector with a double-width lug provides the answer.

.09 As each of the rows *10, 11, 12, 13* and *14* is 1 unit advanced from its predecessor, again a section of continuous spiral appears. Two lugless selectors now represent the absence of 16- and 17 unit allocations. Finally, the top (eighteenth) selector, giving 18 units, is placed with its lug 15 notches (counting both ends) from spline A, representing the fifteenth row.

.10 Row *16*, it will be remembered, has already received its 9 unit lug, and the seventeenth row, controlled entirely by Unit Shift, has the same unit-value as the sixteenth.

.11 The flanged bush, washer and knurled nut can now be replaced, the nut being tightened with the C-spanner. Secure the nut by tightening the three lock screws with the Allen key, after which the selector will be ready for use *but only with the MNA for which it was prepared*. To avoid the labour of re-arrangement which we have detailed, it is preferable that a matched selector should be available for every MNA held by the printer.

03.19.00 Air compressor

.01 For details of starting and stopping the compressor, a separate unit for giving the necessary supply of compressed air, see 12.08.00.

SECTION 4

Primary motions

04.01.00 Definitions

.01 To avoid the possibility of future confusion, it is essential to define the 'cardinal points' of a 'Monophoto' filmsetter.

.02 When the operative stands so that his left hand falls naturally to the handwheel of the machine, he is at the *front*. The control panel is slightly to his left and the mirror bracket housing below his right hand.

.03 Consequently, when he is facing the face adjustment housing, commonly called the prism box, with the mirror bracket housing to his left and the gearbox to his right, he is at the *right-hand side*.

.04 The cover of the set change gear assembly and the driving pulley are at the *rear* of the machine.

.05 The tops of the cam levers, projecting above the camshaft casing, are the conspicuous features of the *left-hand side*.

.06 The expressions *'clockwise'* and *'counter-clockwise'* assume that the components concerned are viewed from the *front* of the filmsetter or from above (as the case may be).

.07 Unless the context clearly indicates otherwise, all references to machine parts and movements are taken as being in accordance with the above definitions.

04.02.00 Camshafts and gears

.01 Lying parallel to each other, at the left-hand side of the machine, are the twin camshafts, of which the inner one is the driver. It receives power for all the mechanical movements from a pulley keyed to its rear end; it is usually belt-driven from an electric motor. Adjoining the pulley is an automatic lock to prevent the shaft being turned clockwise, a motion that would damage the gearbox mechanism. It consists essentially of four spring-loaded rollers lying parallel to the shaft axis in the peripheral recesses of a locking plate secured to the front face of the pulley; if there is any tendency to reversed rotation, they will resist it by binding against the inner face of the housing which is attached to the rear camshaft bearing. Supported by two plain bearings, the shaft carries eight cams and a gearwheel. The shaft rotates counter-clockwise at a constant speed of 190 r.p.m.

.02 The gearwheel on the driving camshaft meshes with a larger, intermediate, wheel on a short shaft, towards the rear of which is a worm. This, continuously revolving, drives an inclined shaft for giving accurate timing to certain air signals (12.12.00) and for effecting the end-of-line sequence when the appropriate signal is received. At the front end of the wormshaft is a wheel for manual operation. It is turned clockwise.

.03 The intermediate gear drives another gear, mounted at the front of the driven camshaft, so that this also rotates counter clockwise and at the same speed as the driving camshaft. It has seven cams and it seats in two bearings. The front face of the driven gear is calibrated at 10° intervals. This marking, read in conjunction with a fixed 1°-increment scale on the casing, enables the camshafts to be turned by hand to any required position for making checks or adjustments. The gear on the driven camshaft also meshes with the drive for the rotary shutter.

.04 The cams on the two shafts are (with one exception) in mating pairs so that there is a constant distance between them as they turn. Each of the seven spaces is occupied by a roller which is therefore given positive movement to both right and left. The exception is the locking bar cam (06.05.03).

04.03.00 Cam levers

.01 Each roller is mounted at the foot of a pivoted lever which is free to rock; its upper end delivers the power required for one of the motions of the filmsetter, the cam-design governing the timing and direction. The cam-contour and the proportions of the lever control the speed and distance.

.02 Listed from the front to rear, the levers operate the following parts, to which the number of the relative section is appended:

Feed- and lock-racks (gearbox) for mirror-bar progression (10.04.04).

Space bar for giving effect to a 'space' signal (10.13.03).

Matrix-case holder for vertical movements of the matrix case and other components (07.01.02, 10.06.03 and 10.13.02).

Locking bars for matrix-case location stop racks (06.05.02).

Jaw tongs for locating the film matrix case (06.12.01) and the unit and justification racks (06.09.01 and 10.06.02 4).

Air tower for progressing the paper ribbon (05.01.02).

Justification drive mechanism (10.08.02).

Unit drive mechanism (10.02.04).

04.04.00 Maintenance

.01 Each of the four camshaft bearings and the two wormshaft bearings is provided with a spring cap oiler, which should be replenished daily (16.08.11–12). Check weekly (and replenish when necessary) the level in the oil pan as (except for the locking bar cam) all the cams should dip into this to keep the rollers well lubricated (16.06.01). The locking bar cam lever is provided with a special oil pipe for this purpose and this must have a fresh daily supply. Oil holes lead to the bearings of all the levers; a little good-quality machine oil should be injected into each, daily (16.08.12).

.02 No method of adjusting the rollers or the levers themselves is provided, but the adjustments at the upper ends of the levers are detailed in the Sections relating to the various mechanisms concerned. As appreciable wear of the cams or rollers makes it impossible to obtain accurate settings, replacement rollers can be substituted in standard size or, if the fault lies with the cams, in one of four over-sizes. This work should be done by one of the Corporation's Staff or their Agent's.

SECTION 5

Air tower

05.01.00 General

.01 The duty of the air tower is, firstly, to allow compressed air to travel through one or more pipes (as selected by the perforated paper ribbon) to its point(s) of operation; secondly, to advance the paper a step so as to position one or more further perforations, and thirdly to wind up the used paper. It also supports the quadder mechanism.

.02 All the motions concerned are derived from the air tower cams (04.03.02) rocking their cranked lever to give the operating rod (12) an obliquely upward and downward travel; this is communicated to the air tower lever (13).

.03 Because of the closely linked inter-action of many of the components, it is essential that all their adjustments should be closely preserved. While the air-control and the paper feed form individual mechanisms, their relationship with each other is such that their adjustments must be undertaken in conjunction. Should a fault be suspected in any part of these sub-assemblies, the operator is recommended to make a complete check, following the sequence detailed in 05.04.00 and effect any necessary correction as soon as the need for it is discovered; he must bear in mind that one change of setting may entail others.

05.02.00 Air-flow (air tower) described

.01 A vertical pipe on the rear face of the air tower supplies a constant stream of compressed air to the hollow air bar shaft (6) on which the air bar (7) is free to rock. An internal passage allows the air at all times to reach the cavity containing the spring-loaded ball valve (12). Except when the paper is being progressed, this ball is held clear of its seating by the valve stem (13) so that the air can pass to an open leather faced duct spanning the row of thirty-one pipe ends in the crossgirt (10). The paper ribbon passes between the crossgirt and the leather seal which is normally pressed on to it by the spring (8); the seal is lifted to ease movement of the paper. The pipes that can receive the air are only those whose ends coincide with the perforations in the paper ribbon at any given moment.

.02 All these pipes lead from the air tower to air pins which act as limiting stops to various spring-operated parts of the mechanism, or to pistons operating control levers or switches, or to valves governing the directions (and therefore the functions) of other air streams. Other than the uninterrupted 'constant' air (12.11.00), every air stream and its pipe is known by the reference letter or number of the perforation from which it originated.

05.03.00 Paper-feed described

.01 At 4° of camshaft rotation, the operating rod (23) starts to lift, turning the lever (22) clockwise. The rise of the stud (21) allows the whole of the connecting rod assembly from the link (20) to the hook (1) to be pressed upwards by the spring (15). This turns the longer arm of the air bar clamping lever (3). Note that there is considerable clearance between this and the nut (5). The shorter arm of the lever (3) lifts the screw (2), so that the air bar valve stem (13) can rise and the ball (12) can be seated by the action of its spring (11). The body (i.e. the casing) of the valve is formed in one piece with the air bar (7); this floats on the hollow shaft (6), through which is fed a constant supply of compressed air.

.02 So far, the spring (8) has been holding the air bar down, with its packing (9) pressing the paper on to the crossgirt (10). As the lever (3) rises, this spring expands until the lever contacts the nut (5) on the stud (4) which then lifts the air bar clear of the paper so that air already in the pipe lines escapes; this is effected at 13°. Further motion of the stud (21) is lost in the slot of the link (20).

.03 With the air thus cut off, and the pressure of the air bar withdrawn, the paper can be advanced.

.04 At this moment (prior to 18° of camshaft rotation), the pin wheel ratchet (30) (the pins of which engage with and control the paper) is held firm by the feed pawl (40); this must be (a) disengaged, (b) moved up (clockwise), (c) re-engaged and (d) advanced (counter-clockwise), without the ratchet (and therefore the paper) being at any time uncontrolled. The locking pawl (26) provides the means.

.05 Since the operating rod (23) started to rise, the spring box has passed the motion on to the outer end of the operating link (44). The spring (25) is tending to draw the right-hand end of this link downwards and at the same time holding the operative end of the feed pawl (40) in close engagement with the ratchet. The whole feed pawl is thus stabilised, together with the lower end of the link (42), at the upper end of which a rivet (43) forms a fulcrum for the link (44). As the outer end of this link is rising, the inner must fall, bringing the locking pawl (26) (attached to it) into engagement with the ratchet wheel, which, at this instant, is therefore held by both pawls. Note that the locking pawl's pivot is fixed in the side of the tower, whereas that of the feed pawl is in the movable ring (43).

.06 The outer end of the operating link (45) continues to rise, but now its inner end, stabilised by the seated locking pawl, forms a fulcrum. The centre of this link therefore starts to lift the connecting link (42), so turning the feed pawl (40) clockwise about its stud (41). This stretches

the spring (25), so bringing the locking pawl more tightly into engagement, while the feed pawl becomes freed from the ratchet. The feed pawl continues to turn till its lower arm is arrested by a D-section stop (39) in the ring. As the operating link (45) is still moving upwards, and the feed pawl can turn no further, it can only rise bodily, taking with it its pivot stud (41) and so turning the ring (43) clockwise till its stop (at the bottom) contacts the left-hand stop screw (35). The linkage is now incapable of any further motion, so the remainder of the operating rod's upward travel is exhausted in compressing the spring (37) in the spring box.

.07 At 60°, the rod's rise is completed and it at once starts to fall. As soon as the spring (37) has expanded, the outer end of the operating link (45) descends. The inner end is still retained by the locking pawl which is held in the ratchet wheel by the spring (25). This same spring is also tending to engage the feed pawl with the ratchet one tooth in advance of its previous engagement, and does so as the operating link allows the connecting link to come down. The camshafts are now at 90°.

.08 Further descent of the operating rod again lowers the outer end of the operating link which now pivots about the rivet (44); this causes the right-hand end of the operating link to rise and, at about 100°, to lift the locking pawl (26) clear of the ratchet and hold it against the foot of the paper feed locking lever (24).

.09 *In the next 38° occurs the actual feeding forward of the paper.*

.10 The right-hand end of the operating link is held, and the left-hand end is descending. The connecting link is thus pressed down. The feed pawl cannot rotate further. Its fulcrum stud (41) is therefore moved downwards, turning the ring (against the friction imposed by the screws (29)) until the lug at the bottom meets the right-hand stop screw (34). The tooth of the feed pawl has turned both ratchet and pin wheel (30) through an equal amount of rotation, thus feeding the paper as required.

.11 So far as the paper-feeding mechanism is concerned, the effect of the remaining descent of the air tower lever (22) is absorbed by compression of the spring (37).

.12 As regards the paper-releasing mechanism, immediately the stud (21) reaches the bottom of the slot in the link (20), the spring (15) is recompressed, and the air bar clamping lever (3) is turned counter-clockwise. The spring (8) presses the air bar on to the paper, the leather facing providing an air-tight joint. The spring (15) turns the air bar a fraction further, causing the screw (2) to depress the valve stem which moves the ball (12) from its seating; this allows the passage of constant air to the perforations in the paper ribbon and thus to the predetermined air pipes.

05.04.00 Air tower adjustments

01. Although the mechanisms for controlling the air-flow and for progressing the paper ribbon appear to be distinct from each other, their actions are so inter-connected that their adjustments cannot be entirely segregated. Therefore, when any such work has to be carried out, the items listed as 05.04.02 to 05.04.10 must be verified as correct or, if necessary, adjusted, in the sequence given. Before making any of these adjustments, slacken the friction screws half-a-turn each, and do not forget to retighten them when the work has been done.

.02 AIR BAR SPRING STUDS (4) When these studs are correctly set, there is a clearance of $\frac{27}{32}$in (21·5mm) between the undersides of the washers (above the springs) and the top face of the guide plate (below the springs). To obtain this condition, with the hook (1) disconnected, slacken the lock nuts and turn the adjusting nuts (5) as required; check that the new setting gives a parallel lift to the air bar before finally tightening the lock nuts.

.03 AIR VALVE OPERATING SCREW (2) With the hook (1) disengaged, the clearance between the operating screw and the top of the valve stem should admit one thickness of paper ribbon but not two. Slacken the lock nut, turn the screw with a screwdriver, relock and finally check. A faulty setting here could put all the air-operated functions of the machine out of action.

.04 OPERATING ROD (23) If this has been correctly set, it will give, from its neutral position at 40°, one-third upward compression of the spring in the paper feed spring box and two-thirds downward compression. If not, as a preliminary, adjust the effective length of the operating rod so that the distance between the centres of its two eyes is $14\frac{7}{8}$ins (378mm), noting that the upper yoke and lock nut are left-hand threaded; because the rod is double-cranked, its upper end must be freed (by removal of the yoke pin) so that it can be swung clear. To keep equal lengths of thread engaged, it is better to turn the rod relatively to both yokes rather than to one only. When replacing, make sure that it can operate without fouling at any point and, when tightening the lock nuts, see that the operating finger for the winding spool drive is correctly angled.

.05 SPRING BOX (38) If lost motion is suspected here, due to uncontrolled end play, turn the camshaft to about 40° and check for free movement of the tube relatively to the spring rod. If this movement is found to exist, slacken the ring-type lock nut with a C spanner, enabling the tube to be screwed further on to the upper connection until the play is eliminated. Secure the tube with its ring nut.

.06 PAPER LOCKING PAWL (26) When a pair of pins on the pinwheels are aligned with the row of holes in the crossgirt, and the lug of the pawl ring is in contact with the right-hand stop screw (34), the nose of the locking pawl must enter the ratchet centrally between a pair of its teeth. To adjust, disconnect the hook (1), raise the locking lever (24) and (if this has not already been done) slacken the friction screws (29) half a turn. Slacken also the lock nut (45). Adjust the right-hand screw (34) to stop rotation of the ratchet in precisely the right place for the locking pawl to enter. Retighten the lock nut and check for accuracy.

.07 PAPER FEED PAWL (40) The nose of this pawl must bed down cleanly between two teeth of the ratchet in the same way as that of the locking pawl, but in this case, the limiting position of the ring's rotation is with the lug against the left-hand stop screw. Deal with this in the same way as the right-hand stop screw (05.04.06).

.08 OPERATING ROD (23) After any or all of the adjustments detailed in 05.04.02 to 05.04.07 have been completed, the limit-positions of the spring box should be checked with the locking lever (24) up. Of the total spring-compression, one-third should be effected when the air tower lever is fully raised, and two-thirds when it is fully lowered. Any required correction is obtained by re-adjusting the length of the operating rod as detailed in 05.04.04.

.09 AIR BAR CONNECTING ROD (14) If this component requires adjustment, it is best to start by completely detaching it. Slacken its two lock nuts noting that the upper one is left-hand threaded, and turn the rod, until it is freed, by the sleeve (18) which is locked on to it. Place the lower lock nut so that six threads of the rod are exposed below it and then screw the rod into the connecting link (20) till this touches the nut which must then be tightened. Similarly screw the hook (1) six threads on to the top of the rod; ensure that the opening is square with its stud and tighten the upper lock nut before finally checking that the hook still fits freely over the stud.

.10 AIR BAR CONNECTING ROD SLEEVE (18) First check that the air bar spring studs (05.04.02) and the right-hand stop screw (05.04.06) are correctly set. Engage the hook (1) and place a piece of paper ribbon folded to give three thicknesses, and an additional single thickness underneath it, between the crossgirt and the air bar sealing strip. Turn the machine till a single thickness of paper ribbon is lightly gripped between the lug of the feed ring and the right-hand stop screw (34). Slacken the lock nut (19) and the adjustable sleeve (18) to give a gap of $\frac{1}{4}$ inch (6 mm) between the washer (17) and its abutment. In this position, lightly re-lock the sleeve. Slacken both the top lock nut (16) (left-hand thread) and the bottom one (adjoining the link), and turn the rod until the folded paper can just be felt touching the leather when moved backwards and forwards. Then retighten the lock nuts. Turn the camshafts to 40°, bringing the stud (21) to the middle of the slot in the connecting link (20). Slacken the lock nut (19) and adjust the sleeve to restore the same degree of freedom for the paper. When the lock nut (19) has been retightened to the sleeve, the adjustment is complete.

05.05.00 Quadder described

.01 It is possible for a signal to suspend the feed of the paper ribbon for five or ten revolutions of the filmsetter so that the selected character or space is repeated the corresponding number of times – 'Quadding'. The keyboard operator will have depressed the Quadder key, giving the additional perforations *GH*.

.02 The resultant action at the filmsetter is fully detailed in 12.17.05, but the effect is that the piston (9) rises until the lever contacts both ends of the pawl (7). The inner end of the air tower lever (5) carries a pin (10) that operates the link (12). This, in turn, gives positive lift to a rocking plate (14) on which the pawl is mounted, carrying it to the left. The piston (9) is now able to rise further, engaging the pawl with the ratchet (3).

.03 When the lever (5) again lowers the link, the rocking plate is partly rotated by the spring (13), causing the pawl to turn the ratchet one tooth (one-twentieth of a revolution) in which position it is retained by the detent spring (4). In consequence, the two control plates (1 and 2) have been similarly turned. Each control plate has four notches equally spaced in its periphery, but the two plates are mounted adjustably to each other so that two opposite notches can be 'blinded', by hand setting.

.04 The arm (16) of the paper locking pawl normally drops into one of these notches when the pawl rises to allow a new perforation to be fed into position. If the control plates have been turned, as described above, this arm movement is prevented. Therefore, the locking pawl cannot rise, the paper is not advanced and the signal is repeated, while the paper-feed spring box spring absorbs the feed-motion. The condition remains unaltered until the ratchet has turned sufficiently to present another notch into which the arm can move.

.05 If four such notches are available, a quarter-turn is necessary – that is, five teeth of the ratchet – requiring five revolutions of the camshaft and so producing five successive

examples of the same character or space. If two of the notches have been 'blinded', a half-turn is necessary to present the next notch – ten teeth, ten revolutions, ten identical products.

05.06.00 Quadder adjustments

.01 In order that the ratchet (3) shall be consistently turned one tooth at every stroke of the air tower lever (5) (provided that the *GH* signal has been given), the relationship of the pawl (7) with the stationary ratchet is critical.

.02 Before attempting any adjustment, check the settings of all components transmitting motion to the paper feed pawl ring (05.02.01–2 and 05.04.04–10). For convenience, obtain from the keyboard operator a piece of paper ribbon with half a dozen *GH* perforations. Secure this in position on the crossgirt by lowering the locking lever. Detach the air pipe covers by removal of the screws retaining each of them. Remove the lock pawl arm (18) by slackening one of the adjusting screws (17) and withdrawing the two retaining screws. With the hook re-engaged, turn the filmsetter by hand until *GH* air raises the quadding piston (9), engaging the pawl with the ratchet. There should now be about 0·020 in (0·5 mm) clearance between the pawl and the leading face of one of the ratchet teeth, and the free end of the detent spring should be touching (or almost touching) the leading face of another tooth. Turn the camshafts and check that there is a slight return-movement of the control-plate group as the pawl disengages.

.03 DETENT SPRING AND PAWL If these conditions are not fulfilled, the first step is to adjust the detent spring. Slacken its retaining screw (6), and reposition it; tighten the screw, making sure that the spring remains correctly aligned with the ratchet, and check the result. Several settings may have to be tried, possibly without eventual success; in this case, refer to the next paragraph.

.04 If difficulty still persists, turning the eccentric pin (10) will give further scope for obtaining the correct adjustment. Normally, the pin has its eccentricity on the centre line of the air tower lever, towards its outer end. The angle of the eccentricity governs both the rest and the pick-up positions of (a) the rocking plate link, (b) the rocking plate, (c) the pivot pin of the pawl, and therefore (d) the nose of the pawl circumferentially to the ratchet.

.05 To gain access, remove the paper lock control box, by uncoupling the two air-pipe unions at its base, and withdrawing the two retaining screws. Slacken the lock nut and use a screwdriver to turn the eccentric pin through about 45°. Retighten the lock nut and, before replacing the control box, examine the result; if necessary, try further settings of the detent spring. Three other ranges of adjustment are provided by additional 45° movements of the eccentric; one of them will be found to give the right foundation for a correct setting of the detent spring.

.06 After finally checking the correctness of the clearance, and ensuring that all parts are working freely, replace and connect up the paper lock control box (see 05.07.02), fully tightening the nut of the inner union before offering up the outer one; finally replace and secure the lock pawl arm and the air pipe covers.

.07 PAPER LOCK PAWL ARM (18) Raise the locking lever to free the paper feed and turn the camshafts to between 50° and 100° to release spring-box compression. The bottom of the lock pawl arm should now be approximately 0·010 in (0·25 mm) above the lower face of a recess in the control plates (1 and 2). To adjust, first see that it is only lightly secured in this position by the upper screw (16). Horizontally, the arm should just clear the periphery of the plates. When this position has been obtained by means of the adjusting screws (17), tighten their lock nuts and then both the retaining screws.

05.07.00 Paper lock control box described

.01 For the series of operations that form the line-end sequence (11.00.00), the signal *ABC* (12.18.02) is used. One of the duties of this air-stream is to halt the progress of the paper ribbon while the machine runs the four revolutions that are required to clear the line just exposed and establish the justification and mirror position for the start of the next line. A mechanically timed flow of constant air (12.14.00) re-establishes the paper feed so that setting continues normally.

.02 The body of the control is a box providing two vertical cylinders of different sizes, the larger bore containing two pistons, one above the other. In the smaller bore is one piston, which, impelled by *ABC* air, rises to rock anti-clockwise a short, centrally pivoted lever (4); the free movement of this is restrained by a spring-loaded plunger. The lever carries a large-headed adjusting screw in its right-hand end, and when this is raised by the piston (5), the screw comes into the path of the arm (1) of the paper feed pawl ring, preventing its clockwise movement. In consequence, the lug of the ring is held firmly against its right-hand stop, even when the spring-operated feed-linkage (05.03.10) is trying to effect a paper-feed. *ABC* air thus stops the feed but the signal itself persists.

.03 When the line-end sequence is almost completed, a cam on the film feed shaft depresses a valve to admit constant air to the bottom of the larger of the two cylinders. The larger pistons, working together, then rock the lever clockwise, freeing the arm of the paper feed pawl ring so that the paper

progresses to the next perforations and the *ABC* signal ceases; normal routine has been restored.

05.08.00 Paper lock control box adjustment

.01 Clearance-holes for the screws securing the control box to the air tower allow for slight variations in the level of the assembly when it is replaced after removal; it must be in such a position that when the lever (4) is rocked clockwise, its normal position, the arm of the paper feed pawl ring will swing clear of the adjusting screw (2). Note that the longer screw must be in the left-hand hole, passing through the front of the air tower housing to secure also the piston block of the quadding mechanism (05.05.00)

.02 When the lever (4) is rocked anticlockwise (its operative position) and the lug of the paper feed pawl ring is against the right-hand stop screw, there should be approximately 0·010 in (0·25 mm) clearance between the bottom of the arm (1) and the head of the adjusting screw (2). To adjust, slacken the clamp screw (3) and turn the adjusting screw as required. Finally, retighten the clamp screw.

05.09.00 Paper winder described

.01 After 'delivering its message' at the crossgirt, the paper is rewound on a spool carried between brackets at the left of the air tower. A spring-loaded plunger (16) forms the rear bearing of the spool and presses its axial shaft (3) forward into the spigot-bearing of the driving shaft (10). From disc (11) attached to the axial shaft, a pin (7) projects through the flange (6) into one of six holes in the driving shaft flange, thus transmitting rotation from the latter to the spool. Withdrawal of the button (1) and plunger to the rear releases the spool, as its light internal spring (14) carries the pin out of engagement with the driving flange and frees the spigot bearing.

.02 The forward end of the driving shaft carries a ratchet (8), engaged by a pawl (21). When the air tower operating rod (20) rises, a finger (19) attached to its upper end lifts the pawl to a fresh engagement with the ratchet. As the rod descends, the spring (18) draws the pawl downwards, so turning the ratchet and spool, and maintaining a light tension on the paper.

05.10.00 Paper winder adjustment

.01 When in its working position, the driving disc pin (7) must project far enough to enter the driving shaft flange, but must not foul the face of the supporting bracket. The 0·015 in (0·4 mm) clearance required is most easily checked and adjusted by the following procedure.

.02 Detach the spool. With a C-spanner, undo the rear plug (15) and withdraw the shaft (3), spring (14), spring abutment (13) and disc (11) from the tube (4). Omitting the tube and rear plug, replace the rest of the assembly. Press the shaft forward so that the driving disc pin does in fact contact the bracket. The correct clearance should now be found between the front end of the plunger (16) and the rear of the shaft. If not, slacken the lock nut (5) and screw the shaft forwards or backwards through the disc, to give the required dimension. Retighten the lock nut and check before completing the re-assembly.

SECTION 6

Matrix selection

06.01.00 General

.01 How air signals are initiated is fully described in Section 05.00.00. How several of them are integrated to give additional signals is described in 12.16.00 et seq. Here we are concerned with the use of two air-streams, which may come direct from the air-tower or from the combination valve box, to select and bring into operative position the required matrix.

.02 It should be noted here that while the character of one matrix is being photographed, the machine is already making preparation to position its successor.

.03 The principle employed is that of a cross-reference grid, as commonly used in map-references. One air-stream is responsible for North-South location and the other for East-West location. (See also 01.02.09.)

.04 A summary of the mechanical sequence which occurs simultaneously in the front and the rear tongs, carrying the jaws, is as follows: An air pin rises to form a stop. One of the pin jaws is brought into contact with it. The second pin jaw closes up to the first; between the two is caught the lug of the stop rack which is thereby positioned. A locking bar moves horizontally to hold the stop rack. The pin jaws revert to their open position in readiness for the rise of the next pin. At the same time, the matrix jaws close on to the stop rack lug, pulling or pushing the matrix case into a corresponding position, and the front matrix jaws also similarly locate the unit rack which is then held by a descending locking pin. With the matrix case lowered on to, and stabilised by, the V-bars, exposure takes place. Meanwhile, the stop rack locking bar is withdrawn and the matrix jaws re-open, while the pin jaws close again for the start of the next cycle, as the camshafts begin a fresh revolution. The unit rack locking pin is raised before the reclosing of the matrix jaws.

06.02.00 Air pins

.01 One group consists of nineteen air pins, small pistons, each of which is raised, usually one at a time, by its own air stream. The position of the selected pin is the first factor in the selection of the required matrix. In addition to the pins, there is a fixed stop at the end of the group, so that if no air pin is raised, this provides a twentieth position. A similar group of fifteen pins and fixed stop, arranged at right angles to the first, gives, with the extra position gained by Unit Shift, seventeen cross bearings or co-ordinates. Consequently, 20 × 17, or 340, different locations can be specified by signal for the matrix case, which is correspondingly constructed (see 13.02.00) to hold up to 340 matrices.

06.03.00 Pin jaw tongs described

.01 To give accurate and positive motion, governed by a selected air pin, to the matrix case requires an intricate mechanism which many students find difficult to master. They may therefore examine with advantage the essential duties of the components, here shown simplified.

.02 An air pin (7) has been raised. The first action will be to bring into alignment with it the lug (12) of a stop rack (3). Motion is provided by a vertical stud (14) which, for the moment, may be considered as travelling to the right. It is connected by a link (13) to an intermediate point on lever (15), which is therefore carried to the right. As the front end of the lever is restrained by a spring (9), the rear end travels further to the right, carrying the connection (16) and the rear end of lever (1), which is pivoted at point (2). Consequently, the front end of lever (1) moves to the left until its cupped socket (6) (termed a 'jaw') meets and is stopped by the raised air pin (7). The whole lever (1) is now at rest, as is also the link (16). As the stud (14) continues to move to the right, the lever (15) now pivots about its junction with the link (16), causing its front end to move to the right against the action of the spring (9). Lever (15) is eventually brought to rest with its projection (10) almost meeting projection (8) of lever (1). But before this happens, the lug (12) of the stop rack will have been carried to the right by projection (11), until it is positively trapped between it and projection (5). In that position, it will be aligned as required – with the raised air pin (7).

.03 At this point, it will be noticed that no part of the lever (15) comes into contact with the airpin – it rides well above its level, even when raised. Therefore, if more than one pin is raised, as occurs in some circumstances, only the one which is first encountered by the right-hand lever produces any effect; one must not be misled by the use of the word 'jaw' which suggests a two-sided bite.

.04 Comparison of the simplified diagram with the illustration of the actual assembly will show a few essential discrepancies. The link (16) is adjustable. The stud (14) does not move in a straight line, but, being mounted on an oscillating crank (06.12.02), it has a slightly curved track. The pivot (2) of lever (1) is not a fixed point, but it is located at one end of a link which is pivoted on a fixed stud; this allows straight-line motion for the jaw at the front end of the lever – it slides on a guide rod. This link and link (13) are each built up of two plates which lie above and below their respective levers. The simple tension spring (9) gives place to a pair (inner and outer) of springs which, by means of a rod, links and levers provide the restraint for the lever (corresponding to 15) in the second pair of tongs which acts at right angles to the first pair to produce the cross-referencing previously mentioned. The air pins are arranged in three staggered rows, with the socket (6) designed to accept all of them.

.05 After a short pause in the closed position (see 06.05.01),

the pin jaws start to open again in readiness to repeat the operation on the next air pin to rise; meanwhile, the air bar has risen (05.03.02), releasing air pressure from the pipe line and so allowing gravity, assisted by a small coil spring, to lower the pin whose mission has been accomplished.

06.04.00 Pin jaw tongs adjustment

.01 The shorter ends of the two pin jaw levers (in each pair) are connected by the adjusting stud (16), the centre of which is a hexagon. Perforate a piece of paper ribbon to raise the *A* air pin in the rear pin block and the No. *1* air pin in the front pin block. Turn the camshafts to 320° and check that each pair of jaws lightly grips one thickness of paper ribbon. If not, re-set the adjusting stud after slackening the lock nuts; note that, seen from the outer ends of the tongs, the left-hand lock nut (of the front or rear pin jaw tongs) has a right-hand thread and the right-hand nut has a left-hand thread. After retightening these nuts, check that the adjustment has been held, that the yokes are not binding on their pins and that when the jaws are fully open, there is a clearance between the root of the recess in each jaw and the first air pin.

06.05.00 Locking bars described

.01 Having been positioned as described (in 06.03.02), each of the two stop racks must be firmly held, as its lug has now to serve the matrix jaws (see 06.07.00) in the same way as the air pin served the air pin jaws – it provides a selected and temporarily-fixed location for their meeting. This anchorage is provided by a locking bar. As soon as the stop rack has been positioned by the air pin jaws, a rigidly guided bar (the front bar has a single tooth at its operative end and the rear bar, two) advances horizontally to engage teeth of the stop rack, so that it is held by spring-pressure until after the matrix case has been positioned by the matrix jaws. As soon as the locking bars are seated, the air pin jaws open to start their next cycle of operation.

.02 Accurately timed movement for the locking bars is provided by a cam (7, 04.03.02). It will be seen that clockwise motion of the cam lever presses the hook at the end of the rod (7) to the right, positively rotating a three-armed bell crank (2) counter-clockwise, to pull both front (3) and rear (1) locking bars out of engagement with their stop racks, so that the latter can move to new positions. Between each locking bar (which needs straight-line motion) and the bell crank (which rotates) is a spring-loaded flexible joint to compensate for the difference between their respective motions; the rear assembly has also means for adjustment.

.03 It will be remembered that the lever (10) is operated by a single cam. When the lobe of this is withdrawn, the spring (9), which had been compressed against the justification rack stop block (8) as its fixed abutment, turns the lever counter-clockwise. It also presses the rod (7) to the left, causing both locking bars to be advanced to re-engage with their stop racks. Note, therefore, that the seating is firmly held by spring pressure throughout the period during which the stop racks must remain stationary.

06.06.00 Locking bar adjustments

.01 To gain access to the locking bar, it is necessary to remove from the machine the front pin jaws (18.02.15A) and the double spring box and bell cranks (18.02.17A). To prevent any chance of the machine being jammed by being rotated while adjustments are in progress, turn back the lock nut (8) of the rear locking bar assembly so that it is well clear of the yoke (4). As a further preliminary, press the rear locking bar (1) to the right and note that from its tip to the centre of the bell crank pin the measurement is $7\frac{9}{16}$ in (192 mm); if necessary, turn the adjusting nut (6) with a pin wrench to give this measurement.

.02 When the camshafts are at 220°–340°, the locking bars are fully withdrawn, and they should then be pointed centrally between pairs of teeth of the stop racks so that they can make a clean entry. At the same time, clearance between the tips of the bars and the tops of the rack teeth must be preserved.

.03 FRONT LOCKING BAR If the front locking bar requires adjustment to give 0·055 in–0·060 in (1·40 mm–1·52 mm) clearance, slacken the left-hand lock nut (left-hand thread) and the right-hand lock nut (right-hand thread) of the operating rod. For turning the rod, to screw it into or out of its yokes, a pin-wrench hole is provided, about $1\frac{1}{2}$ in (38 mm) from the right-hand end. Retighten the lock nuts afterwards. This adjustment will affect also the clearance of the rear locking bar, to which, therefore, attention must now be given.

.04 REAR LOCKING BAR The clearance between this bar and its stop rack should only be adjusted when it is known that the corresponding front components are in correct relationship. With the lock nut (8) slackened, and the locking bar pressed to the right, turn the adjusting nut (6), using the pin wrench if necessary, to reproduce 0·025 in–0·030 in (0·64 mm–0·76 mm) clearance between the bar-tip and the tops of the rack-teeth. Reseat the bar in the rack and hold the adjusting nut firmly with the pin wrench before tightening the lock nut, to ensure that the teeth mesh squarely and check that the pin (5) is not binding in its yoke.

.05 When a locking bar is engaged, the lug of its stop rack should not be touching either of the pin jaws. If this is not the case, both bar and rack will be repeatedly subjected to strain which will impose unnecessary wear and eventual breakage. The cause is that the rack is being incorrectly

located due to excessive wear of the pin jaws or of the upper parts of the air pins, in either case, replacement of the faulty part is necessary to avoid further damage.

06.07.00 Matrix jaws described

.01 The duty of each stop rack lug is to act as a firmly held substitute for the corresponding air pin, which has to disappear early in the cycle of operations to allow time for the routine of the air tower – the preparation for the next signal (05.03.01). Whereas the pin jaws brought the rack-lug into line with the stable air pin, the front matrix jaws now align the head of a draw rod (15) relatively to the stabilised lug and the rear matrix jaws similarly treat an extension (3) of the cross slide.

.02 As the head of the draw rod is at a fixed distance from the matrix case (12), it will be seen that the required row of matrices is selected by the rod, and that the required column is selected by the cross slide. The selected matrix is brought (for exposure) to a point (14) fixed relatively to the intersection of the co-ordinates.

.03 In principle, the matrix jaw tongs exactly resemble the pin jaw tongs. In the diagram (06.03.02) it was shown that motion was applied centrally and the pivot of the assembly was on the right; consequently right-hand motion caused the jaws to close. Examination of the corresponding matrix jaw assembly shows that the pivot (2) is on the left; consequently, right-hand motion causes the jaws to open. That is to say, in each of the front and rear assemblies, while the pin jaws are closing, the matrix jaws are opening, and vice versa. Because pin and matrix jaws both receive motion from the same vertical stud (1), because the pin jaw assembly is mounted above the matrix jaw assembly, and because they are moving simultaneously in opposite directions, it is not easy to understand the fuctions of the components by watching the machine at work, or even stationary, but study of our simplified diagrams should prove rewarding. The subject of the matrix jaws cannot, however, be dismissed until their relationship with the unit and justification racks (see 06.09.00) has also been discussed.

.04 Two incidental points will be noted from the foregoing. It is not necessary for the matrix case to be returned to a zero position before it can be carried to the next operational position, and, because the front and rear matrix jaws are operating simultaneously, the matrix case follows an oblique path – the shortest route – from one location to another; it does not make two journeys, at right angles to each other.

06.08.00 Matrix jaw adjustment

.01 No provision for adjustment has been found necessary for a matrix jaw assembly. Any parts that show signs of excessive wear (which should not occur with proper maintenance) must be replaced by new. For rear matrix jaws, see 18.02.10A; for front matrix jaws, see 18.02.14A.

06.09.00 Unit and justification racks and Unit Shift

.01 Mirror-bar travel, responsible for the amount of line-length allocated to a character, is primarily dependent on the row in the matrix case (see Section 13.00.00) in which the character is situated, and this – as has been explained – is related to the closed position of the front matrix jaws. Correspondingly to the principle of the normal wedge of a composition caster, the unit rack is made to travel to every such position; through the train of mechanism described in Section 10.00.00, this regulates the movement of the mirror bar consequent upon the exposure of a character. When positioned, the unit rack is secured by the spring-loaded locking pin (2) being lowered on to it by the descending matrix case holder lever.

.02 Similarly, and under given conditions, the coarse and fine justification racks are positioned to give the mirror-bar feed required by justified spaces.

.03 For any given position of the closed matrix jaws, either of two rows in the matrix case can be selected, according to whether or not the supplementary signal *K* is given. This provision, known as 'Unit Shift', has two advantages – (a) it provides flexibility in establishing the arrangement of matrices in a case (see 13.01.08) and (b) it provides access to an additional row of characters. Reference to the diagram of a Matrix Negative Arrangement will show the 17th row at the foot with all characters over-lined, indicating that they are reached by Unit Shift and therefore carry the unit-value allocated to the line above.

.04 Mechanically, Unit Shift is achieved by leading the *K* (T) air (see 12.19.04) to a piston (3) which, when raised, causes the domed head of the draw rod (4) to seat in a deeper recess in the front matrix jaw (6). As this recess is 0·2 in (5·08 mm) deeper than the normal socket, the matrix case is displaced by a similar amount, bringing into operational position the adjoining row of matrices but, it must be observed, without affecting the position of the unit rack as this is, at all times, located by the matrix jaws. To enable the front draw rod to take up the Unit-shift position, its 'fixed' end is provided with a knuckle joint (2).

06.10.00 Matrix-case movements

.01 The matrix case is capable of three-dimensional movement. It travels backwards and forwards to position the required column of matrices, controlled by the rear matrix jaws. It travels sideways to position the required row of matrices, controlled by the front matrix jaws. It travels downwards and upwards, controlled by the bridge mechanism (see

07.02.00), to engage with or to be freed from its stabilising seatings.

.02 Flanges at the sides of the matrix case (8), engaging with corresponding slots on the underside of the sliding frame (11), give vertical support while allowing the matrix case to slide backwards and forwards. It is made to do this by having the hook (2) at its rear end engaged with the slot of the cross slide (3). The rearward extension of this has a lug (4) which, being situated between the rear matrix jaws (5), is positioned by them (06.07.01).

.03 As its name suggests, the sliding frame is itself capable of movement, travelling transversely on flanges of the carrying frame (9). It receives its motion from the knuckle-jointed end of the draw rod (13) which is positioned by the front matrix jaws (1). The corresponding transverse movement of the matrix case causes its hook to slide along the groove of the cross slide.

.04 The combination of these two movements provides the necessary co-ordinates which, as shown in our much simplified diagram (01.02.09) quickly make available the required matrix.

.05 Every row and column of matrices corresponds with a pair of V grooves (15) machined in the underside of the matrix case to provide maximum accuracy in locating it. After the matrix has been selected and placed (by the draw rod and cross slide) under the condenser lens (12), the matrix case is lowered by the bridge lever (14) – see also 07.02.00. The grooves register with three V-bars one of which is set at right angles to the other two on the shutter housing cover (6). One (16) is sprung, moving vertically in minimum-clearance slots. When the descending matrix case has contacted this bar, it continues downward until the two fixed bars (17) enter the grooves (15) which are at right angles and finally bed-in at the apex, both arresting and precisely locating the matrix case just before the photographic exposure. The sprung bar rises to its normal height when the matrix case is withdrawn upwards, a movement that is not sufficient to disengage the hook (2) from the cross slide (3).

06.11.00 Matrix-case movement adjustments

.01 Unless there is very close agreement between (a) the position to which the matrix case is carried by the draw rod and the cross slide and (b) the position in which it is precisely located by the sprung and fixed bars in the shutter housing, damaging strains will be set up. Therefore, whenever the matrix case is changed, and at least once every week, the two following adjustments should be checked and, if necessary corrected.

.02 DRAW ROD Perforate a piece of paper ribbon to select a character approximately central in the required matrix case without the use of Unit Shift, apply it to the crossgirt, and lower the air bar. Turning the camshafts by hand for two revolutions, bring the matrix case down on to its locating bars. Slacken its lock nut and screw the draw rod (13) out of its yoke until it is firmly pressed against the left hand matrix jaw. Measure accurately the distance between the right-hand matrix jaw and the nearest face of the draw rod head. Reset the draw rod to give as nearly as possible half this distance. Retighten the lock nut. This procedure will ensure that, when the locating bars are operating correctly, the head of the draw rod will be able to float freely over a short distance in either direction when the matrix jaws are closed, without offering opposition to them.

.03 CROSS SLIDE With conditions as detailed for the draw rod, note the clearances between the hexagon-headed screw (1) in the lug of the cross slide and the matrix jaws on either side of it. If they are not equal, slacken the lock nut (3) and make this correction, retightening the lock nut again afterwards. Ideally, there should be 0·003 in (0·08 mm) each side of the adjustable screw.

06.12.00 Motion for tongs

.01 In following the chain of control from the air tower to the matrix case, we assumed (06.03.04) the regulated oscillation of two cranks, one each for the front and rear groups of air pins and tongs, without examining the source of the motion. This is provided by the rocking of a cam lever (9).

.02 The upper end of the cam lever carries an adjustable ball-ended extension (24). Fitting in the socket (18), this constitutes a universal joint with the double spring box assembly which is designed to transmit two separate but simultaneous drives to the bell cranks (4 and 5) for the front and rear sets of tongs respectively. The two spring boxes operate entirely independently of each other, allowing the two motions to be individually adjusted (06.13.04).

.03 The socket is screwed into the tube cap (17) which is separated from the end plate (28) by two tubes, the whole being united by two long nutted studs (25). The contents of the tubes are the same – two compression springs (16) with a central abutment (15) and two end abutments (26), a pair of wooden cones (27) forming a restraining brake, and the reduced-diameter part of a rod (19 and 22). Each rod carries, at the left-hand end, an adjusting nut (13) and a lock nut (12) with a grease nipple. Note that the holes in the end plate allow the passage of these nuts one of which is in contact with the male part of the brake. The right-hand spring abutment is in contact with the shoulder of the rod which continues through, but independently of, the tube cap.

.04 The upper rod is screwed into a crosshead (20). This carries a short rod terminating in the socket (1) for a ball plug secured by a clamp bolt and collar in the upper bell crank (4) operating the front tongs assemblies.

.05 The lower rod passes through a hole in the extension (24) and also through the crosshead, without being affected by their movements. It is connected to, and operates, the lower bell crank (5) similarly to the upper half of the mechanism.

.06 When the cam lever carries the ball (23) to the left, the whole casing moves to the left. The right-hand spring abutment (in each tube) is moved to the left, compressing the springs (16) against the left-hand abutment so that it presses on the brake. As this is seated on the nut (13), this and the rod also move to the left, turning the bell crank. If any obstruction accidentally limits its travel, arresting the rod, the left-hand spring abutment is also stopped, but, as the right hand abutment continues to move, the springs take up the difference, and no serious injury to any part of the mechanism occurs.

.07 When the cam lever carries the ball (23) to the right, the whole casing moves to the right. The left-hand spring abutment (in each tube) is moved to the right, compressing the springs (16) against the right-hand abutment so that it presses on the shoulder of the rod, which consequently travels to the right. Accidental stoppage of the bell crank arrests the rod, its shoulder holding the right-hand spring abutment; again, spring-compression absorbs the difference of motion.

.08 A further duty of the springs, in which they are aided by the brakes, is the absorption of shock or overthrow effect resulting from the inertia of the rapidly moving matrix case particularly when it is being taken from the zero position to that of the first two or three air pins.

06.13.00 Tongs motion adjustments

.01 SOCKETS FOR BELL CRANK BALLS It is essential that these should provide a snug working fit, as faulty adjustment here can quickly lead to a breakage during operation. If play be suspected, it is first necessary to detach from the machine the bell cranks and the double spring box (18.02.17A) which is secured to its cam lever by two clamp bolts. The whole assembly of cranks and spring box can now be laid on the bench, with access to the ball joints. With a C-spanner, slacken the ring-type lock nut (4 and 7) of each socket; the lower spring rod (8) can be easily screwed into or out of its socket, but before the ball plug (3) for the upper joint can be turned, its lock nut (2) must be slackened. After making the adjustments in this way, retighten the ring type lock nuts and again check the joints for faultless operation. When retightening the hexagon lock nut (2) make sure that the socket is correctly angled to avoid the possibility of binding. The bell cranks, and matrix and pin jaw tongs can then be replaced in the reverse order of removal. When re-assembling, note that the front matrix jaw tongs have arrows (pointing towards the crank fulcrum) on the upper levers, whereas the rear matrix jaws do not carry these distinguishing marks.

.02 SOCKET FOR BALL EXTENSION Freedom of movement and absence of play are again essential; the ball is held between the spherical surfaces of the socket (11) and the pad (19). It is intended that the work shall be done with the ball extension in an intermediate position, roughly central in the aperture at the bottom of the cap. The position of the socket relatively to the tube cap is regulated by the ball socket plug (14); this is turned by flats on the shank of the button (17) which is locked by the nut (16). A small double-ring spanner is provided for slackening this nut an for turning the squared end of the plug (a pin projects fro the opposite end of this to locate the pad). After adjustin retighten the nut which presses the button (17) against th washer (15), and this against the end of the cap; the nu also tends to draw the plug outwards, but it is screwed int the socket (11) and this bears against the socket plug (18 which is screwed into the cap, so that the adjustment is nov locked up solid, but check the action before proceedin further.

.03 BALL EXTENSION When replacing this in the socket a the top of its cam lever, note that a gap of $\frac{1}{4}$ in (6 mm should exist between the top of the cam lever and the bas of the squared part of the extension. Raising or lowering th ball head will increase or reduce the movement of bot the bell cranks, in both directions. Regulate the adjustin screw (23) to give the required clearance. When tightenin the clamp bolts, be sure that the rod (8) has a clear passag through the extension. As any alteration to this setting wil affect the matrix jaw motions, check these again, as in 06.13.05–6 and if necessary, repeat the adjustment.

.04 JAW TONGS SPRING BOX See that the isolator switch is OFF and the air supply ON. Insert the wooden wedge in the unit latch to hold it disengaged, and turn the machine one revolution to give it effect. Remove the cover of the matrix case lever (two hexagon screws) and the bridge (18.02.04A). Turn the machine to the neutral position (about 40°). At the left-hand end of the spring box, undo the two lock nuts and slacken the adjusting nuts. By hand, oscillate the front pin jaws while gradually tightening the upper adjusting nut till play is eliminated, and then tighten the lock nut. Bring the front pin jaws towards each other and note that there is a clearance of approximately $\frac{1}{32}$ in (0.8 mm) between them at the limit position; if not, reset their adjustable link (06.04.01), but it is not necessary to lock its adjustment

if the instructions in paragraphs 06.13.05–6 are also to be carried out. Deal with the rear pin jaws in the same way, making the adjustment to the nut on the lower spring box rod.

.05 MATRIX JAWS – CLOSING First check that the adjustments detailed in 06.13.02–4 are correct and that the same preliminaries have been fulfilled. Perforate the signal *A1* in a piece of paper ribbon, close the pin jaws and obtain $\frac{1}{32}$ in (0·8 mm) clearance between them by means of the adjustable link. Turn the machine slowly by hand, observing the closing of the front and rear matrix jaws – they should be simultaneous. To adjust, slacken the top hexagon nut at the spring box crosshead and turn the rod clockwise to advance the closing of the front matrix jaws. Now check to see if the two pairs are closing simultaneously; if not, repeat the adjustment until they do. Then lock the nut tightly. If there appears to be undue resistance to the hand-turning of the machine, it is because one or both pairs of pin jaws has lost clearance as a result of the first stage of this adjustment. Consequently, the adjustable link (06.04.01) must be shortened to restore the $\frac{1}{32}$ in (0·8 mm) clearance. The camshafts can now be rotated by hand and the correct settings verified. Proceed to 06.13.06.

.06 MATRIX JAWS – OPENING With the machine as it stands at the end of 06.13.05, turn the handwheel till the pin jaws are together; they should lightly grip a single thickness of paper ribbon when positioned against the *A* and *1* air pins. If not, reset the adjustable link to produce this effect and tighten its lock nuts. After turning the camshafts several revolutions by hand, lift the air bar. With the matrix jaws fully apart, check that there is a clearance of $\frac{1}{16}$ in. (1·5 mm) between each of them and its spring-loaded abutment. To adjust, bring the machine to a normal position (about 40°) and slacken the hexagonal lock nut at the right-hand end of the spring box. Turn the collar half-a-turn with the tommy pin, clockwise to reduce the clearance, and vice versa. Restore the air bar and check that the pin jaws close to a clearance of one thickness of paper ribbon; if necessary, again correct the adjustable link, not forgetting to lock it afterwards. Cut off the air flow and rotate the camshafts to check the matrix jaw clearances. Repeat the procedure, if it is required, until they are approximately $\frac{1}{16}$ in (1·5 mm) and, with the same setting, the pin-jaw clearance of one thickness of paper is preserved. The adjustment may now be finally locked up, but, at the same time, check that the cut away parts of the spigotted washer abutment clear the top and bottom rods. Turn the camshafts to bring the matrix jaws together (i.e., not capable of oscillation). The reading should now be 105° to 108° – if not, check over the whole series of jaw adjustments, as an error will almost certainly have arisen in this somewhat complicated procedure.

SECTION 7

Bridge

07.01.00 General

.01 A rigid steel platform – the bridge (12) – straddles the shutter mechanism. It is a fixed support for the projection lamp in its ventilated housing and condenser lens, the axis of which is centrally above the matrix selected for exposure. The bridge also forms the foundation for the mechanism for lowering the assembly of carrying frame (9), sliding frame (10) and matrix case (27) until the latter is securely seated on its V-bars (see 06.10.05), and raising it again after exposure, for a different matrix to be positioned. Three legs support the bridge; each has a foot projecting inwards. Through them, two screws (reached from above by a long screwdriver) and a bolt pass to secure it to the main stand, while accurate location is ensured by two dowel pins.

.02 Motion from the cams rocks the matrix-case holder cam lever (19) to which is rigidly attached the matrix-case holder lever (17), forming a large bell crank to deliver vertical motion at its right-hand end for raising and lowering the matrix case.

07.02.00 Matrix case fall and rise – description

.01 A link and pin (16) transmit the motion of the matrix-case holder lever to the free end of the bridge lever (15), the other end of which is anchored by a pin (4) to the fulcrum rod (8). Lying obliquely below the bridge lever is a cross beam (6) with a central stud (1) projecting up through the bridge lever. The stud passes through both a compression spring (5) that conveys the downward movement, and also through an adjustable nut (3) that imparts the lift positively on the return stroke.

.02 Attached by nuts to the ends of the cross beam are the tops of two guide rods (24); their bases are secured to the carrying frame (9) so that this, together with the sliding frame and matrix case, receives the required lift, the downward movement having been transmitted by the cross beam bearing on the shoulder of each rod. The rods slide in long bushes to preserve parallel motion, with lubrication provided by oil caps at the tops. Surrounding the bushes are coil springs to hold up the frame assembly when the bridge lever is disconnected from the matrix-case holder lever. A fibre stop (25), held in position by a light spring, is interposed between the top of the carrying frame and the bases of the bushes to absorb the shock of impact between the two, and to limit the upward travel of the carrying frame.

.03 The other duties of the matrix-case holder lever concern the coarse justification rack (10.06.04), fine justification rack (10.06.04), space bar (10.13.02) and unit rack locking pin (10.02.02).

07.03.00 Matrix case fall and rise – adjustment

.01 BRIDGE LEVER When the matrix case is about to be moved horizontally, it is essential that there should be a safe clearance between its underside and the top of the sprung V-bars. With a matrix case in position in the sliding frame, and the bridge lever connecting link pin (16) inserted, turn the camshafts to bring the matrix-case holder lever (17) to the top of its stroke – say 90°. Looking through the aperture on the right-hand side of the machine, position one of the crests or ridges on the underside of the matrix case directly over the sprung bar, and measure the clearance with a feeler gauge. It should be 0·032in (0·81mm). If not, slacken the lock nut (2) and use a C-spanner to turn the adjusting ring nut (3) as required. Check that the clearance remains correct after tightening the lock nut.

SECTION 8

Projection lamp

08.01.00 General

.01 Maintenance of optimum illumination of the film matrix is essential if good, consistent images are to be produced; they are, of course, necessary for the preservation of a high standard in the eventual print. It is false economy to attempt to use a bulb when its efficient working life is finished. We therefore stress the advisability of frequent photometric tests, the details of which are fully described.

08.02.00 Replacing lamp

.01 It is important for the filament of the lamp bulb (9) to be so positioned that it is centred on the condenser lens (10), and if the bulb is changed this adjustment must be checked (see 08.03.02c).

.02 The lamp is a pre-focus, 12-volt, 48-watt projection bulb positioned in a housing (2) and secured by a clamp screw.

The holder of the lamp ensures that it can be fitted into the housing in one position only, so that the filament is always correctly located relatively to it.

.03 Mounted on the bridge, the lamp housing is secured by three lock screws (14). When these and the three screws retaining the housing cover (1) are slackened, the housing can be moved backwards and forwards on the machine, and to right or left; do not forget to retighten the screws after making the adjustment.

08.03.00 Light output control

.01 The product from a filmsetter can alter according to several variables; exposure and development especially need to be controlled.

.02 The quality and quantity of light may be affected by:

a) Variations in the electricity supply to the lamp, possibly caused by bad contacts on plug pins, wire connections to terminals, or dirty contacts on the lamp pin. On a low voltage circuit of this kind, a very small increase in resistance will definitely affect the power of the lamp: therefore good contacts are vital.

b) Dirty or old lamp. The projection-lamps age relatively quickly and lose power, especially if they are overloaded with too high a current. A constant-voltage transformer is fitted which should prevent any variation in the lamp current.

c) Incorrect positioning of the lamp, so that the filament is not central to the optical path. This should be checked by projecting the lamp image without a matrix case in position. With the 10pt lens bar inserted, and the left-hand prism in the 6–12pt position, the actual filament can be brought into focus on the ground-glass screen of the test rig by winding the right-hand prism near to the middle of its track. When the filament of the lamp is focused, see whether it is central to the optical path. If not, then the lamp housing should be moved accordingly.

d) The optical glass and mirrors may become dirty or scratched (see Section 09.15.00).

e) Matrix cleanliness. The matrices should always be clean and the 'Vybak' cover sheet should be unstained and clean.

f) Lens diaphragm setting. This must always be 'spot-on'.

g) Speed of the machine. Check that the belt is tensioned correctly and is not slipping because of being loose or oily. If the machine-speed drops, the exposure-time will be increased proportionally.

h) Shutter timing (see 09.05.00).

.03 The correctness of all these variables should be verified at the time of installation, and thereafter they must be kept constantly under control by systematic maintenance. The best check is to apply a light meter to the light emerging at the film-drum stage and to note the reading (at a given type-size adjustment and diaphragm setting), when the whole system is known to be clean and properly adjusted. Then, daily, a similar light-reading can be made, and any variation investigated.

08.04.00 Calibration

.01 Not only when a new machine is installed, but also whenever a new kind of film or paper is to be used, the following procedure should be carefully carried out.

a) All the preceding variables should be brought to the highest-quality standard. In the case of 08.03.02f, the lens-diaphragm settings recommended on the optical housing door should be used.

b) Run a piece of text through the machine and carefully develop it at the temperature and time-allowances recommended by the film manufacturers, but ignore the grey scale.

c) When dry, the film should be critically examined for quality of the image and the grey-scale reading noted. No. 2 grey scale should develop solid black and No. 3 half black, if the image has been correctly exposed, i.e. producing a crisp shape with correctly proportioned serifs and sharp acute angles in the W's and X's.

d) If the image is under- or over-developed, i.e. too fine and lacking full black opacity, or bold with badly shaped serifs and acute angles, adjustment should be made to correct this. It must be realised that correct exposure is of paramount importance in order that, when the film is developed at correct time and temperature (according to the manufacturers' instructions), the correct image is produced.

.02 In no circumstances should the grey scale be used to control the development time during these calibration tests.

.03 In the event of imperfections as noted in 08.04.01d, several adjustments are possible:

a) The lens diaphragm opening may be increased or decreased. This adjustment is the least desirable, because the range of the settings has been chosen to suit the conditions required in changing type sizes from 6–24 pt. If, for instance, it seems necessary to increase the exposure, it might be decided to open up the diaphragm setting two stops. However, if this were done, it would mean that at 24 pt a setting outside the possible range of the diaphragm would be demanded. Hence, this adjustment is not suitable for the whole range of sizes.

b) The lamp brightness may be varied. This adjustment is an easy one and probably the most suitable.

c) In order that proper standards may be maintained, careful tests should be made with all grades of film likely to be employed, using a light meter (see 08.04.04), to establish and record the necessary level of brilliance of the lamp for these. Processing should be carried through to the plate-making stage before a decision is made as to the most suitable exposure.

.04 When these records have been made, they can be used as a standard reference on future occasions, but it should be realised that in adjusting light brilliance for a variety of lamps (because the lamp on which the original tests are carried out will have a limited life and be subject to replacement), a stable and unchanging light meter must be used to confirm that the light output conforms to the reference. Such a meter is the EEL Lightmaster Photometer, made by Evans Electroselenium Limited, and obtainable from The Monotype Corporation Limited.

.05 Maximum lamp efficiency may be obtained on a 'Monophoto' filmsetter by using this photometer in the following manner.

.06 Clean the optical system and the mirrors of the filmsetter, and insert a new lamp in the lamp housing. A dirty optical system will affect the photometer reading. Cleanliness at all times is imperative.

.07 Set the calibration on the variable resistor (or rheostat) to read 70 (or 50 in the cases of machines up to no. 91059), by turning the knob (6) on the right-hand side of the control panel, and set also the optical system in the position required for producing 10 pt. Adjust the iris aperture of the lens to zero.

.08 Remove the matrix case from the filmsetter and insert on the crossgirt a piece of paper ribbon perforated to give the *Q* signal. Rotate the machine by hand until the shutter is fully open, which will be found at 235°.

.09 Switch on the lamp by turning the switch (4) to the LAMP position, and, with the dust cover (on the mirror bracket housing) open, move the mirror bar so that the illuminated patch on the front mirror is roughly central.

.10 Bring the filament into focus on the screen of the test rig by adjustment of the right-hand prism, and check that the image is central to the optical path; if not, reposition the lamp housing as required.

.11 By means of a practical test, which should call for some examples of the 0·4 in × 0·2 in matrices, if these are likely to be used, establish the most suitable setting of the variable resistor for individual use. For example, run a few lines of 10 pt text with the resistor at each of several different settings throughout its range, and process the result. We recommend the use of a lith emulsion film, processed according to the manufacturer's instructions, at 68°F (20°C); this gives a good black on the second step of the grey scale. Processing should be carried through to the plate-making stage before a decision is made as to the most suitable exposure.

.12 Having selected the most suitable test, with a wax pencil mark the appropriate setting on the white surround of the resistor knob. Reset the filmsetter for producing 24 pt with the resistor set at the marked position.

.13 Take the photo-electric cell from the case containing the complete EEL photometer, and insert the plug into the socket, with the red spot on the plug adjacent to the spot on the socket. Switch to the number 2 range on the meter; if number 1 range were used, with maximum illumination, damage would probably result.

.14 Position the photo-cell over the illuminated patch by resting it on the mirror bracket housing cover, and, by moving the cell in each direction in a horizontal plane, obtain the maximum reading on the scale of the meter. Record this reading for future reference when checking the efficiency of the optical system.

.15 If the variable resistor (2 ohms) is turned past the 90*-mark, a pressure in excess of 12 volts will be produced, which will result in a shorter working life for the bulb. When new, the bulb has a consumption of 48 watts, but with age, a resistance builds up in the filament necessitating a higher voltage-input in order to maintain this wattage. It is therefore advisable to select a setting below 90 (say about 70, or 55–60 for early-type machines) when recalibrating with a new bulb, so that the input may be increased when required.

*or 50 in the case of machines up to No. 91059 which are fitted with 1-ohm resistors.

A new bulb should be substituted when the variable resistor needs to be turned past the 90°-mark to maintain the light-intensity.

.16 Consistent image-quality will be obtained by regular checks using the photometer daily, or, preferably, more frequently, and adjusting the variable resistor to give the required lamp output. *Note:* The photometer is a delicate instrument and should be handled with care.

08.05.00 Standardising

.01 Where more than one filmsetter is installed, calibration tests should be carried out as described in Section 08.04.00 but, with the added need to bring all machines to a common standard, the main requirement is to establish that standard having regard to economy of lamp life (i.e. avoidance of lamp over-run). The lamp brilliance of all machines should then be brought to this level by adjusting their rheostats.

.02 Light meter checks should be carried out at regular intervals and particularly whenever a lamp is changed.

.03 Any departure from the matched characteristics of the machines should be intelligently investigated.

.04 It should always be realised that a general decrease in light may alter the calibration of the grey-scale system, and adjustment of the rheostat to alter lamp brilliance should be used sensibly.

.05 Regular checks will reveal any spontaneous or unusual decrease in light. This is a defect, and a defect needs investigation and remedy.

'or 50 in the case of machines up to No. 91059 which are fitted with 1 ohm resistors.

SECTION 9

Optical system

09.01.00 Some characteristics of light

.01 These introductory notes are given because they embody principles applied in 'Monophoto' filmsetters. Each machine has two lenses (condenser and projection), two mirrors involving the critical angles of a transparent substance (glass) – these are the prisms – and two first-surface mirrors. It also has a plain, flat-sided piece of glass (09.12.00) used for refraction.

.02 In any transparent medium, such as glass, air or water, it is natural for light to travel in a straight line, provided that there is no change of density in the medium.

.03 When light encounters a transparent substance of different density, much depends on the angle of impact. If this is perpendicular to the plane of the surface, the light travels straight on, unaffected. If the impact (or 'incidence') is somewhat oblique, the path of the light is bent at that point; thereafter it continues in a straight line, but at an angle to its original path. This bending is termed 'refraction'; without it, there would be no such thing as a lens, and the depth of water in a swimming bath (for example) would not be deceptive. Note that the 'angle of incidence' is measured between the ray of light and the *perpendicular to the surface* of the medium.

.04 When light passes from a denser medium (such as glass) into a rarer medium (such as air), the emerging beam is refracted at a greater angle. The maximum angle of incidence from glass to air is approximately 40°, giving a beam that emerges at about 90° – that is, it is just glancing along the surface. This 40° angle is known as the 'critical angle' because, with any greater angle of incidence, the light no longer penetrates the surface but it is completely reflected back into the denser medium. Note now, that the angle of incidence is equal to the angle of reflection.

.05 Mirrors, of the kind familiar to all of us, are made of opaque materials; usually, this is a thin deposit of silver covered by a protective glass, but they are also made (as they were in ancient times) of highly polished bare metal – bare so that the light is not absorbed or distorted by a protective cover. These are known as 'first-surface' mirrors, and, obviously, they require to be treated with the utmost care for the preservation of their high-efficiency reflection.

09.02.00 Condenser lens

.01 Light from the electric projection lamp (08.00.00) spreads in all directions. From the diagram, it will be clear that the intensity of illumination of the plane surface below it will be greater at the nearest point than towards the edges. A condenser lens is therefore introduced to bend the divergent rays in varying amounts dependent on the varying thickness of the glass, so as to cause them to give an equal distribution of light over the working surface, which, in the case of the filmsetter, is the film matrix of a character. In general optical terms, this character-bearing piece of film is known as the 'object' and where this word occurs, it will be helpful to visualise it as a film matrix, although allowance must be made for exaggerations (for the sake of clarity) in the diagrams.

.02 The condenser is a detachable assembly housed in a bush secured by three screws in a socket formed in the bridge immediately below the projection lamp. It consists of two lenses, the upper plano convex and the lower double-convex, assembled with their curved faces towards each other. They are separated by a distance-ring and held in the bush, with the plane face pressed up to an internal flange, by a fine-threaded ring which can be slackened (if necessary) by a finger-nail. The same 'tool' can also be used to lift the assembly from its socket for cleaning, but do not dismantle it without cause. When replacing, note that the flange of the protective ring should be at the bottom.

09.03.00 Film matrix case

.01 This comes next in the light-path from the lamp, though as it provides the 'object' of the system it is, in a sense, its starting-point. Selection of the matrix has already been discussed (06.00.00) as has also its lowering into, and retention in, its precise position (06.10.05 and 07.02.00).

09.04.00 Variable aperture

.01 Provision is made in the matrix case for the inclusion (if required) of double-size matrices (0·4 in × 0·2 in – 10·16 mm × 5·08 mm) of large mathematical signs. Only half of one of these would be visible through the aperture immediately below it, unless arrangements were made for extending the aperture. On the other hand, a permanently enlarged aperture with a standard matrix would result in the image of the adjacent matrix being projected as well. Accordingly, the signal for any one of these large characters incorporates the Q perforation which, as described in 12.19.08, causes the size of the aperture to be doubled for the exposure of that character, after which it reverts to normal. See also 18.07.07E.

09.05.00 Shutter

.01 Replacing the cam-operated oscillating component of earlier filmsetters, the shutter is a constantly-rotating horizontal disc, with a circular aperture that gives a fixed exposure of approximately $\frac{1}{50}$ second. The shutter rotates at camshaft speed, and is timed so that the start of the exposure for a matrix of normal size takes place at approximately 225°.

.02 The drive for the shutter is taken from the gearwheel at the front end of the driven camshaft. An assembly, consisting of spur wheel, connecting shaft, bevel pinion and bevel gearwheel is contained in a housing secured to the back of the bottom front gear cover. The flexible drive, surrounded by its protective casing, terminates in short square-section shafts which spigot into the shaft of the driving gearwheel and the shaft of an assembly attached by three screws to the shutter housing. This assembly includes crossed helical gears driving the shutter spindle.

.03 Precise location of the shutter housing cover is of prime importance as it controls the ultimate placing of the matrix. Two dowels therefore govern the position of the cover which is held down by six screws; one of these also forms the spring post for the enlarged-aperture mechanism. When these screws have been taken out, two of them can be inserted in the holes previously vacant, for use as extractors if access to the shutter is required. Note that when the cover is lifted, it may retain the ball race that forms the upper bearing of the shutter spindle. If the spindle also rises, the gears will be unmeshed and care must be taken to ensure that the timing is correct (see 09.05.01) on re-assembly. If not, refer to 18.02.05E.

.04 Removal of the shutter disc will expose the cut-off mask operated by the *M*, *AC* or *BC* air stream (see 12.19.06, 12.17.02 and 12.17.03). For further details of cleaning and precautions in re-assembling, see 18.12.07A–D.

.05 If it should be necessary to remove the flexible drive to the shutter, undo the hexagon nut at each end of the outer cable. Do not allow the machine to be turned when either end of the cable is undone, or the shutter will have to be re-timed (18.02.05E). Release the rubber grommet from the bracket holding the upper control panel and withdraw complete the cable and union nut through the hole in the bracket. If a new cable is to be substituted, detach the grommet and thread it on to the replacement. Note that the driving end (that nearest the camshafts) contains the thrust bush, and then replace the grommet in the bracket.

When connecting the upper end of the cable to the shutter casing, make sure that the squared end of the inner cable fits correctly into its socket; engage and retighten the hexagon nuts. As a precaution, check the shutter timing.

09.06.00 'Prism box'

.01 Light that has passed through the aperture in the shutter now enters the face adjustment housing, generally called the 'prism box', a light-tight casing with a hinged door. Here it first encounters the optical flat, an auxiliary device, consideration of which is deferred to 09.12.00, as it is important to appreciate first the main principles of the lens and prisms in the box, and the reasons for their relative locations being correctly adjusted for every job. This requires the understanding of a little more theory.

09.07.00 Lens

.01 A lens is (amongst other things) a transparent substance with one side or opposite sides curved – generally the curve is spherical. Except when it is at right angles to the surface, a ray of light passing from air into glass is deflected and again deflected as it passes from the glass back to air. All the rays (A) parallel to the axis of the double-convex lens (B) are thereby concentrated at a point (F) on that axis. A familiar example is the burning glass which gathers sun-rays (travelling, for all practical purposes, from an infinite distance, and therefore all parallel) to a point where heat can rise sufficiently to cause a fire – hence the name 'focus' which is the Latin for 'hearth'. The distance of this focal point from the centre of the lens is known as the 'focal length' of the lens and, for a material of given density and curvature, it is a constant. Except by regrinding, therefore, it is not possible to alter the focal length of any glass lens.

.02 A ray of light passing through the centre of a lens continues straight on, without appreciable deflection. So consider two rays, from the same point at the top of an object. Beyond the lens, they converge and meet at a distance that depends firstly on the distance between the object (O) and the lens (L) and secondly on the focal length of the lens. In the plane of this meeting-point, an image is formed; note that, compared with the object, it is inverted.

.03 By varying the distance between object and lens, we can produce the image at different distances from the lens. The sizes of the object and the image will be in the same proportion as these distances; thus, if the object-distance is twice the image-distance, the object will be twice the size of the image, or, if the object-distance is (say) 4 units of length, inches, miles, centimetres or kilometres, and the image distance is 20 units, then the image will be 5 times as large as the object. This is the principle of 'reduction' or 'magnification', as the case may be.

.04 Provided the object is brightly lit, the image can be seen on a piece of white paper or a screen placed at the appropriate distance from the lens; the projected lantern slide (or 'transparency') is a familiar example. If the paper or screen is not at exactly the right distance, the image will have indistinct outlines and it will be said to be 'out of focus'.

.05 In a filmsetter, the duty of the projection lens is to produce a sharp image of the object (the film-matrix character) at the right degree of magnification; film-matrix characters are generally in approximately 8 pt size, and the images, which will be photographically recorded, may be needed in any size from 6 pt to 24 pt. (But see also 13.01.03–6.) It will be

realised that, to give a range of magnifications it is not sufficient to move the lens from one position to another between fixed positions for the object and the image, as this would also give loss of focus; the distance between the object and the image – i.e., the total light path – will have to be varied as well.

09.08.00 The prisms

.01 Changing the length of the light-path from the matrix case in its exposure-position to the point on the film where the image is focused would be easy if it were mechanically practicable to alter the position of either the start or the finish of the path, but this is not the case. Other means must be found.

.02 In principle, what has been done is to introduce two movable mirrors into the light path; by varying the distance between them, we vary the over-all length of the path and, at the same time, we have reduced to convenient size the space in which it has to be accommodated. We have folded it up.

.03 Each mirror is actually formed by a right-angled glass prism. Light entering the longest side perpendicularly is not deflected, but travels on to meet the inner face of one of the shorter sides at a 45°-angle of incidence which is greater then the critical angle (09.01.04). The light is therefore reflected across to the other short side, where the same thing happens again so that it emerges from the longest side, in a line parallel to that of its entry, but in the opposite direction. By duplicating the prism-mirror, we economise in space and establish a well-ordered and convenient arrangement. But dust, haze or oil on the clear surfaces will impede the light and reduce the brilliance of the image; cleanliness is therefore essential.

.04 At this point, it is appropriate to note that the range of object/image distances is considerably extended by moving the lens sideways, so that instead of having it before the first prism, we place it after the second prism. This change-over is effected by swinging the lever at the head of the prism box, though this must be done with full regard for the focusing bars (see 09.09.03).

09.09.00 Focusing bars

.01 From what has been said in 09.07.03, it will be clear that the largest images, requiring × 3 magnification (8 pt matrix to 24 pt image) will require that the length of light-path from film-matrix to lens shall be $\frac{1}{3}$ of the length from lens to image. The lens must therefore be brought comparatively near to the film-matrix and the subsequent light-path must be the maximum. The lens is therefore placed in its right-hand alignment (as seen in the prism box) and raised and supported on its longest focusing bar, the first prism is as low as possible and the second prism raised and supported on its longest focusing bar.

.02 Conversely, for the smallest image, requiring a reduction from 8 pt to 6 pt, the light-path from film-matrix to lens must be $\frac{8}{6}$ of the distance from lens to image – a long path before the lens and a shorter one afterwards. For this condition, therefore, the light comes down to the first prism, up to the second and then down to the lens, which is now in the left-hand alignment and therefore comparatively near the image-position. For 8 pt images, the distances must be equal, and, for other intermediate sizes, corresponding intermediate distances must be established.

.03 To produce exactly the right degree of magnification (or reduction) while retaining pin-sharp focus, it is necessary that lens and prisms shall be rigidly supported in exactly the right relative positions. This is done by the set of focusing bars, taken from a protective box and quickly fitted into position; each is clearly marked with the purpose (LENS, R. PRISM or L. PRISM) and size (6, 7, etc. or 6D, 7D, etc.) which it serves. At the bottom of each is a spigot for fitting into a corresponding socket in the prism box, and at the top of each is a carefully adjusted hexagon-headed screw, secured by a lock nut. The screw also is provided with an axial spigot which seats in a recess in the base of the lens- or prism-holder. It will be self-evident that if any dirt disturbs the seating at the top or bottom of a bar, the precision of the adjustment will be lost, affecting both the sharpness of the image and its size. On no account must the adjustment of any focusing bar be disturbed, as each has been most carefully set according to the needs of the individual machine; neither should any focusing bar provided for one machine be used on another. The number of its own machine is marked on each focusing bar, on the face opposite to the one where its duty is described. For this reason, whenever a replacement bar is ordered following loss or accidental damage, the number of the machine must be quoted.

.04 The height of the projection lens or a prism is varied by turning a knurled knob on its holder. This rotates a pinion engaging with a fixed rack. For resetting, first raise the lens or prism so that the spigot-end of the focusing bar can be lifted out of its socket, place the required bar in position, noting that it beds down firmly and then lower the component gently – but, again, firmly – on to the adjustable top end. A coil spring in the lens holder presses a friction pad against the slide to prevent free motion during the change-over, while flat springs on the prism holders serve a similar purpose.

.05 For 6- to 12 pt or 6- to 11D working, with the lens-axis in the left-hand alignment, the left-hand prism remains in its

uppermost position and the right-hand prism is adjustable. Similarly, for 14- to 24 pt or 12- to 24D working, with the lens axis in the right-hand alignment, the right-hand prism remains in its lowest position and the left-hand prism is adjustable.

09.10.00 Iris Diaphragm

.01 The intensity of light falling on the film matrix is – or should be – constant, and this governs the amount of light that can be transmitted to the image. If the image is a small one, the light will be concentrated to a small area, and therefore the image will be brilliant. If the image is a large one, the same amount of light must be spread over a large area which will, in consequence, be duller. It is a typographical requirement that all images should be equally brilliant, irrespective of size. Consequently, means must be provided for progressively lessening the available amount of light as the image-size diminishes.

.02 Inside the prism-box door will be found a table of sizes (point and Didot) and settings for the iris diaphragm, a device whereby the effective area of the lens can be reduced by turning a knurled ring attached to it. The ring carries a series of numbers corresponding to the figures in the table and any one of these can be registered against an index line engraved below the ring; a click can be both felt and heard as each position is reached. Note that this table also provides the mirror-bar stop settings mentioned in 10.18.06.

.03 The iris can be used to increase the available light in order to penetrate an anti-halation backing on a sheet of film (e.g. when exposing reverse-reading images through the back to obtain a direct-reading product). The iris can be opened a maximum of two extra notches for the 6–20 pt range, but at 22- and 24 pt settings, only one extra notch is available.

09.11.00 Safety vane

.01 The image-bearing beam of light leaves the prism box through an aperture in its base communicating with the mirror housing. So that stray light cannot pass the same way to produce possible fogging of the film, the aperture is provided with a spring-loaded safety vane which automatically covers it whenever the prism-box door is opened; take care not to open the vane accidentally. For this reason, the door must not be opened to consult the table, or for any other purpose, while the filmsetter is working.

09.12.00 Optical flat

.01 Although this is the first item in the prism box to be encountered by the light, consideration of it has been deferred from 09.06.01 because it is an auxiliary item for occasional use and does not form part of the essential optical sequence. It consists simply of a thick piece of glass with optically ground flat parallel faces through which the light-beam can pass at right angles thereto, without distortion or deflection.

.02 This glass is mounted between a flexible ring and the retaining flanges of its holder, which is carried by a rotatable spindle passing through the rear side of the prism box. Here it is fitted with a lever operated by the piston controlled in turn – by *L* air (12.19.05), for mathematical and other special working such as chemical formulae. When the spindle and glass are rocked through an angle, the light no longer meets the upper surface perpendicularly and consequently, on entering, it is refracted to one side because of the change in density. It continues in the new direction till it meets the lower surface, where, emerging into air, it is again refracted an equal amount, but in the opposite direction, so that it is now on a path parallel to the one followed when the *L* signal is absent.

.03 The signal is perforated when the keyboard operator requires – usually for mathematical setting – a character in the inferior position. The matrix case does not provide inferiors, but, on account of the change of light-path, a superior character will be deflected so that its image occupies an inferior position relatively to the normal alignment of the text.

.04 Because the light has not yet reached the lens to start forming the image, the amount of deflection given to it will be proportional to the body-size of the character. A hand-control at the rear of the prism box regulates the amount of the deflection: the head of an adjustable screw is calibrated with 60 equal divisions, and a small vertical scale registers up to six revolutions of the screw. The whole 240 available settings allow for the maximum deflection of 60%, so that close precision can be obtained. Inside the prism-box door, a table gives the settings for 5% increments, as the scale-readings are not actual percentages.

.05 While mathematical working will generally require a face of 8-, 10- or 12 pt or Didot, the principle of the deflecting flat allows it to be used for any size.

09.13.00 Travelling mirrors

.01 Having traced how a sharp image of the required size is produced, we now have to see how successive images are made to occupy successive and correctly spaced positions in the text. Light, bearing the image of the first character to be projected, passes down vertically (09.11.01) into the mirror housing where it strikes a 'first surface' mirror of highly polished bare metal adhering to a glass backing. The mirror, held by spring-pressure in two retaining clips, is mounted at 45° to the horizontal in a mobile frame which also carries a duplicate mirror, facing the first, and angled

at 90° to it. The light, therefore, is reflected horizontally from the first mirror to the second, which throws it vertically upwards. It passes through a slot in the top of the mirror housing, through a corresponding slot in the base of the film drum housing and so reaches the film attached to the drum. Distances have been so calculated that the point where the beam reaches the film is also the point where it comes to a focus, giving a sharp momentary image which is permanently recorded by the light-sensitive emulsion of the film.

.02 As soon as an exposure has been completed, the frame carrying the two mirrors is moved a short step towards the rear of the machine by the mirror bar, in anticipation of the next exposure. The length of the step is governed by the width of the character or space; how this movement is accurately measured and transmitted is described in Section 10.00.00.

.03 As the mirror-assembly moves through a succession of positions, the light travels a progressively longer path to a point further down the first mirror, across a progressively shorter path to the second mirror and up a progressively longer path to the film. The geometry of the scheme shows that the total length of the three paths remains constant. Consequently, neither sharpness of focus nor degree of magnification is lost by change of mirror-position. It will also be seen, on examination, that the distance moved by the image at any step is equal to twice the distance moved by the mirrors.

.04 Early examples of the Mark 4 filmsetter (up to and including no. 91148) incorporated two parallel horizontal rails on which the mirror bracket assembly was carried by four bushed wheels – one at each corner. Above and below each carrying rail was an additional rail for lateral stability. At the left-hand side of the mirror bracket assembly were three nylon discs, one at each top corner and one at the foot. These were pressed against their guide rails by correspondingly placed spring-loaded plungers, mounted in the assembly and sliding in contact with the two right-hand guide rails. Later models dispense with both the upper (guide) rails; the assembly is now carried on two steel balls in limited-travel grooves, one (19) being formed in the upper face of the support bar (11) and the other in the lower face of the tie bar (13). As seen from the front of the machine, the assembly therefore tends to swing clockwise, bringing a nylon guide, adjustable by a screw (22), into contact with the right-hand face of the lower guide bar (20). These relative positions are maintained by a spring-loaded nylon plunger (23) which presses against a guide bar attached to the side cover of the chamber. Risk of the assembly rising is countered by spring-loaded nylon plungers retained in the housings (15) by the screws (14); these plungers bear down on the upper face of the tie bar.

09.14.00 Optical Test Rig

.01 The optical test rig is used for viewing the projected image when checking the optical system. It consists of a slotted base plate with two locating pins on its under surface, and corresponding hand-grips on its upper surface. The slot corresponds with the aperture in the base of the film drum housing, and the locating pins ensure precise positioning on the machine. Mounted on the base plate is a translucent screen on which is etched a 12 pt scale graduated in half-ems from 0 to 60 ems, or, for Cicero, 0 to 56. The lower (frosted) surface of the screen is in exactly the same position (i.e. the same focal plane) as the emulsion surface of the film when on the drum. The zero position on the scale is the position from which normal projection commences (the end of the line), and, provided the mirror bar micrometer stop is adjusted according to the directions given in 10.18.06, no other adjustment is required.

.02 To assist accurate adjustment, the special sighting lens (supplied), should always be used with the optical test rig. For making the final line-up of character with any required setting of the mirror bar, first perforate the paper ribbon to address the roman capital H. Next, mount the rig on the machine in place of the film drum housing, with the zero reading of the scale to the front of the machine. Then switch on the constant voltage transformer (the main switch on the lower control panel) and position the control switch at LAMP. With air on, turn the machine by hand, to project the H. Place the sighting lens over the glass screen above the character, and adjust the focus of this lens to suit your sight. Ensure that the mirror bar is returned by hand to its line-starting position.

.03 The projected image of any other character can be examined in the same way.

09.15.00 Optical system maintenance

.01 It is imperative that all optical surfaces be kept free from dust and finger marks. The prism-box door should not be opened unless it is absolutely necessary to do so, and the dust cover on the mirror box should always be swung into position immediately, when the film drum housing is taken from the machine. Dust can best be removed with the special camel-hair brush supplied; if finger marks are found on any of the optical surfaces, they should be removed by careful polishing with a clean 'Selvyt' cloth.

.02 Every morning, inspect the mirrors, lens, prisms and optical flat for dust etc., and gently remove any such deposit with the special brush. To remove grease spots, use sparingly a high-grade lens-cleaning fluid e.g. alcohol, but this should seldom be necessary if all excess oil is regularly wiped from the bridge mechanism and adjacent parts.

.03 Every week, remove and clean the condenser lens with the special camel-hair brush and a 'Selvyt' cloth only. Reposition the projection lamp housing, using the meter and optical test rig as described in 08.04.06–10, 08.04.12–16 and 09.14.00. Clean all the other optical surfaces, except the mirrors, with cleaning fluid used sparingly to remove any atmospheric haze.

.04 A specially shaped tool is provided for wiping the first-surface mirrors with the 'Selvyt' cloth, and this should be done with the greatest care and only when the need is apparent. In extreme cases, remove the mirrors (18.07.06A) for washing in plain warm water only, with every precaution against scratching. As the reflecting surfaces have no protection, the cleaning process will accelerate their very gradual loss of reflecting power, which can only be remedied by replacement.

.05 Whenever any part of the optical system has been disturbed, it should be tested with a light meter (08.04.06–10 and 08.04.12–16) before work is resumed.

09.16.00 Optical faults and remedies

.01 If the image appears out of focus, check the designations and seatings of the focusing bars. Examine the optical system for grease or finger-marks.

.02 If a white spot is repeated in the same character, use an inspection glass to check its film matrix for dust or oil spots.

.03 If characters in a certain position in every line are unevenly exposed, verify that there is no dust or oil on the mirrors.

.04 If there is a density-drop of the images, examine the optical system for dust etc., make sure the projection-lamp housing is adjusted for maximum illumination (08.03.02), and confirm that the contact in the lamp holder is clean. If necessary, change the projection lamp. Be quite certain that the transparent cover of the matrix case is clean.

.05 If the image is blurred, and characters overlap in consequence, check the seatings of the focusing bars, project the image on to the optical test rig screen and check it for focus. Check the film matrix.case V seatings.

.06 Lamp efficiency. After taking any of the actions described above, check the lamp efficiency with a photometer (08.04.05 etc.).

SECTION 10

Mirror bar motion

10.01.00 General

01. As was mentioned (01.02.10), the successive positions of images in a line of filmset matter are arranged by a travelling pair of mirrors (see also 09.13.02) which normally move after every exposure, and after every non-exposure that represents a space. To achieve a justified line, therefore, calls for very precisely rationed movements. These must agree with the number of units of set allocated to each character or fixed space and with the units and fifteenths of units that constitute a justified space in every line, with due allowance for the set-size of the face being used.

.02 With this summary of our total mirror-bar-feed requirements in view, we can trace the means by which each demand is met. It will be seen that different routes must be followed until all meet at the point just prior to where the unit-allocation has to be converted, by consideration of the set-size, to a measurement. Our descriptions, therefore, will follow these convergent paths, and we will deal with their individual adjustments, before examining the course common to all of them. This will also help to make efficient and convenient use of the illustrations.

10.02.00 Unit feed

.01 It was pointed out (06.09.03) that Unit Shift provides for a given position of the matrix jaws (and therefore of the unit rack) to select either of two rows of matrices. As a general rule, every row contains characters of the same unit-value; exceptions are the occasional 'stray' characters that cannot be accommodated in their logical positions, and special provision is made by a supplementary signal for progressing the mirrors proportionally to the needs of these characters. Effect is given to the principle by the distance, measured from a zero point, at which the unit rack (7) is halted (simultaneously with the film matrix) prior to an exposure being made.

.02 This movement of the rack turns a spur gear (6) on a layshaft (12) at the right-hand side of the machine, and so revolves a helical gear wheel (2) at its rearward end. This, therefore, turns either clockwise or counter-clockwise as the rack is advanced or withdrawn by the matrix jaws (10). When positioned, the unit rack is securely held by the spring-loaded locking pin (9) carried down by the matrix case holder lever, so that the tip of the pin engages between two teeth on the upper face of the rack. This condition is maintained while the unit drive anvil (10.02.08) is positioned, the required amount of feed is measured by the descent of the selector on to it, and the anvil subsequently moved aside. The locking pin is then lifted by the matrix case holder lever in readiness for a new allocation of character-width.

.03 Meshing with the first helical gear is a second, mounted on a vertical shaft (3) to the left of the layshaft. This second gear is provided with a key so that it turns the selector assembly (03.17.00) which is, nevertheless, free to slide up and down under the control of the yoke (35) embracing the flanged sleeve (38).

.04 The yoke receives its motion from the camshaft. The rear-most cam rocks the unit drive cam lever (14), the top of which is normally attached to a pair of vertically swinging plates (15) by a latch (13) shaped like a broad inverted U. When no unit-feed is required, as, for example, during justification or for double-exposure, an air signal (12.19.07) operates a piston to move a trip finger (18); this lifts the latch out of contact with the cam lever which continues to rock without effect until the link-up is re-established by cessation of the signal. Meanwhile, the plates are stabilised by the tension springs attached to the plates (16).

.05 In case any accidental obstruction or malfunction should interfere with the free working of the unit selector mechanism, a safety device is placed between it and the swinging plates that convey the motion. This device takes the form of a spring box (20) which (in the illustrations, showing the mechanism from the rear) gives a positive thrust from right to left, by the right-hand end of the box pressing on the end of the rod (29); damage is unlikely to occur during this stroke. On the return stroke, the box moves to the right, pressing the spring against the abutment at the end of the rod. If the rod is free to move, it also travels to the right, but, if it is prevented, the spring is compressed. The guide (31) at the left-hand end of the box carries a pin (33) which, as it is moved to the right, trips a small bell crank or trigger (32) mounted on the rod, to allow a spring-loaded plunger (30) to travel to the right, relatively to the spring box. Further motion of the spring box (the main spring being still more compressed) brings the plunger into contact with a plate (22) which, in turn operates the air valve (24) in a fixed housing. This releases constant air to switch off the current to the electric motor (14.08.04). When the cause of the trouble has been rectified, the air valve is reset by finger-pressure on the extension of its spindle, and the trip-gear by pulling back the plunger and re-engaging the bell-crank trip by the use of a small screwdriver blade.

.06 By these means, up-and-down movement is given to the left-hand arm (still as seen from the rear) of the unit drive operating yoke (35), the duty of which is to raise and lower the selector operating sleeve (38) by a fixed amount; the illustration shows the components in the UP position, i.e. at rest. Note that this sleeve floats on, and is not attached to, the feed shaft (36), which has scope for considerable end-wise movement, but is required to turn very slightly also.

.07 Secured to the feed shaft is a feed yoke (37) which (10.02.03) embraces the top of the selector assembly and, in this condition, supports it, being itself held up by the operating sleeve.

.08 As the operating yoke (35) turns counter-clockwise, the downward travel of the operating sleeve is such that the 'follower', a horizontal projection from it, comes to rest a short distance above an anvil (39). The interval is slightly greater than the thickness of a selector ring. The angle through which the selector assembly has been turned by the unit rack (10.02.02 3) is such that the lug, representing the number of units allocated to the selected row in the matrix case, is positioned vertically over the anvil. If, now that they are unsupported, the feed yoke and selector assembly do not naturally fall till the lug rests on the anvil, they are lowered by pressure of the follower on the lug. Note that the amount of the fall has been determined by the position of the lug in the assembled selectors – that is, by the unit-value of the row in the matrix case. The importance of this is that the feed shaft (36) has descended an equal amount (10.02.10).

.09 Continued rotation of the cam now gives positive motion to turn the operating yoke (35) clockwise, raising the driving sleeve the full distance back to its rest position and returning the selector assembly, flanged sleeve, feed yoke and feed shaft *only through the distance they previously fell*. It will now be recognised that, if there are (say) two rows of matrices of equal unit-value in the matrix case, and the unit rack consequently advances by two different amounts, the fact that there are two lugs *on the same level* (i.e. a double lug) in the selector assembly results in an identical amount of fall and rise for the feed shaft in each case. Similarly, a triple lug selector serves three equal-value rows of matrices.

.10 In the lower part of the gearbox it will be seen that the feed shaft carries a feed rack (51). By means of a bell crank (10.04.04) the shaft can be rotated through a few degrees so that the rack is swung into mesh with, or carried clear of, a gear (47) mounted on the differential shaft (49); this lies parallel with the camshaft and passes to the rear of the gearbox. While the feed shaft is at rest in the raised position and while it is being lowered, its rotational angle is such as to keep the feed rack disengaged; during this period, a lock rack (48) secures the gear. Before the feed shaft is raised, it is automatically turned so that the feed rack is engaged and the same mechanism disengages the lock rack. This turning is not sufficient to disturb the interaction of the yoke (37) and flanged sleeve (38). Consequently, the measured rise of the feed shaft gives the pinion and differential shaft an amount of rotation that is proportional to the unit-value of the character concerned. The effect of this turning of the differential shaft is described in 10.15.00

10.03.00 Unit feed adjustments

.01 LOCKING PIN BEARINGS. Although the pin must slide freely in its bearings, it must not have any side-shake. Hold the unit drive latch out of engagement by inserting the wooden wedge (supplied) and adjust by tightening the nut (5) which draws together the split conical base of the bearing bush (8) and the split conical sleeve (6) at its head, thereby causing the bush to contract. If the nut is accidentally over-tightened, slacken it back and tap it lightly on top with a piece of wood or soft metal; then retighten it, but not so far as previously. Never leave the nut off its seating

.02 LOCKING PIN – TRAVEL. When the matrix case holder lever is at the top of its stroke, the tip of the locking pin should be $\frac{1}{16}$ in (1·5 mm) clear of the upper side of the unit rack. Turn the camshafts to 90° and press in the unit rack to present a plane face to the locking pin; using two spanners to avoid turning the pin, slacken off the lock nut and adjusting nut (1) at the head of the pin until its tip rests on the rack. Advance the adjusting nut to make contact with the abutment piece (3) and then tighten it exactly one-and-a-half turns more, before securing it with the lock nut, again using two spanners.

.03 Before attempting any adjustment of the unit feed, isolate the gearbox from the cam lever by removing the spring box complete with its mechanism; it can be lifted out after the pin in the yoke at each end has been withdrawn (see illustration 10.04.04). Also disconnect the feed and lock rack operating rod by removing the pin in the yoke attaching it to the adjustable extension of the operating bar. Swing the rod forwards to clear the yoke.

.04 CAM LEVER LATCH. As a preliminary to correcting any of the four following adjustments, slacken back the adjusting screw (13), which must be corrected finally (10.03.07). When the latch is in the raised position, with the swinging plates inwards, it must abut solidly against the end of the finger (10), with no tendency for the latter to force the latch downwards. To correct, see that the plug on top of the unit drive control box, which limits the rotation of the finger, is projecting upwards approximately $\frac{9}{16}$ in (14 mm), but vary this measurement as may be required to give a positive stop to the latch. Tighten the lock nut, and check.

.05 The clearance between the foot of the raised latch and the cam lever when in its outward position should be $\frac{1}{16}$ in (1·5 mm). To adjust, actuate the trip finger by giving the *ABC* signal and turn the camshafts to 230°. After slackening its lock nut, turn the screw (16); this will vary the horizontal distance between the fulcrum-points of the trip finger (10)

and the latch (11), thus varying the height to which the latch is lifted. Remember to retighten the lock nut. Adjustments 10.03.06–8 will now be necessary, as the rest position of the swinging plates (17) has been altered.

.06 The limiting inward position of the cam lever relatively to the swinging plates must now be adjusted. With the camshafts at 165°, slacken the lock nut and turn the screw (14) so that there is a clearance of 0·002 in (0·05 mm) between its tip and the abutment pad (15) facing it. Retighten the lock nut and re-check the adjustment.

.07 To ensure that the latch, when lowered, fits snugly over the top of the cam lever, see that the screw (13) makes only light contact with its abutment pad (12); although the plunger in the top of the cam lever is spring-loaded, the small clearance at the end of screw (14) allows no margin for error.

.08 If any further adjustment to the unit drive is required, the operative is recommended to obtain the services of a qualified engineer, for whom the following information is given.

.09 VALVE-OPERATING PLATE (see illustrations in Sub-Section 10.02.00). There should be a minimum clearance between the plate (22) and the end of the valve (24); this can be verified manually with the parts in position, but, if adjustment is needed, the sub-assembly should first be removed. To do this, detach the two air pipes from the valve box and then take out the two hexagon-headed screws securing the mechanism to the support bracket bridge (26).

With the plate resting against its stop, slide the valve box (23) into the appropriate position after slackening its retaining screws. With the adjustment made, retighten these screws and replace the mechanism in the reverse order of removal.

.10 DRIVING SLEEVE – UPPER POSITION.* Adjustment of the unit drive rod (25) is responsible for the position of the driving sleeve when raised – i.e. with the cam lever inwards (camshafts at 165°). When correct, this gives a clearance of 0·004 in – 0·007 in (0·10 mm – 0·18 mm) between the top of the selector yoke (28) and the base of the stop block (27); to rectify, first check that the adjustments detailed in 10.03.05–6–7 are correct. Then use an Allen key to slacken the screw holding the trigger block to the rod, and ease off the left-hand-threaded lock nut (26). Turn the rod with a tommy pin to give the required clearance above the selector yoke. Retighten the lock nut, check that the clearance has been kept, and then examine the effect of the alteration on the lowered position of the sleeve – see next paragraph.

.11 DRIVING SLEEVE – LOWER POSITION.* When correctly adjusted, this has a clearance of 0·006 in – 0·0011 in (0·15 mm – 0·28 mm) above a selector lug resting on the anvil (33). If the gap is too wide, the stroke of the longer arm of the operating yoke (21) must be increased by proportionate reduction in the effective length of the shorter arm, and vice versa. To effect this, first check that the adjustments detailed in 10.03.04–5–6 are correct; then remove the unit selector assembly (31), slacken the two securing screws (23) and turn the adjusting screw (22) as required to achieve a clearance of 0·104 in – 0·109 in (2·54 mm – 2·77 mm) between the anvil and the operating sleeve; gauge 21020A gives this measurement. As this alteration will also affect the angle of the rod (25), the adjustments detailed in both paragraphs 10.03.08 and 9 must be repeated alternately until both are simultaneously complying with requirements. After a final check, attend to the trigger and its block (21).

.12 TRIGGER (see illustrations 10.02.05). This must operate the air release for stopping the machine if any mishap should cause the gap between the lowered follower (29) and the anvil (33) to be increased to 0·186 in (4·72 mm), but it should not operate if the gap is less then 0·176 in (4·37 mm); gauge 25610D gives these measurements. First remove the three selector assemblies and disconnect the actuating lever of the gearbox feed- and lock-mechanism, with the lock racks engaged. After slackening its Allen screws, slide the trigger block (21) into approximately its correct position, and resecure it. Accurate adjustment of the point at which the trigger (32) is released can be obtained by varying the position of the pinch nuts on each side of the plunger washer.

10.04.00 Unit feed, feed rack and lock rack – described

.01 Mention has already been made of the alternate applications of feed- and lock-racks to control the unit-feed pinion on the differential shaft (49) (10.02.10). It will be noted that this shaft carries also two other gears (42 and 39); these contribute the proportions of feed for coarse and fine justifications, as described in 10.06.00 and 10.08.00. Each of the three gears is progressed by a feed-rack and held stationary at other times by a lock-rack. All six racks are moved simultaneously towards the engaged and disengaged positions respectively by the same group of mechanism.

*This procedure also applies in principle to the adjustment of the corresponding parts of the fine justification mechanism.

.02 As the operative stands at the right hand side of the filmsetter, he can look into the upper part of the gearbox. In the foreground are the three vertical shafts carrying the selector assemblies, the unit assembly (7) being the one on the right. Behind, and staggered, are the three feed shafts, each with a long countersunk key (15) and the tightly secured yoke (6) above the free-sliding selector operating sleeve (2). Shaft and key are a sliding fit in the pivot-hole of a 2-armed bell crank (24) which gives the shaft its rotary motion. The right arm of the bell crank supports the anvil (10.02.08) which is thus carried out of reach of the selector lugs when they are being positioned, to avoid obstruction.

.03 Behind the feed rack operating shaft is the shaft carrying, nearer its foot, the lock rack (32) and, at its head, a firmly attached lever which provides the rotary motion.

.04 Timed power for actuating the bell cranks is provided by the cams (44) at the front end of the camshafts, and the motion is transferred in two stages to the other side of the machine. A connecting rod (46), ball-jointed at both ends, links the top of the cam lever to a short intermediate lever which, through the operating rod (49), gives push-and-pull to a yoke. It will be seen how this operates the upper actuating lever (26), its shaft (28) and (pinned to the foot of the shaft) the lower actuating lever (27). Through this train, endwise movement is given to a bar connected to one arm of each of two bell cranks (30 and 18). The nearer crank (30) as seen from the right-hand side of the machine is located by key on the coarse justification feed shaft; through another arm, it transmits the movement to the bell cranks (25 and 24) which turn the fine justification and unit feed shafts respectively. Similarly, the further crank (18) gives rotary motion to the shafts of the fine justification and unit lock racks respectively. When the bar (31) moves towards the centre of the machine, all the bell cranks turn clockwise, bringing the anvils into the orbits of the selector lugs during the downward stroke of the feed shafts (with their feed racks disengaged), and swinging the lock racks into engagement.

.05 To summarise the co-ordinated movements, a timing diagram can be helpful. Starting at 5°, the matrix jaws move the matrix case and the unit rack to the positions needed for exposure of the next character; the action is completed at 105°. At 154° the locking pin starts to descend, becoming fully seated in the top of the unit rack at 172°. Meanwhile, at 160°, the anvil has started to move into its operative position, which it reaches at 186°. Operated by the same mechanism as the anvil, and therefore simultaneously with it, the unit feed rack in the gearbox is carried out of mesh with its gear wheel, and the lock rack is engaged instead, so that the feed shaft and rack can descend freely in preparation for their rising feed-stroke. At 276°, the anvil starts to swing clear of the selector assembly, while the feed rack is being remeshed with its gear and the lock rack is disengaged. At 306° (fractionally before the feed rack becomes fully engaged at 311°), the feed shaft and rack start the ascent which forms the feed for the mirror bar. Note that the locking pin which has been holding the unit rack since 172°, starts to release it only at 353°, just in time for its new positioning to start at 5°; the locking pin reaches its uppermost (rest) point at 10°.

.06 To prevent uncontrolled reversing of the unit feed gear wheel while the rack functions are being changed, it is provided with a pawl, lightly spring-loaded, which bears against its teeth at all times. Similar pawls safeguard the coarse and fine justification gears.

10.05.00 Unit feed, feed rack and lock rack – adjustments

01. If any adjustment is required to the positioning of the unit feed anvil or the unit feed or lock rack (the operation of the justification components being satisfactory), the operative is advised to obtain the services of a qualified engineer, as it will be necessary to detach the whole gearbox and carry out the work on the bench. Full details of the procedure are given in 18.08.03E–7E.

.02 If the justification feed and/or lock racks are also affected in the same way as those of the unit feed, also refer to 18.08.03E–7E.

10.06.00 Justification

.01 When the keyboard operator came to the end of a line, the width of the justified spaces was calculated, and signals, saying how many steps of coarse justification and how many of fine were needed for each space, were punched into the paper ribbon. Because of the reversal of the ribbon, these signals arrive at the filmsetter immediately before those for the characters of the line. The constituents of the space are therefore built up in advance of requirements and remain 'on tap' for use whenever a justified space is required until the exposure of the line is completed, when fresh justification will be needed for the next line.

.02 It will probably clarify the chain of events if we follow an actual example. Supposing that the line requires seven steps of coarse justification and twelve of fine justification to construct each of its spaces; the keyboard operator will

Justification	Keyboard	Perforations
Coarse	7, UPPER	*AC 7*
Fine	12, LOWER	*ABC 12*

first tap the 7 key on the upper justification row and then the 12 on *both the upper and lower rows*. The perforations for coarse justification are *A* and *C* and they will be accompanied by the 7 perforation, to form the first signal tapped. For fine justification, the perforations are *B* and *C*, so that the second signal consists of perforations *A,B,C,* and *12*. Section 12.17.02 .3 explains how the *A,B* and *C* air-streams interact, but the result is that the *AC* combination raises one air pin (4), and the *BC* combination raises another. (Remember that it is the full *ABC 12* signal that reaches the filmsetter first.)

.03 Each of these pins rocks a small bell-crank, the second arm of which presses forward a justification rack lever arm (11), lightly spring-loaded for return when the signal-air is released. The head of a rod (14) projecting upwards from each arm is thus brought into engagement with a recess in the matrix case holder lever (16) when in its downward position; as this lever rises, it therefore lifts the rods and causes the rack levers to turn on their pivots.

.04 Above the lower jaw of the rack lever (5) lies the coarse justification rack, normally held down by the upper jaw (so that the security teeth on its under-face – not the operating teeth – are anchored by a fixed centring tooth (7)), but now raised by the lever. Similarly, the fine justification rack is raised by an adjoining lever. The lugs at the ends of the racks have thus been brought up to a level at which they are caught between, and can be re-located by, the matrix jaws. These respond to the signal *12* and therefore carry *both* the racks to the corresponding position. At the cessation of the signal, a pair of small coil springs ensure reversal of the two levers; thus both racks are lowered to rest on the centring tooth, where their security racks hold them firmly in position.

.05 The *ABC* signal is also responsible for controlling other machine-functions essential to the starting of a fresh line. These are discussed in 11.00.00 and 12.18.02.

.06 In the example (10.06.02) being investigated, the next signal to arrive is *AC7*. As before, the *AC* operates the air pin (4) which eventually brings the head of the coarse justification rack *alone* into the path of the matrix jaws. These are positioned by the signal *7*, and the location of this rack is established in the same way as before.

.07 Operatives who have had experience of 'Monotype' Composition Casters will be familiar with the steps of 0·0075 in and 0·0005 in for coarse and fine justification respectively. These measurements do not apply in the case of 'Monophoto' Mark 4 Filmsetters. Mechanical details have been simplified by 'Proportional Justification' – that is, by the use of steps which are proportional to the set of the face being exposed. Every character has been designed with a certain number of units to indicate its width relative to its height; the steps of the coarse justification are, accordingly, of one unit each – *one unit of the set of the face*. The steps of the fine justification are each one-fifteenth of the same unit, so that the same relationship exists between coarse and fine as in hot-metal working. The description is continued in 10.08.00 (fine) and 10.10.00 (coarse).

10.07.00 Justification – adjustments
(See illustration 10.06.03)

.01 BELL CRANKS. If the setting is correct, the rod (14) clears the inner face of the slot in the matrix case holder lever (16) by $\frac{1}{64}$ in (0·4 mm) when the air pin (4) is raised and the lever at the bottom of its travel (i.e. between 220° and 320°). In this direction, the displacement of the rod is governed by the abutment screw (3). To adjust, perforate and transmit the signal *AC* (for the coarse justification), slacken the lock nut (1), re-set the abutment screw to give the required clearance, and retighten the lock nut. Check that the accuracy of the setting has been held. When both air pin and matrix case holder lever are down, the stop screw (2) should preserve the same clearance between the rod and the plate (15) at the open end of the slot. The lock nut and screw should be treated in the same way. Repeat the operation for fine justification, using the signal *BC*.

.07 LIFTING RODS. The matrix case holder lever (16) will break the lifting rod (14) if this is too short, attempting to raise either of the justification racks too high. On the other hand, if the rod is too long, the rack will still be held by the centring tooth (7) when it should be mobile, at the disposal of the matrix jaws. To avoid accident during the adjustment, uncouple the air tower hook, engage the tops of the lifting rods and turn the machine by hand. If all is in order, at 15° (i.e. with the matrix case holder lever fully up and the matrix jaws almost fully open), the racks, pressed to the right into the 1–1 position, should have the tops of their lugs approximately two-thirds of the way up the faces of the jaw-extensions. If not, slacken the lock screw (13) of the faulty rod and adjust the rod with a screwdriver. Check each rod separately (with the other disengaged) by pressing forward the base of its justification lever (5) to make sure there is vertical clearance between the head and the plate (15) on the matrix case holder lever. If necessary, re-adjust to obtain this clearance.

10.08.00 Fine justification (continued from 10.06.07)

.01 In its advances and withdrawals, the fine justification rack (7) rotates a spur wheel (6) mounted on a tubular shaft which encloses most of the layshaft operating the unit selector. The tubular shaft carries, at its rear end, a helical gear (3) driving a vertical shaft with a long key. On this

10.12.00 Engagement of feed and lock racks

.01 This sub-section is intended for the guidance of qualified engineers, and is to be read in conjunction with 10.09.00 and 10.11.00.

.02 GENERAL FAULT OF FEED AND LOCK RACKS. Incorrect timing of the rack-operation can only be due to abnormal play somewhere in the train of motion from the camshaft, giving rise to lost motion. Check all the following points, feeling for excessive freedom which will entail renewal: Ball-and-socket joints at the top of the cam lever (11) and at the right-hand end of the connecting rod (10). Fulcrum screw (8) on which the intermediate lever (9) pivots. Screw uniting the intermediate lever with the operating rod (7). Yoke pin (6) between this rod and the adjustable extension (5) of the actuating lever. Pins and lock screw securing the actuating levers to their shaft (2). Shaft bearings. Pin (1) linking the lower actuating lever to the connecting bar (4).

.03 Correct positioning of the rack-operating mechanism at the start of the cam lever's operating stroke is dependent on the proper adjustment of the hexagonal connecting rod (10) and the operating rod (7). The connecting rod has a left-hand threaded lock nut at its inner end; the length of this rod controls the position of all the racks, and it should be adjusted, if necessary, with the feed racks fully engaged, to give a minimum clearance between them and their gear wheels. Additional adjustment is provided, if required, by the operating rod which is joined to its yoke at the right-hand end by an adjustable coupling; the right-hand lock nut has a left-hand thread.

.04 The adjustable extension (5) has a right-hand-threaded lock nut; as this controls the length of stroke given to all the feed- and lock-racks, it should be carefully adjusted, if necessary, after the gearbox has been re-attached. With the camshafts at 200°, give minimum clearance (as for the feed racks) between the lock racks and their gear wheels. After making any change to this adjustment, recheck the previous adjustment, as the two work in conjunction with each other.

10.13.00 Inserting a justified space

.01 When a justified space is required, the *S* perforation is punched in the paper ribbon. It has to control the simultaneous employment of the coarse and fine constituents, represented – as we have seen – by the rotational position of the respective selector assemblies.

.02 From the air tower, *S* air comes in a direct line to raise an air pin (4) situated between those for raising the coarse and fine justification wedges. Its action is similar in turning a bell crank (3) to position a rod so that its head can receive lift from the matrix-case holder lever (2), but the mechanism at the foot of the rod is different. Straight lift is given to the 'free' end of the shifter lever (5), the centre of which carries a tubular spring abutment (23), lifting the bases of two concentric springs (24 and 25). The outer spring, bearing against the fixed projection of the locking pin stand will return the mechanism when the matrix-case holder lever descends again. The inner spring exerts upward pressure on its upper abutment (a sliding fit in the locking pin stand) and so, through the nut at the top, lifts the space bar shifter (6). Passing through its lower end is the space bar (7), locked in this position until now it is free to travel lengthwise.

.03 At every camshaft revolution, the space bar cam lever is rocked from right to left. At its upper end, a spring box (21) links it to the left-hand end of the space bar which is therefore drawn to the left (when free) by the cam action transmitted through the spring, and positively returned to the locked position. When the space bar is locked, the spring box absorbs the cam lever motion. The bar is transfixed by a pin (8) which passes between the twin-yoked arms of the operating lever (9). Through a shaft (11), movement of this lever is conveyed to an intermediate lever (12) and connecting rod (13) to a camshaft (15). Outward movement of the space bar thereby rotates the cam (16) counter-clockwise, releasing the shorter arm of the latch (17) which falls.

.04 The latch is mounted on a pair of swinging plates (18). As these are now secured by the latch to the justification drive cam lever (19), they provide the power for operating the justification mechanism in the same way as the neighbouring plates provide power for the unit mechanism (10.02.05–10.05.02). But it must be remembered that, whereas the air-controlled latch for the unit selector assembly is generally engaged, the mechanically controlled latch for the justification selector assembly is generally *dis*engaged.

10.14.00 Space-system adjustment (See illustrations in previous sub-section)

.01 BELL CRANK. This is adjusted in the same way as the justification bell cranks, 10.07.01.

.02 LIFTING ROD. When the matrix case holder lever (2) is fully down and the central lifting rod engaged, there should be a slight clearance below its head; it is held down by the action of the outer spring (25) through the lower abutment and shifter lever. A very slight manual lift (about 0·005 in, 0·15 mm) should be possible before the additional effect of the inner spring is felt. If not, slacken the lock screw and turn the head of the rod with a screwdriver until this condition is obtained. Then retighten the lock screw. This will establish the correct relationship between the shifter and the space bar.

.03 SPRING BOX. As the clockwise movement of the cam lever gives a positive return to the space bar, the correct length

of the connection between the two is essential to avoid damage. A correct setting can be verified by rotating the driving pin in the yoke, when the lever is in its clockwise position, and finding out whether it can turn freely. If it binds, slacken the lock nut on the plunger (22) and turn the camshaft to carry the lever outwards. The withdrawal of the spring box will expose a hole in the plunger which can, therefore, be turned (right-hand thread) with a tommy pin to reduce its effective length. Return the cam lever before attempting to check the result. If the rod is shortened too much, the shifter will not regularly enter the recess in the space bar, and justified spaces will be scattered about the text; consequently, accurate adjustment is necessary. Retighten the lock nut.

.04 OPERATING CAM. When the space bar is locked, the upper face of the operating cam (16) should be parallel with the corresponding cam of the unit drive; if not, it will fail to give correct disengagement of the latch (17). Access to its adjustment is obtained by disconnecting the four latch springs, reached from the rear of the machine. Behind them the operative will see the hexagonal connecting rod (13) which is screwed into its connecting yokes by a right-hand thread at the upper (or outer) end and by a left-hand thread at the other. Slacken off the lock nuts and turn the rod as required to restore the correct angle of the cam. Check after retightening the lock nuts, and reconnect the springs. When this adjustment has been made, check that the settings of the justification latch and main drive to the gearbox are still correct.

.05 JUSTIFICATION DRIVE CAM LEVER LATCH – ADJUSTMENTS. Except that the space trip finger will be already disengaged, the three adjustments affecting the latch are carried out in the same way as those of the unit drive cam lever latch (10.03.05–07).

10.15.00 Gearbox

.01 The three vertical feed shafts, representing (left to right in the illustration 10.04.02) coarse justification, fine justification and unit feeds, have – as we have seen – provided individual motions to three pinions on the gearbox shaft. The rack-motion resulting from each washer of the unit-selector assembly is proportional to one unit of set. The same applies to the coarse justification feed rack. But equal movement of the fine justification feed rack is required to represent only *one fifteenth of a unit*, so that means must be provided of obtaining a 15:1 ratio of reduction for this feed. The treatment of the three feeds must be examined first separately and then together, to understand how they give (still in terms of units of set) motion for a character-width, a justified space from the two justification-feeds simultaneously, or a justified space combined with character-width. The latter provision, 'combined spacing', results in economies in paper ribbon and in the filmsetter's running time, of some 16%.

.02 First notice that the coarse justification gear wheel C, the fine justification gear wheel F and the unit gear wheel U are all carried on bushes floating on the gear shaft. The only wheel in the gearbox attached to the shaft is E which gives it the combined effects of any or all of the three inputs. Constructionally, note also that the planet units consist (in each case) of a short shaft, with a pinion at each end, carried in bearings which, for our purposes, may be treated as though integral with the gear wheels F and U; the shafts pass through apertures in these gear wheels and counterweights are provided for balance. In each case, let us consider a feed of 6 teeth from the driving rack.

.03 A feed of 6 teeth turns gear U through $\frac{6}{96} = \frac{1}{16}$ of a revolution ↻ as seen from the rear, thus carrying the axis of the planet gears B D through a displacement of $\frac{1}{16}$ of a revolution ↻. Note that if B D were unable to rotate about their own axis, the teeth of D (being meshed with gear E) would cause E also to rotate $\frac{1}{16}$ of a revolution ↻. But, with gear A being fixed, B will roll ↻ round A and thus rotate $\frac{1}{16} \times \frac{28}{24}$ of a revolution ↻ about its own axis. (The condition is comparable with U being fixed and A turning ↺ so that B is rotated ↻.) This rotation of B – and consequently of D – will tend to drive E $\frac{1}{16} \times \frac{28}{24} \times \frac{18}{42} = \frac{1}{32}$ of a revolution ↺. However, we have already seen that the planet gear D has been displaced $\frac{1}{16}$ of a revolution ↻ round E, so that the net angular movement of E will be $\frac{1}{16}$ ↻ $- \frac{1}{32}$ ↺ $= \frac{1}{32}$ *of a revolution* ↻.

.04 Dealing now with the coarse justification feed at gear C, a 6-tooth feed will turn it through $\frac{6}{90} = \frac{1}{15}$ of a revolution ↻, and gear K is turned similarly. Because both the gears F and U are held by their feed racks, the train of motion through K, G, H, J, A, B, D and E is simply a matter for multiplication and division of the driving and driven teeth – $\frac{1}{15} \times (\frac{30}{18} \times \frac{18}{32} \times \frac{28}{24} \times \frac{18}{42}) = \frac{1}{32}$ *of a revolution* ↻. That is to say, feed to the coarse justification produces the same effect as the same amount of feed to the unit mechanism.

.05 Examination of the fine justification feed to gear F is a little more involved, but the principles employed for the unit-feed can again be applied. Here, as with the coarse justification, the gear F has 90 teeth, so that a 6-tooth feed gives it $\frac{6}{90} = \frac{1}{15}$ revolution ↻. Assuming, first, that the planet gear GH is locked on its own axis, then this turning of F would cause J also to rotate $\frac{1}{15}$ of a revolution ↻. But, since we are treating K as fixed, G will roll ↻ round it and thus rotate on its own axis $\frac{1}{15} \times \frac{30}{18}$ of a revolution ↻. This rotation will tend to drive J $\frac{1}{15} \times \frac{30}{18} \times \frac{18}{32} = \frac{1}{16}$ of a revolution ↺. At the same time, the planet gear has been carried round J (by F) $\frac{1}{15}$ of a revolution ↻. Therefore the net motion imparted to J is $\frac{1}{15}$ ↻ $- \frac{1}{16}$ ↺ $= \frac{1}{15 \times 16}$ revolution ↻, which is also the

motion of A. As the gear U is being considered as locked, the gears A, B, D and E may be treated as a straightforward double-reduction of $\frac{28}{24} \times \frac{18}{42} \quad \frac{1}{2}$, so that the angular movement of E will be $\frac{1}{2} \times \frac{1}{15 \times 16} \quad \frac{1}{15} \times \frac{1}{32}$ *of a revolution* ↻ – that is, the required fraction of the output resulting from an equal feed to either the unit or the coarse justification gear.

.06 Each of the feeds, Unit and Coarse and Fine justifications, has been considered in turn. It is reasonable to suppose that, with suitable introductory mechanism, they could all be given successively to a single character, for combined spacing. Time and mechanism are both saved by giving the three feeds (or two only, according to requirements) simultaneously, their effects being simply added together, though the tracing of such motions in full detail would confer no advantage.

.07 After the exposure has been made, the next character or space will add its quota of motion, and so on, step by step until the line is finished. The justification racks will then be repositioned and other preparations made for the succeeding line.

10.16.00 Differential shaft – adjustment

.01 No perceptible end-play should be allowed in the differential shaft; an adjustable thrust-bearing is therefore provided at its forward end. To reset this, slacken the lock nut (2) and turn the adjusting screw (1) clockwise to take out any play. This screw presses the thrust ball (4) against the end of the shaft, causing this to carry the unit gear wheel E (which is secured to it by a taper pin) towards the rear. The boss of this gear wheel abuts against the flange of the rear bearing of the shaft. After checking that the shaft is still free to turn, tighten the lock nut and finally check that the adjustment has been correctly held.

10.17.00 Set gears

.01 The output shaft of the gearbox has been given motion corresponding to the required number of units and fifteenths of units of set, irrespective of what the set may be. The mirror bar, on the other hand, will need to be moved a specific distance* which is the product of the unit-feed and the set of the face (01.03.00). Conversion from the unitary count to actual measurement of distance is effected by introducing a gear ratio, variable according to the set of the face.

.02 Accordingly, the output shaft, projecting from the rear of the gearbox, is keyed to carry and drive an interchangeable set-change gear (3). This is one of a number provided to meet all requirements; in addition to the ranges of 5 to $16\frac{1}{2}$ set in quarter-set increments, and from 17 to 30 set in half-set increments, gears are supplied (as standard equipment) for 4 and $4\frac{1}{2}$ set, 28, 29 and 30 set.

.03 Two considerations prevent the arrangement from being the direct engagement of two simple gear wheels: a) Provision must be made for correct meshing with a variety of driving wheels (10.17.04). b) The large number of ratios required to be available would necessitate an equal number of driving wheels, if no change of driven wheel were possible (10.17.05).

.04 An intermediate gear wheel (2), having an adjustable axis-position, conveys the motion from the driving gear (3) to the driven gear (7). It is mounted on a swinging frame (6) which can be locked at any suitable angle by the hand-grip nut (8), and the intermediate gear can be positioned as required on the arm and held there (though free to revolve) by the hand-grip nut (1) or, in the case of 28–30 set, by the lock nut. By this means, it can be brought into correct mesh with both of the other gears simultaneously, irrespective of their diameters.

.05 Choice of two ratios is provided by the driven pinion (7) which, as can be seen, is a double gear. It slides on a keyed shaft so that it can readily be reversed to bring either of its sets of teeth into alignment with the intermediate gear (2).

.06 Protection to this train of set gears is given by a hinged cover with a spring latch. When it is closed, two bosses (5), integral with the cover, serve to hold the driving and driven gears on to their respective shafts; when it is open, change of gears is quick and simple as they are stamped with the sets to which they relate.

10.18.00 'Final' drive

.01 Now that the amount of feed, whether for a character, a space, or both at once – an actual distance, and no longer a proportion – has been determined, it only remains to deliver it accurately to the mirror bar, so that the succeeding character can appear in its correct position in the line being exposed.

.02 The shaft carrying the double gear (8) therefore takes the drive forward again, into the 'final' drive housing, below the gearbox, to a helical gear (14) meshing with a corresponding vertically mounted wheel (2). Note that the horizontal shaft passes through an oil seal (6) and that it is supported by two plain bearings (9 & 13) which are themselves housed in a flanged steel sleeve (11) secured to the gearbox by two screws (4); a grub screw steadies the front bearing. Rearward movement of the shaft is prevented by contact of its shoulder against the flange of the front bearing (13); forward movement is prevented by the single-ball thrust bearing (15).

*This is half the distance needed for the movement of the image

.03 Carrying at its top the helical gear wheel (2), a short vertical shaft projects downwards, through an oil seal (18) in the base of the gearbox, to provide movement for the upper half of the magnetic clutch – movement which, as we have seen, has been carefully calculated and measured. It turns a thin horizontal plate of corrugated metal (33), to the outer edge of which is secured an annular armature. While no current is flowing to energise the clutch, the springy nature of the plate holds the armature up against its support (20), the whole being shielded by a cover (34).

.04 An extension of the lower part of the gearbox supports the remainder of the clutch – the rotor. When switched ON, an electric current in the coil surrounding the rotor (22) magnetises it so that it draws the armature down (a very small distance) into close contact. All rotation of the armature is thereby transferred to the rotor without any possibility of backlash though, as a precaution against damage, any major obstruction in a later part of the mechanism will result in slip at this junction. The rotor is secured by a retaining plate, screw and key to another vertical shaft (24). After passing through a bearing bush, this shaft carries a circular adjusting nut (26), a lock nut and the driving pinion (28). It rests on a single-ball bearing (29).

.05 Immediately behind the driving pinion (as seen from the right hand side of the filmsetter) is the rack (39) of the mirror bar, backed by a spring-loaded plunger to keep the two in close contact. A pair of small ball races maintains the horizontal positioning of the rack so that its teeth are parallel to those of the pinion and meshed throughout their length. The starting position of the mirror bar (representing the end of a line of text) is at the front and it is withdrawn to the rear as exposure of the line proceeds.

.06 Forward of the rack, a micrometer stop is attached to the mirror bar. Its purpose is to ensure correct alignment for the first characters in all lines (apart from signalled indents), irrespective of the size of character being projected. Operational adjustment is by turning a milled disc (37), which carries a scale of numbers to the position given on the table in the prism box (09.10.02). Note that a spring pointer engages the selected one of the 50 milled notches, each of which represents a value of ·02. A complete revolution of the disc (clockwise) reveals the first of two white rings painted, for identification, on the spindle. Another full turn reveals the second.

.07 Normally, the zero position of the micrometer stop is where it is in contact with a fixed abutment (35) at the rear face of the mirror bracket housing. When multi-column work is to be undertaken, one (or more) of a set of gag blocks is placed on the rod (38) above the forward end of the exposed part of the mirror bar, and secured there by the clamp, thus providing for variation of the zero position. At the same time, it is advisable to detach the two auxiliary springs from the yokes of the mirror return lever spring box if the work is more than 30 ems wide; this will avoid the application of excessive pressure.

.08 Inside the mirror bracket housing (part of which extends below the prism box), the front end of the mirror bar is coupled to a cage fitting on the rear face of the rear mirror bracket. The front and rear brackets are united by a tie bar, making the whole a rigid, triangulated structure. See also 09.13.04.

10.19.00 'Final' drive adjustments (See also illustrations in preceding Sub-section)

.01 Great care has been taken to allocate precise widths to characters and spaces throughout the mechanism leading to the set gears. It is therefore of prime importance that there should be an absolute minimum of lost motion between this point and the travelling mirrors that finally direct the images on to the screen. The operative can contribute to this ideal by ensuring that the set, intermediate and reversible double gears (8) are fully meshed, and that the swivel arm and the intermediate gear it carries are adequately secured before a run is started. He should also be sure that there is no play between the interchangeable set gear, nor the reversible double gear, and their respective shafts.

.02 Three adjustments are provided for the mechanism of the 'final' drive sub-assembly, to counteract (a) endwise movement of the horizontal shaft (3), (b) lateral movement of this shaft and (c) rise of the vertical drive shaft (1). As all these adjustments, and those that follow, are critical, should any of them require attention, the operative is advised to obtain the services of a qualified engineer, for whom the following information is given.

.03 Although it is obvious that adjustment (a) above can be made on the machine by means of the screw (17), the conditions under which the setting can be made are only satisfactory when the 'final' drive sub-assembly is detached. Adjustment (b) is most conveniently effected at the same time. Refer, therefore, to 18.09.02E. Adjustment (c) is made with the sub-assembly in position on the machine (10.19.04), but only when adjustments (a) and (b) are correct.

.04 VERTICAL DRIVE SHAFT. This must rotate without end-play which would induce some degree of rotation. The underside of the driven helical wheel (2) rests on the flange of the bearing bush through which the vertical shaft passes. Upward movement is prevented by a single-ball thrust bearing regulated by the screw (12, Fig. 10.15.02). To adjust, first drain the oil from the lower half of the gearbox

by removing the drain plug (13, Fig 10.15.02); if the oil is run into a clean receptacle with a capacity of $\frac{3}{4}$ gallon ($3\frac{1}{2}$ litres) or more, it may be re-used subsequently. Take off the lower side cover of the gearbox (fourteen Allen screws)

this will be necessary because of the repositioning of the pawls towards the end of the operation. Access to the adjusting screw is most readily obtained by removing the complete differential shaft. To do this, detach first the intermediate gear and the swing frame (with its guide screw) of the set gear assembly at the rear of the gearbox. Remove the four Allen screws securing the housing of the rear differential shaft bearing; to withdraw the housing from its two taper pins, borrow, as jack screws, two of the $\frac{1}{4}$ in screws from the support blocks of the selector shaft plate, obtainable after taking off the layshaft cover. The housing will now come away complete with the bearing, shaft and differential gears. As soon as it is clear, find and safeguard its front end thrust bearing ball (4, Fig 10.15.02) which may have fallen on to the gearbox floor, or it may be trapped between the differential shaft front bearing and the plug carrying the adjusting screw. At once replace the two borrowed screws, tightening them firmly, and the layshaft cover. Next, take off the clutch housing (18.10.01A). Remove the clutch plate and partly replace the central brass screw; by holding this, any vertical play of the shaft can be detected. Working with the right hand through the aperture left by the differential shaft bearing housing, use first a spanner with an opening of $\frac{1}{2}$ in (12·7 mm) to slacken the lock nut of the vertical shaft adjustment screw, and then a spanner with an opening of $\frac{1}{4}$ in (6·4 mm) to turn the adjusting screw (T2, Fig 10.15.02) itself. Meanwhile, with the left hand, check that vertical play is eliminated but that the shaft is still free to turn. Retighten the lock nut and check that the adjustment has been held. Before replacing the differential shaft, use vaseline to secure the end-thrust ball in the socket at the front end, and then insert this through the rear aperture. With the left hand, depress the three ratchet pawls in the base of the gearbox so that there is clearance for the gears to pass; when the rear bearing of the housing is fully home, release the pawls and note that they all locate correctly with their respective gears. After replacing and tightening the four Allen screws check that the shaft is free to rotate, without end-play, proving that the ball is in its right position. Replace the clutch housing (18.10.01B) and the lower gearbox side cover with its fourteen Allen screws, and return the oil through the upper half of the gearbox. Replace the swing frame and the associated gears.

.05 PINION SHAFT SUPPORT. The shaft (24) must be so supported that a clearance of 0·004 in to 0·006 in (0·10 mm to 0·15 mm) is maintained between the rotor (22) at the upper end of the shaft and the armature (21) which rotates with the vertical drive shaft (1), constituting the two members of the electro-magnetic clutch. The pinion shaft rests on a single ball (29) supported by a conically-based locating insert (44). The foot of this mates with the conical end of the adjusting screw (45). Before correcting, slacken the pinion shaft restraint (10.19.06); then turn the adjusting screw (after releasing its lock nut) to give the required clearance which can be measured with a feeler gauge. In case of any irregularity, treat the above dimension as the minimum permissible. Retighten the lock nut and check. After any alteration to this setting, a further correction, as detailed in 10.19.06, will be necessary.

.06 PINION SHAFT RESTRAINT. To prevent the pinion shaft rising when the magnetic field of the clutch is operative, it is provided with an adjustable ring nut (26) which, bearing against the base of the bush (25) in the bearing block, acts as a thrust ring. It should permit free rotation, but there should be no perceptible end-play of the shaft. To adjust, use C-spanners first to loosen the lock nut (27) and then to turn the adjusting nut as required. After retightening the lock nut, check the adjustment.

.07 MIRROR FEED BAR – VERTICAL MOVEMENT. Minimum clearance should be allowed between the mirror feed bar and the roller bearings (41) between which it runs. These bearings are eccentrically mounted on the two pins (40) each of which is locked by a small Allen screw in the rear face of the housing. To adjust, take off the cover plate (one cheese-headed screw), release one of the Allen screws and turn the pin as required; use a spirit-level, first on the mirror bracket housing cover and then on the feed rack, to check that these are strictly parallel. If there is insufficient movement, treat the other screw and pin in the same way. After locking up, check that the adjustment has been held.

.08 MIRROR FEED BAR RACK – LATERAL MOVEMENT. Correct meshing of the pinion and rack is maintained by a nylon pad (49), spring-loaded, and carried by the bearing block (48). This block is secured by the nuts on two studs (47) passing up through elongated holes in its base; these enable regulation of the pressure which the pad exerts on the rack. When the setting is correct, it should be possible to insert a 0·002 in (0·05 mm) feeler (but not a thicker one) between the rack and the pad, causing the pad to bottom in its recess. To adjust, proceed as follows: Facing the bearing block, slacken the nuts on the vertical studs (47) and also the lock nuts on the two adjusting screws (43). Ease back the screws a couple of turns. Insert the feeler gauge between the rack and the pad, and draw the block firmly, but not forcibly, towards you, thereby compressing the springs (46) behind the pad. Without relaxing your grip on the block, do up the adjusting screws until they are in contact with the studs. Then tighten the lock nuts and verify that the minimum clearance of 0·002 in (0·05 mm) is maintained

along the whole length of the rack. If so, retighten the holding down nuts and give a final check.

.09 MIRROR FEED BAR RETURN SPRING BOX. If this spring box has been removed for any purpose, or if a replacement is being fitted, make sure that the spring rod (56) is screwed sufficiently far into its yoke to ensure a clearance of approximately $\frac{11}{16}$ in (17·5 mm) measured from the centre line of the forward stud securing the clutch pinion bearing block, to the rear face of the return lever roller, when the line feed mechanism is at rest. After adjusting, check that there is still an ample length of rod threaded into the yoke, and that a $\frac{1}{4}$ in (6 mm) compression of the spring is visible when the mechanism is fully forward.

SECTION 11

Line-end sequence

11.01.00 General

.01 When the keyboard operator had completed a line of text, he tapped a key for the coarse component of the justified spaces required and then two keys for the double justification (fine and coarse components). The perforations recorded were *AC* (plus a number) and *ABC* (plus a number), respectively. Sections 12.17.02 and 12.18.02 describe how the effects of the individual air streams, though not the streams themselves, are combined by the filmsetter, and Section 10.06.00 deals with the construction of the justified spaces in preparation for use in the succeeding line.

.02 Because the paper ribbon is fed through the filmsetter in the reverse order, the double-justification signal *ABC* arrives first and it is the point of demarcation for the preparations for the new line. It must not be forgotten that this combined signal does not simultaneously cancel the individual effects of *A* or *B* or *C*, or of *AC*, or *BC*. The last two simultaneously position both the coarse and fine justification racks to the requirements of the fine justification.

.03 Consideration of the conditions to be established shows that several functions must be put into action. The mirrors must be returned to their zero position so that the beginnings and endings of complete lines shall be in true vertical alignment. The film must be fed on, by a specified amount corresponding to point-size and interlinear spacing (if any). But meanwhile, the shutter must be kept closed to avoid unwanted exposures, and the unit drive to the gearbox is disconnected as an incidental consequence of the *AC* and *BC* components of the signal. (The normal state of the justification drive is 'unlatched'.) Furthermore, it would be impracticable to make the mirrors, in returning to zero, reverse the action of the gearbox assembly, so the clutch-drive must be interrupted. Finally, the paper-feed must be suspended for 4 camshaft revolutions to enable these changes to proceed without the arrival of any fresh signal.

.04 These constitute the line-end duties to be performed by the *ABC* signal; to this may also be added the *D* perforation which gives (when present) a supplementary film-feed. This will be of 6 points unless modified by hand control, subtracting $\frac{1}{2}$ pt, and/or by an extra perforation in the *E*-to-*I* range (See 11.07.00).

11.02.00 Paper lock

.01 To suspend the paper-feed, a lead is taken from the *ABC* air stream (see 12.18.02) to the space below a piston (5) in a control box mounted on the side of the air tower. The rising piston tilts a lever (4) above it, so that it obstructs the movement of the arm (1) of the paper locking pawl which is, of course, in the locked position in the teeth of the pin wheel (see 05.07.02).

.02 When the camshafts have made four revolutions (without paper-feed), the film drum feed shaft (see 11.03.02) will have completed one revolution, bringing a cam into contact with a lever. This depresses an air valve from its seating, allowing constant air to pass to a piston (6) in a cylinder adjoining, but larger than, the one operating the paper lock. It reverses the tilt of the lever (4). Consequently, the locking pawl is released and paper-feed proceeds normally, transmitting, in the case of justified text, the *AC* signal for lifting the coarse justification rack, so that the matrix jaw tongs can reposition it where it is needed before the first of the characters is signalled.

11.03.00 Ratchet and gear shafts

.01 On the shaft carrying the handwheel is a worm (1) giving continuous motion, but at the reduced ratio of 4:1, to an inclined ratchet shaft (5). As one of the two cams (4) which this shaft carries is four-lobed, it can transmit to the operating bar impulses synchronised with the main camshafts, and these impulses are used to time air-flows *ABC*, *AC* and *BC* in the lower signal timing box described more fully in Section 12.12.00. (*K* air, for Unit Shift, is timed by the [illegible] eight-lobed cam (3)). Keyed to the foot of the ratchet shaft is the ratchet (7) itself; it has four teeth for giving intermittent timed motion to the functions of the film drum feed shaft (15).

.02 On the same axis as the ratchet shaft and immediately below it is the gear shaft (12). This carries, at its head, the disc (8) on which is pivoted the pawl (9), normally held back to where it is clear of the ratchet on the ratchet shaft by one arm of the trip lever (11). *ABC* air, timed by the cam (4), presses the other arm of the trip lever to the rear so that the pawl is released and is then drawn by its spring into engagement with a tooth of the rotating ratchet. Consequently, the disc and gear shaft turn with the ratchet shaft, giving the motion to the bevel gear (14) which mates with a corresponding one on the film drum feed shaft (15) to effect the main actions of the line-end sequence.

.03 Before the disc (8) has completed a revolution, *ABC* (timed) air pressure is cut off and a spring-loaded plunger returns the trip lever so that its other end arrests the outer end of the pawl, disengaging it from the ratchet and so cutting off the drive. Any tendency of the disc (and its following mechanism) to 'run wild' is overcome by the two spring loaded friction pads (10) pressing against its circumference.

11.04.00 Return of mirrors

.01 For the return of the mirrors to their starting point for the next line of text, a track cam (3) is provided in a cylindrical member at the rear end of the film drum feed shaft (1). Running in this track is a roller (2) mounted on the cam lever (4) which is therefore caused to oscillate by a revolu-

tion of the shaft. The mirror-return movement is conveyed to the mirror return lever (13) by the tube-enclosed spring and by the auxiliary springs (6). The longer arm of the return lever carries a second roller (9) which, when the lever swings forward, contacts the base of the adjustable stop (10) attached to the mirror bar, and quickly presses it to the zero position. After a pause, the cam positively carries the lever rearwards again, by end-pressure on the tube, so as not to interfere with the mirror-bar feed as setting recommences. See also 10.19.10.

11.05.00 Eliminating reverse drive

.01 Without provision for a break in the transmission line, the forward travel of the mirror bar to zero would require reversal of all the mechanism back to the unit and justification gears in the gearbox. Paragraphs 10.18.03–4 refer to the magnetic clutch. It is included for the purpose of breaking the drive and re-establishing it without slip or back-lash. One of the duties of *ABC* (timed) air is to operate a piston which opens a switch in the rear control panel (14.09.05) to cut off the current to this circuit, rendering the clutch inoperative until the switch is restored by spring-action at the cessation of the air-stream.

11.06.00 Normal line feed

.01 From the procedure mentioned in Section 03.00.00, and examination of the film drum, it will have become fairly obvious that the positions occupied by the film to produce successive lines of text, at pre-arranged intervals, are obtained by partial rotations of the drum – a measured amount of turn before every fresh line is begun. The amount of turn can be regulated in $\frac{1}{2}$ pt steps from 0 up to 24 pt, after which one or more blank lines would have to be signalled, if necessary. In normal operation, the filmsetter responds automatically to the line-spacing selected on the external scale; Section 11.07.00 deals with signals calling for occasional extra 'leading', to borrow the term familiar in hot-metal working. Timing is clearly synchronous with other line-end functions; it is controlled by the *ABC* (timed) air and powered by the same source as the mirror-bar return – the film drum feed shaft (4).

.02 Immediately forward of the driven bevel gear are two additional cams providing timing related to the line-end sequence of the film feed shaft rather than to the production-routine of the main camshafts. One cam, of the single-lobed type, is for the release of the paper lock mentioned in 11.02.02, but see also 12.14.02. The other cam is an interrupted ring (2) which normally retains the diamond-shaped pad on a lever (3); when the cam rotates, the pad can escape (under the influence of *D* air, if signalled) through the gap in the ring, allowing movement of the lever and this, in turn, releases constant air to effect the signalled automatic variable line feed – see also 12.19.02.

.03 On the front part of the film drum feed shaft are two cams and a crank. These provide the motions necessary for the controlled turning of the drum, effected through the turning of the graduated gear (11). The normal routine for advancing the drum is as follows: (A) Following its last movement, the drum is held during the line of exposures by the maintained hold of a stationary rack (13) meshing with the graduated gear (11). (B) In front of this, a second rack – the feed rack (17) rises into engagement with the graduated gear. (C) As soon as these teeth have started to engage, the first rack is lowered out of engagement. (D) The feed rack moves to the right, turning the graduated gear, and then remaining stationary. (E) The first rack rises to re-engage with the graduated gear. (F) The feed rack is lowered out of engagement and returned to the zero position, leaving the graduated gear held by the first rack. Functions A–F are effected by the crank (8) and cam (7). Note that the first rack, which, in normal operation, acts simply as a lock rack, has an additional feed duty described in 11.07.00.

.04 The vertical movements of the racks are provided by the cam (7) which has one roller above and another below it. The top roller is mounted at the end of a two-part lever (18 and 21), pivoted at its further end; this lever carries the first rack, for locking the graduated gear, and it is engaged when the lobe of the cam is uppermost. If it is necessary at any time to turn the drum by hand, the hold of this rack can be freed by slackening the hand-grip nut, the spindle of which secures the two parts of the lever to each other.

.05 The bottom roller is mounted on a lever (25) with an intermediate bearing so that its right-hand end is lowered when the two-part lever (18 and 21) rises. A spring (26) ensures that both rollers remain in contact with the cam. Attached to the right-hand end of lever (25) is the T-shaped slide (14) carrying the feed rack which thus receives vertical motion. Behind it, the first rack (13) rests in a recess in the top of its carrier (18) and, as will have been noted, it rises and falls in opposition to the travel of the feed rack (17), thus providing the alternate, but overlapping, engagements of the two with the graduated gear.

.06 Horizontal motion, to advance the feed rack, is provided by the crank (8) on the film drum feed shaft. It carries a roller which, oscillating in a vertical groove in the left-hand end of the film drum feed cross slide (22), causes it to move transversely on supporting rollers, and so to actuate a lost-motion mechanism. By means of this, any required proportion of the cross-slide travel can be transferred to the driving head (23). This projects into the base of the feed-rack (17), carrying it through whatever may be the predetermined amount of line-feed, regulated by knob (19) and

indicated by the pointer (16) registering with the scale on the cover.

11.07.00 Automatic variable line feed

.01 Occasions may arise where additional white space is required between lines of text – e.g. at paragraph-ends. An increment of up to six points can be automatically provided in response to a signal tapped at the keyboard. In addition to the *ABC* signal for a normal line-ending, the perforation *D* is included; this gives the full 6 pt increase, but if one of the perforations *E–I* is also present, the amount is reduced. Manual control enables the filmsetter to be pre-set to reduce the whole range of extra-space provisions by $\frac{1}{2}$ pt each.

.02 The mechanical effect of the *D* air-stream is to give endwise motion to the component referred to in 11.06.03 as the 'first rack', so converting it into a feed-and-lock rack, the feed function being the required increment. For this purpose, the rack is capable of sliding longitudinally in the recess in the upper face of the lever (19), its position being at all times governed by the position of the pin (9).

.03 Power is supplied by the cam (2) keyed to the film drum feed shaft behind the crank (11). Its action is to press to the right the roller carried on the cam lever (3); the timing provides that this occurs when the feed-and-lock rack has been raised into engagement with the graduated gear.

Attached to the top of the lever by two yokes and an adjusting stud (5) is the slide (7). This is normally held to the right by the head of the plunger (14) preventing movement of the button (8) – and therefore of the slide – in opposition to the pull of the spring exerted through the cam lever. In this condition, the rotation of the cam has no effect; the pin (9) remains stationary and the rack (21) merely rises and falls in the course of its locking function.

.04 *D* air, timed by a cam (see 11.06.02) to introduce a slight delay in its action, is led to a small cylinder where it causes a piston to tilt the rocker (6). This depresses the plunger (14), releasing the slide. As the feed-and-lock rack is now lowered, out of engagement with the graduated gear, there is nothing to prevent the left-hand travel of the pin and the slide, drawn by the spring, as the cam-lobe withdraws. The slide moves its full distance which is equivalent to a 6 pt feed, but, of course, in the reverse direction.

.05 The timing is such that the rack now rises into re-engagement, and then the cam (2) restores the lever, slide, pin and rack to their normal positions. It will be seen that this constitutes the supplementary feed of six points contributed by the feed-and-lock rack. Although cessation of the *D* air will have released the rocker (6) before the operation is complete, the detent pin (16), pressed in by the spring (15) as soon as the plunger was lowered, will hold it down until the returning slide carries both spring and pin to the right again. By this time, the button (8) will also have returned, allowing the plunger (14) to re-enter by pressure of its spring, in readiness for the next cycle.

.06 The yoke pin at the top of the cam lever is eccentric, with a throw equivalent to a feed of $\frac{1}{2}$ pt; it can reduce the travel of the slide (7) by this amount. A flat on the side of the pin-head is engraved to show which condition applies, and the pin can be turned to give effect to either before the filmsetter is put into action. Refer also to 03.05.03 for details of operation.

.07 From the foregoing, it will be apparent that a supplementary feed of less than 6 pt (or $5\frac{1}{2}$ pt, according to the setting of the eccentric yoke pin) can be obtained by introducing a stop to prevent the slide from travelling its full distance to the left, before it returns a similar distance to the right to impart the feed. Five such intermediate stops, of which two (12) are shown in the illustration, are accordingly provided. They are pistons, each lifted by one of the air streams *E–I* against the pressure of its return spring. The air comes direct from the air tower, so that the corresponding piston is immediately raised, passing through an aperture in the locking plate (18), in readiness to intercept one of the projections on the under side of the slide (7). Only after this lift has occured can the timed *D* air (see 11.06.02) arrive to lower the plunger (14) and release the slide. In addition to the detent pin, the spring (15) also carries the locking plate to the left, causing it to seize by the neck the raised piston and hold it up until the slide has returned, although the air-flow will have ceased some time previously. When the plunger is in the normal – i.e. the raised – position, it holds the detent pin outwards from the block; when *D (T)* air depresses the plunger, after an *E–I* signal has been received, the spring carries the pin (as well as the slide) to the left, so that the plunger is locked in its downward position until the stroke of the slide has been completed.

11.08.00 Timing

.01 In view of the close inter-action of the several mechanical details concerned in the line-end sequence, it is convenient to examine them in the light of the accompanying Timing Diagram. This clearly shows that they fall into three groups – air, film drum feed shaft and the drum-driving racks, the latter being dependent on the motion of the shaft. The diagram gives details of one revolution of this shaft, which corresponds (because of the reduction gearing to the ratchet shaft) to four revolutions of the main camshafts. These are also indicated because in them lies the responsibility for the timing of the initial and the repeated air-flows. Note that a complete camshaft revolution precedes the motion of the film drum feed shaft and the action of the latter continues

into a sixth camshaft revolution, by which time the normal production routine has been resumed.

.02 The angles marked in the diagram and detailed in the following paragraphs must not be regarded as strictly applicable to every Mark 4 filmsetter. This is because the correct meshing of teeth in the drive to the feed shaft is of greater importance than the precise angular relationship between this shaft and the main camshafts, and a certain amount of variation, up to say ±7°, may result. The angular *intervals* of the feed-shaft functions, however, may be taken as constant within narrow limits. The object of the diagram is to illustrate the relative positions and conditions at any moment rather than to be a guide for regulation and adjustment as – for example – in the case of the ignition timing of a petrol engine.

.03 At *100°* (camshaft), the paper-feed starts, finishing at *137°*. At *144°* the *ABC* air signal is given (together with any others that may have been punched in the same frame), but its main effect is suspended by the latch of the lower timing control box (12.12.00) until this is released at *274°*; this is done by the action of one of the lobes of the four-lobed cam mounted on the constantly-turning ratchet shaft (11.03.01–2). The *ABC* air then lifts a valve to admit constant air to a pipe-line which is, for convenience, known as *ABC(T)* – i.e. *ABC* timed air – and this immediately performs various line-end duties (see 12.18.02) including the release of the ratchet pawl which, engaging at *20°* in the next camshaft revolution, starts the motion of the film drum feed shaft. The cam-lobe has come out of action at *340°* (i.e. after a 16°-turn of the ratchet shaft) and the *ABC* air is cut off at *10°*, but because the valve has been trapped by the latch, the *ABC(T)* air continues until the arrival of the next cam-lobe frees the latch at *274°* unless the *ABC* signal is renewed. Note that, although all the original air streams are cut off at *10° (second rev.)*, they are renewed in each succeeding camshaft revolution because the paper-feed is suspended; the motion of the film drum feed shaft, initiated by the persisting *ABC(T)* air at *20° (second rev.)*, then provides the timing required to produce the *D(T)* air for supplementary line-feed, if the *D* perforation has been included in the signal.

.04 No further consideration need be given to the air during the second, third or fourth revolution of the camshaft; attention must be turned to the film drum feed shaft, taking its starting point as *0°* (as we are now concerned with a fresh group of mechanism), and following it through one of its revolutions.

.05 Examine first the motion given by the track cam (which is at the rear end of the feed shaft) to the mirror return cam lever, for bringing the travelling mirrors forward to their starting point for the beginning of the next line. Initially, the lever is in its rearmost position, but when the shaft has turned through 8°, it starts to travel forward, completing the movement at 201°. Here it again dwells while the shaft turns a further 50° (to 251°) before starting to carry the lever back till it comes to rest again in its rearmost position, at 360°. The lever remains here until it is re-activated by the next cycle of the shaft.

.06 When the film drum feed shaft reaches 228°, the single-lobed cam which is mounted in front of the bevel gear (see 11.02.02) depresses the air valve for releasing the lock governing the paper feed; cam-action ceases at 276°, but the conditions for normal routine have been re-established. Because the *ABC(T)* air is no longer operative, the driving pawl will be mechanically withdrawn from engagement with the ratchet when the shaft reaches the end of its revolution (360°). Shortly after it has stopped, the paper feed comes into action at *100°* of camshaft revolution – as before – but after having been held inoperative during four complete camshaft revolutions.

.07 The actions of the feed and the feed-and-lock racks must be considered together, as each in turn has to be engaged with, and disengaged from, the graduated film drum gear without the latter being uncontrolled at any time. When the feed-shaft motion starts (0°), the drum is already secured by the feed-and-lock rack, the feed rack being disengaged. But almost immediately (5°) the feed rack starts to rise in preparation for giving the film drum its normal, predetermined line-feed. At 30°, this rack is fully engaged with the gear, so that at 16° the feed-and-lock rack has been able to start dropping out of engagement; it is clear of the gear at 41°, and remains stationary for a period which is dependent on whether or not additional line feed has been signalled. Consequently, at 45° the feed rack is timed to start turning the drum gear. While it is doing this, and if extra line-feed is required, the feed-and-lock rack starts, at 67°, to withdraw so that its later return can contribute the extra feed. If the maximum of six points extra is signalled, the withdrawal is completed and a period of rest starts at 172° – otherwise, earlier. At 90°, the normal line-feed has been completed, and the feed rack then remains stationary, engaged with the gear. At 186°, the feed-and-lock rack starts to rise into engagement and at 196°, the feed rack starts to descend, but before it is fully down (at 219°), the feed-and-lock rack (fully up at 210°) has taken control of the gear so that it is not completely free at any time. The feed-and-lock rack pauses after engagement. During this period, the feed rack starts (at 225°, i.e. soon after it is fully down) to withdraw so that it will be ready to resume feeding in the next cycle. If the full six points of extra line-feed have been signalled, the feed-and-lock rack starts (at 316°) the travel that supplies this to the drum; a smaller additional feed would start later, but any motion of

this rack ceases when the shaft stops turning at the end of its cycle (360°): the stationary rack is still in engagement with the drum, which is therefore firmly located during the exposures of the succeeding line of text. The reverse movement of the feed rack also stops at 360°, so that this rack is now ready to rise and contribute the normal film-feed when the next line-end cycle is initiated. This completes the series of motions needed to turn the film drum the required distance.

11.09.00 The film drum

.01 A matt-surfaced, light-metal cylinder constitutes the basis of the drum (3) on which the film is carried, the character-images being projected by the front travelling mirror through a slot in the base of the drum housing. To prevent stray light entering when the housing is detached from the filmsetter, a metal strip – the film drum shutter (7) – is attached to the face of the drum which is turned to register it with the slot. A flange or lip (4) at one end of the drum and a locating pin (5) are provided to give accurate positioning of the film; this can have a maximum working area of 23ins (584mm) × 10ins (254mm), or, when using a 24in (610mm) length of film, a drum reading of 138 ems, the longer measurement being taken circumferentially round the drum. The axis is a horizontal spindle (8) supported on self-lubricating bearings in the front and rear end plates of the housing. The spindle, located at the front end by a double thrust bearing, passes through the end plate and carries a scale marked in picas (up to 144) or Ciceros (up to 132) and indicating when the shutter is in the safe position.

.02 Locating pins ensure that the housing is accurately situated on the filmsetter, and two quick release hand-grip knobs serve to hold it down firmly. The upper part of the housing is a detachable light-proof cover which, when lifted off, exposes the upper half of the drum for fitting and removal of the film. Handles (2) are provided on the main part of the housing; the clips (1) of the cover should never be used for carrying the assembly.

.03 When the drum housing is correctly seated on the filmsetter, the graduated gear (14) is in position to mesh with both the feed rack (15) and the feed and lock rack (16), and so to be turned by the longitudinal movement of either of them. This gear carries a dial graduated to show point-by-point travel of the drum's circumference (i.e. actual film-feed) and half-point progress can be readily estimated; it is a one-tooth feed. One revolution of the dial and gear represents 72 points. Up to this stage, the feed mechanism has been working on an enlarged scale to minimise error – the size of the dial markings is very much greater than $\frac{1}{72}$ inch (0·35mm). Reduction-gearing is necessary here to achieve the indicated movement.

.04 Behind the graduated gear, and turning integrally with it is a small gear pinion (13). This meshes with a larger gear (12) that turns integrally with another small one (10), and this, in turn, meshes with a toothed ring (11) fixed inside the end of the film drum; a double reduction has thus been provided. It is now highly important that there shall be no backlash which would disturb alignment. The gears (10 and 12) are therefore of special design. Each consists of twin toothed discs (12 & 17 and 10 & 21), the teeth of one being slightly out of phase with those of the other, but the angular distance between corresponding teeth is subject to a spring loading. Consequently, a pair of teeth on gear (12 & 17) grip firmly on a tooth of pinion (13), and similarly, a pair of teeth on gear (10 & 21) grip firmly on a tooth of the ring (11); as a result there is no scope for play here, and the ring, and therefore the drum, are turned exactly the amount needed for line-feed.

.05 The foregoing train of gears applies to the commonly used reverse reading setting, but, if direct-reading is required, a slightly different pattern of housing for the gears is necessary. This contains an additional pinion which changes the direction of the feed (and therefore of the rotation of the drum) without affecting the over-all reduction ratio. (See illustration 18.06.04D.)

.06 Different ratios are available for the reduction gear according to whether work is being done on the point or the Didot system. A pair of gears for point-working gives a reduction of 44 to 22 teeth, whereas for Didot working the ratio is 43 to 23. A change from the point system to the Didot system, or vice versa, can be effected by changing the gear assembly and fitting the appropriate film-feed scale. These parts are clearly marked PICA or DIDOT but, in order to maintain the accuracy of the functional settings, it is essential that any change of system should be made by the Service Staff of the manufacturer. It is strongly recommended that separate drums should be kept for each system.

.07 Manual rotation of the drum in its closed housing can be carried out in two ways, provided that the feed rack and the feed-and-lock rack are disengaged. A knob attached to the graduated gear (14) enables any alignment on the circumference of the drum to be established or re-established. A separate control knob (9) is on the same spindle as a gear that directly meshes with the ring (11); this is a relatively quick-action control, conveniently used with the main (pica) scale.

11.10.00 Unit drive suspended

.01 In varying circumstances (see 12.17.02–3) either the *AC* or the *BC* air stream may be required to disconnect the unit drive to the gearbox, which is one of the actions to be undertaken in the line end sequence. This is started by the *ABC*

signal which, as mentioned in 11.01.02, does not cancel the effects of *AC* or of *BC*. An air-lead of each of these is taken to the timing device operated by the constantly-revolving ratchet shaft (11.03.01), and the emergent air streams *AC(T)* and *BC(T)* are therefore synchronised with the main cam-shafts. These streams come into action when the cam lever for the unit feed operation is at rest.

.02 Both *AC(T)* and *BC(T)* air are led to a cylinder adjoining the unit drive cam lever, where either or both press up a piston (5) to rock a small lever. As explained in 12.19.07, the same action can also be performed by *N(T)* air. The lever rocks a spindle, causing a trip finger (6) to hold the latch (1) in the disengaged position. On cessation of the air-signal, a spring-loaded plunger (2) returns all these components.

11.11.00 'Shutter' (closed)

.01 Because the normal effects of the *A*, *B*, and *C* air-streams are not suspended, unwanted exposures could be made during the end-of-line sequence; these must be prevented.

.02 Any one of the three air-streams *AC(T)*, *BC(T)* or *M(T)* can (as explained in 12.17.02–3 and 12.19.06) give the effect of closing the shutter (1) without actually interrupting its rotation or affecting its aperture. The air-stream operates a piston which rocks a small lever carrying a circular mask at its free end; the motion brings this mask into the path of the light-beam, cutting it off, so that no exposure is made.

SECTION 12

Air

12.01.00 Compressor – description

.01 Mounted on the air reservoir tank (10) are the compressor itself, its driving motor (4) and the auxiliaries, forming a self-contained unit. Secured by a cottered nut, taper and key to the compressor crankshaft is a heavy wheel, grooved to accept the multi-belt drive and having inclined-plane spokes to give a cooling stream of air. Its weight constitutes it a flywheel also. The shaft is supported by ball (outer) and roller (inner) bearings, both of which are housed in the detachable side cover.

.02 Two horizontally-opposed cylinders in the main casting accommodate a double-ended piston, each end of which is furnished with two compression rings. One end carries the gudgeon pin for the roller-bearing 'little end' of the connecting rod, the 'big end' of which is formed by a second roller bearing nutted to the crank. On the side of the crankcase opposite to the flywheel is an inspection cover; removal of this gives access to the big-end nut, secured by a cotter pin. After removal of this nut, the flywheel and then the cover on the flywheel side, the whole crankshaft and bearing unit can be withdrawn, should either require attention. Be careful to avoid putting any side-strain on the connecting rod, to prevent it being bent, and ensure that the rollers do not mark or score the track of the outer race. When replacing, make sure that the jointing rings are intact, giving oil-tight seals, and that the flywheel is correctly fitted and its nut fully tightened. The security of this nut should be periodically checked.

.03 In each cylinder head is a pair of automatic disc valves, lightly spring-loaded. One of each pair is an inlet valve, admitting air under atmospheric pressure as the piston withdraws from the cylinder head; the other, the delivery valve, is blown open by air compressed by the returning piston. Both the delivery valves discharge into a common chamber which communicates by pipe with the reservoir tank (12.04.03). The valves must always work freely, and the faces must make good air-tight joints with their annular seatings, or the efficiency of the compressor will suffer severely.

12.02.00 Compressor – lubrication and maintenance

.01 Provided that it has adequate lubrication (and this is essential) the compressor will run for long periods without other attention. Every week, the two oil-chambers should be topped up with clean 'Boreasol 40', 'Shell Talpa 40', 'Vacuum DTE Heavy' or an equivalent grade of compressor oil. Take out the combined filler-and-level plugs (14 and 15) in the top of the compressor and in the inspection cover (26), and replenish to the bottom of the screw threads.

.02 Adjoining the upper oil-chamber are two wick-holders (1). Each contains a cotton wick which gives a drip-feed through the cylinder-wall on to the upper face of each of the piston skirts. Radial holes allow some of this oil to pass to the little-end bearing (19), and again to travel on to the lower face of the piston. Once a year, open the slides in the top cover of the compressor and renew the wicks; be sure that the replacement bears the same number (Z 471/ followed by its length in inches) and that it has nine strands of cotton, 18 in (457 mm) long. See that one end of the wick is well pushed down to the bottom of its hole, and that the other end is deeply immersed in the oil. Check for the presence of dirt or condensate, and clean if necessary.

.03 Inside the inspection cover is the second oil-chamber, feeding two wicks, or three in the case of the HP33 or HP44 model. These provide a drip feed to a short stationary tube (27) on the axis of the crankshaft. It projects into a vertical dished member (the banjo lubricator) (29), also co-axial but rotating with, the crankshaft (30). Oil that accumulates here is flung by centrifugal force towards the perimeter of the lubricator, where it passes through an aperture to feed the big-end bearing (23). These wicks require the same treatment as those mentioned in 12.02.02.

.04 Once a week, or more frequently if this be found necessary, withdraw the drain plug (13) from the base of the inspection cover and run off the excess oil from the sump.

.05 Very little attention is required by the crankshaft bearings, as these are packed with grease at the time of assembly. A grease-gun nipple is fitted to the side cover (31), and this should receive a charge every six months; use 'Mobilux Grease No. 2', 'Energrease LS. 3' or 'Shell Alvania 3' grease.

.06 Every three months, unscrew the wing nut at the top of the air filter and withdraw the shroud and the element. This must be thoroughly cleaned with trichlorethylene – never use petrol or paraffin, and do not apply oil. Use a blast of compressed air to blow out the element from the inside, as a partly choked filter will reduce the output from the compressor and also cause over-heating.

.07 Faulty valves (17 and 18) will lead to loss of output. Make sure that they seat so as to make air-tight joints; if badly ridged on one side, they may be turned over and lapped in position with fine grinding paste which must be fully cleaned off afterwards with petrol or other solvent. Valves should be replaced if they are warped, chipped on the edges, discoloured by heat, or worn on the face to a depth of more than 0·005 in (0·13 mm) or if there is more than 0·040 in (1 mm) clearance between the disc and the replaceable guide which should be smooth and not discoloured. Valve springs softened by heat should be discarded. Valve-seats may be re-cut and the face of the cylinder cover may be re-ground.

.08 Abnormal rise of temperature may be due to a faulty non-

return or delivery valve, a choked silencer or faulty lubrication caused by hardened wicks or the presence of condensate. External dirt, preventing adequate radiation, may also be responsible.

.09 Every effort should be made to identify the nature and cause of abnormal noise. A continuous rumble, possibly accompanied by grinding, probably results from failure of a bearing. A regular metallic tap, as from a light hammer, indicates piston-slap due to wear of the piston, its rings or the cylinder bore. A heavier thumping or knocking is caused by the flywheel being loose on its taper or by a badly worn bearing; *it is dangerous to ignore this symptom as serious damage can quickly result.*

.10 The following table gives a useful guide for maintaining compressor efficiency, but note that, in addition to standard replacements, reboring can be carried out and over-size components fitted.

12.03.00 Compressor motor and drive

.01 Supplied with a winding to suit local voltage, the electric motor provides sufficient power to drive the compressor at its normal working speed and pressure. It has an overload cut-out which should not be altered. Turning clockwise (as viewed from the control-side of the unit), it drives the compressor through a set of V-belts. The inspection cover of the compressor also shows the correct rotation.

.02 Check the belt-tension periodically. If the middle of a belt is held between finger and thumb, it should be possible to twist it a quarter turn, but not more than half a turn. Tighten the belts by jacking the motor away from the compressor, using the positioning screws (2 & 4), but be sure to keep the driving and driven pulleys correctly aligned.

.03 No attention need be paid to the bearings of the electric motor as they have been packed with lubricant on assembly, and this should last throughout the motor's life.

12.04.00 Compressor auxiliaries

.01 Pressure gauges are calibrated in pounds per square inch or kilogrammes per square centimetre, referring to pressures in excess of the normal atmospheric pressure of approximately 15 pounds per square inch or 1·05 kilogrammes per square centimetre. The letter f ('force') is included in the abbreviations, lbf/in^2 and kgf/cm^2, indicating that the pressures are not 'absolute' but exert a force of this amount after allowance has been made for the opposing pressure of the atmosphere. The abbreviation for 'atmosphere' is atm.

.02 The outlet pipe from the chamber (12.01.03), fed by the piston of the compressor, is branched. A short pipe goes to an escape valve (6) which is electrically operated (12.04.04). When the pressure has been built up to working level, this solenoid valve is automatically opened, and the compressor delivers the air to the atmosphere through a silencer (7).

.03 The second air-lead passes, through a non-return valve (4), to the cylindrical reservoir which is provided with a precautionary safety valve, spring-loaded (6, Fig 12.01.01); no attempt must be made to alter the setting of this. Note that, in some countries, the reservoir is subject to periodical examination by factory inspectors, but, even where this is not the case, examination by an engineer at least once a year is a safety precaution that should not be omitted.

.04 From the right-hand end of the reservoir, a capillary tube (11) carries air-pressure to the gauge and the adjustable pressure-operated electric switch (18). This is pre-set at the Works to 'make' the circuit which opens the escape valve when the pressure rises to 55 lbf/in^2 (3·87 kgf/cm^2) and to 'break' the circuit to close it again when the pressure falls to 52 lbf/in^2 (3·66 kgf/cm^2), thereby maintaining a reasonably constant figure. The switch is also connected to the motor circuit so that, when the stop button (8) is depressed, the solenoid valve (6) opens, releasing the pressure in the compressor cylinders and immediate pipe-work; because of the non-return valve (4), the reservoir is not emptied. When the start button is depressed, and the motor restarted, the valve is thereby closed, but the motor starts from rest in an unloaded condition and the pressure switch regains control. Make certain that there is no leakage from the tube or the switch, or the motor will be over-loaded. Any filmsetter operative who feels inclined to attend to the electrical system of a compressor unit should first study the warnings given in 14.01.01; such work is **for the fully qualified electrician only.**

.05 Considerable importance is attached to reducing the humidity of the air; if its water-content is deposited in operating cylinders at the filmsetter or keyboard, rusting will result, with irregular operation as an unavoidable consequence, and, in some climates, this can be severe. After being heated by the act of compression, the air – still at relatively high pressure – is allowed to start cooling in the reservoir tank. In doing so, it gives up part of its moisture; this condenses and collects in the right-hand end of the reservoir (as this is mounted at an incline) from which it must be released daily by the drain cock (7, Fig 12.01.01). A container of 1-quart (1-litre) capacity can be used if no open drain is available.

.06 Further drying of the air by cooling is carried out when it leaves the reservoir. It passes through the heat-exchanger (2), an inclined brass tube containing a cold-water pipe (17 & 1) that projects from both ends. The water pipe is

surrounded by a wire coil that increases the effective cooling area, and inside the pipe is a spiral strip to induce turbulence of the water. The cold supply should be fed, by a plastic hose, to the right-hand end of the heat-exchanger, and the warm water led away from the left-hand end to a drain. Adjust the flow so that, in normal running (after, say, half an hour), the right-hand quarter of the brass tube feels as cool as the water-supply. A longer cool area will not be more effective – it will only waste water unnecessarily. Hard or dirty water will leave a deposit on the spiral strip, causing inefficient cooling; mechanical solids such as flakes of rust from the supply pipe may be removed by detaching the plastic piping from both ends and sending a powerful air-blast down the water-way from the left-hand end. Failing success by this method, use pliers to grip the left-hand end of the strip and withdraw it for cleaning. For replacement, link a piece of wire into the hole at the right hand end of the strip and draw it back into position, rather than attempting to push it in.

.07 At the right-hand end of the heat-exchanger, both air and the water condensed from it pass into a combined filter and separator (16) where the air is again filtered and the water collected for automatic discharge at intervals. If the effluent cannot be piped to a drain, it should run into a container of at least 1-gallon (4-litre) capacity for emptying by hand.

12.05.00 Filter/separator for compressor HP12 only

.01 Air enters an annular chamber (12) in the main body (1), and passes down through louvres which cause it to swirl as it descends further into the bowl (4). The centrifugal effect deposits suspended moisture and any solid material on the wall of the bowl, at the bottom of which it collects. A baffle (5) provides a space of still air above the deposit so that this is not picked up again. As the water accumulates in the bowl, it raises the float (9) to open the escape valve which closes again when the level falls. Should it ever be necessary to empty the bowl manually, this can be done by carefully inserting the flat end of a pencil or similar article in the open end of the drain and pushing it gently upwards; remember that the water will be ejected under pressure. A deflector assembly (2) ensures that the air cannot come into contact with the filter element until it has deposited its moisture.

.02 To clean the filter and bowl, first shut off the air-supply, and disconnect any drain pipe that may be attached to the outflow from the bowl. Remove the bowl (4) by unscrewing it from the main body (1). Unscrew the baffle (5), releasing the shield plate (10) and the filter element (11). If it is necessary to detach the louvred ring, the filter guide (3) can be unscrewed with a wrench; this will also release the deflector (2). Before replacing any part, check that the gasket or O-ring against which it seats is in good condition, to give an air-tight joint. The filter element should be washed in paraffin and blown out thoroughly with compressed air. From the bowl, lift out the monel screen (6), float and cap. If it is necessary to withdraw the valve-assembly, this may be done by releasing the knurled metal ring (7) on the outlet. Wash the bowl and valve assembly in warm soapy water only; do not use chemical cleaners as these may destroy the bowl. Blow out the monel screen with compressed air. Replace the components in the reverse order of dismantling, and ensure that the monel screen has its internal guides at the bottom of the bowl.

12.06.00 Filter/separator for compressors HP22, HP33 and HP44 only

.01 Air enters the filter/separator assembly inside the filter element (2). After passing through this, it receives turbulence from the louvred ring, causing it to circulate in the intermediate body (9) and deposit suspended moisture. This falls down through the louvred baffle to the bowl (5), while the air travels up through the centre of the deflector (10) to the outlet. As the water accumulates in the bowl, it raises the float (8) to open the escape valve which closes again when the level falls. Should it ever be necessary to empty the bowl manually, this can be done by carefully inserting the flat end of a pencil or similar article in the open end of the drain and pushing it gently upwards: remember that the water will be ejected under pressure.

.02 To clean the filter and bowl, first shut off the air-supply, and disconnect any drain pipe that may be attached to the outflow from the bowl. While supporting the intermediate body, which carries the bowl and baffle assembly, release the clamp ring (1) by withdrawing the screw; the nut of this embodies a friction lock. Do not use a lever to separate the halves, but raise the intermediate body and slightly rotate it to release. Placing the intermediate body and bowl temporarily aside, unscrew the deflector (10), so freeing the filter element (2) which seats between two plastic rings. Wash the element in paraffin – nothing else – and back-flush it with compressed air. Replace the element on the deflector, and screw this back into position, making sure that both the seating rings are correctly placed. Inside the intermediate body, release the retaining snap ring (4) so that the baffle can be lifted out. The flange of the bowl rests on a rubber ring – press the bowl upwards to free it, and lift out the float (8). If it is necessary to withdraw the valve assembly (7), this may be done by releasing the knurled metal ring (6) on the outlet. Wash the bowl and valve assembly in warm soapy water only; do not use chemical cleaners as these may destroy the bowl. Replace the components in the reverse order of dismantling, and ensure that the valve assembly and the bowl seat firmly on their respective rings.

12.07.00 Pressure-regulator

.01 From the separator on any one of the alternative compressors, the dry air goes into a pressure-regulator. This can be adjusted by the T-control above it, and the pressure of the out-going air is indicated by the adjoining gauge. First, shut off the air-supply and release the hexagon lock nut (1). Turn the control (14) counter-clockwise till it is free of spring-loading. Then admit the air supply and turn the control clockwise to give 17 lbf/in^2 (1·20 kgf/cm^2) under full working conditions, and lock the spindle by tightening the hexagon nut (1). Beyond the pressure-regulator, the air enters the permanent pipe-line for distribution to keyboards and filmsetters.

.02 In the upper chamber (or bonnet) (13) of the pressure-regulator, which communicates with the open air, an adjustable spring (2) holds down the diaphragm (11). The delivery side of the regulator communicates with a chamber below the diaphragm so that when the pressure here reaches the predetermined point, the centre of the diaphragm rises, allowing the valve assembly to rise also. This action causes the valve (7) to seat, cutting off the air-supply from the feed side until the delivery pressure starts to fall: the diaphragm then descends, re-opening the valve.

.03 With the air-supply shut off, removal of the valve guide plug (8) gives access to the valve assembly, and the strainer (9) which should be cleaned periodically with paraffin and dried with compressed air. The valve must always seat efficiently, or there will be fluctuations in the delivery-pressure; these can also result from obstructions in the valve guide plug (8) or faulty contact being made by any of the O rings which may need replacement; when re-assembling, smear them with silicone grease. If there is continuous leakage through the vent in the bonnet, remove the latter by undoing the six screws (4) and examine the sealing surfaces of the relief valve (12) and valve pin (10), which ought to make an air-tight joint, and verify that the diaphragm is intact.

12.08.00 Starting and stopping the compressor

.01 The electrical controls are very simple to operate. To start the compressor motor, turn the main switch to ON, thereby opening the escape-valve, and then push the START button. The valve will automatically close, and pressure will start to build up, but no supply should be drawn off until the working pressure of 55 lbf/in^2 (3·87 kgf/cm^2) has been reached.

.02 Push the STOP button to shut down the compressor – this will allow the escape valve to be opened in addition to cutting off current to the motor – and then switch off the isolator. For starting, remember to operate first the isolator and then the START button, so that initially the compressor piston is unopposed by high-pressure air in the delivery pipe. If the machine has stopped due to over-load, make sure that the cause is traced and rectified, and that a couple of minutes are allowed for the over-load coils to cool down before pressing the STOP button (it will act as a manual re-set) and then the START button. Remember also to turn off the cooling water and to dispose of the water ejected from the separator, if necessary, when shutting down.

12.09.00 Air reaches filmsetter

.01 Generally, it is convenient for the fixed air piping to end at a control-cock near the filmsetter, to the left-hand side of which the line is completed by a length of plastic hose. This is secured to an admission cock at the side of a combined pressure-regulator and final filter. So that the operational air-pressure can be conveniently checked, a gauge is fitted.

.02 In this combination fitment, the air enters a passage surrounding the housing of the regulator valve, and travels downwards; a deflector plate prevents immediate access to the filter element (15), so that moisture and solids may be deposited on the inner wall of the bowl (7), where they run to the bottom. A baffle (14) provides a space of still air above the deposit so that this is not picked up again. The air passes inwards through the filter element (15) and then through ducts in the valve guide plug assembly (13) into the chamber containing the regulating valve (12) and its seating spring. In the upper chamber (or bonnet) (9) of the pressure-regulator, which communicates with the open air, an adjustable spring (21) holds down the diaphragm (19). The delivery side of the regulator communicates with a chamber below the diaphragm so that when the pressure here reaches the predetermined point, the centre of the diaphragm rises, allowing the valve assembly to rise also. This action causes the valve disc (12) to seat, cutting off the air-supply from the feed side until the delivery pressure starts to fall; the diaphragm then descends, reopening the valve.

.03 The pressure of the air admitted to the filmsetter is adjusted by the T-handled screw (1), and it is indicated by the adjoining gauge. First, shut off the air-supply and release the lock nut (2). Turn the control (1) counter-clockwise till it is free of spring loading. Then admit the air supply and turn the control clockwise to give 17 lbf/in^2 (1·20 kgf/cm^2) under full working conditions, and lock the spindle by tightening the hexagon nut (2). Keep an eye on the accumulation of water in the bowl and never allow it to reach the baffle (14). Empty it by opening the drain cock (8) so that it is blown out into a drain or portable receptacle.

.04 Cleaning of the combined pressure-regulator and filter requires first that the air-supply shall be turned off at the

control cock and then that the filter bowl (7) be detached. To do this, unscrew the clamp ring (5) and lower the bowl, which should be rinsed out with paraffin only; do not use acetone, ethyl acetate, ethylene dichloride, toluene, thinners or similar solvents as these will destroy the bowl. Release the filter element (15) by unscrewing the baffle (14); wash the element regularly in paraffin and afterwards blow it out thoroughly with compressed air. If necessary, the valve and its seating (17) can be withdrawn for examination (and/or renewal) after unscrewing the valve guide plug (13). Before re assembling (in the reverse order of dismantling) check that the valve seatings and O-rings are in good condition, to give air-tight joints.

.05 The valve must always seat efficiently, or there will be fluctuations in the delivery-pressure; these can also result from obstructions in the valve guide plug (13) or faulty contact being made by any of the O-rings which may need replacement; when re-assembling, smear them with silicone grease. If there is continuous leakage through the vent in the bonnet, remove the latter by undoing the six screws (20) and examine the sealing surfaces of the relief valve and valve pin (10) which ought to make an air-tight joint, and verify that the diaphragm is intact.

12.10.00 Air lubricant

.01 From the combined filter and pressure-regulator, the air flows through a lubricator; its purpose is to pick up a very fine oil mist which will automatically lubricate all air-operated parts, and considerably reduce the possibility of sticky air valves. Like the air filter, the lubricator is entirely automatic and requires no attention other than maintenance of the oil-level as marked on the plastic bowl. Only approximately five per cent of the oil seen passing through the sight-feed glass is actually used in the machine at any given time, the remainder returning to the bowl of the lubricator. It is important that the correct grade of oil be used; a fine grade, such as that supplied for lubricating a 'Monotype' keyboard, is recommended for giving the best results. To refill with oil, turn off the air and unscrew the knurled cap at the top of the bowl bracket.

.02 Excess oil passed into the air-stream by the lubricator will tend to cause sticking valves, so that regulation is important. To check, first verify that the oil-level in the lubricator is correct, and provide a paper ribbon that gives repeated signals for line-end with automatic variable line feed, i.e. maximum air-consumption. Run the machine with these signals operative and see that two drops of oil per minute are supplied. If necessary, regulate the flow by turning the adjusting screw (3) (adjoining the sight feed dome) with a small Allen key; clockwise to reduce the feed. If the range of this is insufficient, disconnect the air pipe to the automatic variable line feed from the main supply at a point adjoining the air lubricator, and in its place connect an air pressure gauge. Run the machine with the same signals and check that the flow from the pressure regulator is at 17lbf/in^2 (1·20kgf/cm^2) (adjust, if required, as detailed in 12.09.03) and, at the same time, that the temporary gauge shows not less than 15lbf/in^2 (1·06kgf/cm^2). Now stop the machine and turn off the main air cock. Remove the clamping ring and the sight-feed dome. With a screwdriver in the top of the venturi plug, move the point of the arrow towards the mark A to increase the pressure-drop and consequently the oil-flow, or towards mark B to reduce them. Refit the dome and clamp ring and repeat the test, remembering that attention can again be paid to the external adjusting screw. If results are still unsatisfactory, the procedure for adjustment of the venturi must be repeated.

12.11.00 Constant air

.01 This is the name applied primarily to static air under pressure, awaiting release to a delivery pipe either by a perforation in the paper ribbon or by means of some mechanically operated valve, or by means of a valve which is itself operated by an air signal but which has its action delayed mechanically until a predetermined point in the cycle of operations has been reached. In the latter case, it is no longer known as 'constant air' but it assumes the designation of its controlling stream (01.02.08), with the suffix *(T)* to show that it is timed. For example, *K* air* cannot raise its piston until a latch is mechanically released; it then opens a valve to allow constant air to pass (to raise the unit shift piston), but this operational stream is known as *K(T)* air.

.02 The principal supply of constant air goes to the air tower (05.00.00) where the perforations in the paper ribbon distribute it as signals through the fifteen numbered and sixteen lettered vents in the crossgirt, to various destinations. It will be recalled that there are two fixed pins (06.02.01) to locate the pin jaws when no air is supplied to either pin block, giving the effect of two additional air-streams from the air tower.

.03 Another supply of constant air is led to the safety device for the unit and justification drives where it is mechanically triggered (10.02.05) to switch off the electric motor (14.08.04).

.04 To serve as mechanically timed relays for four signals, constant air is made available at the lower signal timing box (12.12.00), adjoining the inclined ratchet shaft.

*i.e. constant air which the *K* perforation in the paper ribbon has admitted to the end of the *K* air pipe in the crossgrit of the air tower (05.03.01-2).

.05 From the constant-air supply to the lower signal timing box, a branch line communicates with the upper signal timing box (12.13.00), located a little higher, where four more signals are mechanically timed.

.06 Constant air is also supplied to the control box adjoining the film drum feed shaft, where it provides timed air-power for line-end operations (12.14.02 and 12.19.02).

12.12.00 Lower signal timing box

.01 This assembly controls the timing of the effects of the three air-streams *ABC*, *AC* and *BC* simultaneously, and *K* independently. The mechanism for the latter is most conveniently discussed first.

.02 *K* air, on arrival, attempts to raise its piston and the lever above it, but this is temporarily restrained by a latch. Immediately below the gear wheel on the ratchet shaft is an eight-lobed cam, each lobe corresponding to one of two angular positions of the main camshafts. The lobes, on passing, move to the right an operating bar which presses outwards the spring-loaded latch. When the latch is moved, piston and lever can rise, opening the valve to allow the passage of constant air (though, as previously mentioned, this is now termed *K(T)* air) to the outlet. But note that the lever has been trapped by the ledge of the latch and remains up (i.e. the *K(T)* signal persists) after the cam-lobe has passed and after the originating *K* signal has ceased. If the *K* signal is not repeated, the piston, lever and valve resume their normal positions when the passing of the next lobe again moves the latch. (See also 12.19.04).

.01 A four-lobed cam, a little lower on the ratchet shaft, contacts a second operating bar to move another latch, in this case controlling three separate air-flows, the *ABC*, *AC* and *BC*, but at a timing different from that of the *K* air. The mechanical inter-action of the pistons, levers, latch and valves is, however, exactly the same, but here, each lobe corresponds to a single position of the camshaft. (See 12.18.02, 12.17.02 and 12.17.03).

12.13.00 Upper signal timing box

.01 Located above the lower box, this assembly is somewhat different in appearance but just the same in principle, in that the initial urge of five air-streams (in this case, *L*, *M*, *N* and *Q*) is restrained by a timed latch from immediately opening five relay valves. At the time of compilation of this Manual, no duty had been allocated to the fifth piston group, and no air pipe was connected to it. The latch for this box is operated by a pivoted bar from the larger latch of the lower box, so that both these latches open and close together (see 12.19.05–8).

12.14.00 Paper-release valve box

.01 For the line-end sequence, the paper feed was suspended by the *ABC* signal. At the conclusion of four revolutions of the main camshafts, or one revolution of the film drum feed shaft, the paper-feed must be restored for normal routine to proceed.

.02 The film drum feed shaft therefore carries, just in front of its bevel gear wheel, a special split cam (1), the two halves of which are clamped round the boss of the gear wheel and secured to each other by two screws. (The front face of the cam, in the form of an interrupted ring, is dealt with in 12.19.02). Behind the disc of the cam will be found a lobe which, at the conclusion of one revolution of the shaft, presses on the free end of a small pivoted lever (3). This lever depresses the end of a valve stem and so admits constant air to the outlet pipe. This leads to the larger cylinder of the paper lock – see 05.09.00 – where it allows normal paper-feed to be resumed. A spring-loaded plunger (4) restores the cam-operated lever after the passing of the lobe.

12.15.00 Single-perforation signals

.01 First, a reminder of the effect of no perforation being presented, either in the numbered half of the crossgirt or in the lettered half. The result is that the air pin jaw tongs encounter no intermediate stop before reaching their limit-position, and the matrix case, correspondingly, is positioned with an outside column and the last-but-one row over the exposure aperture – the final row would need the Unit-shift *(K)* perforation.

.02 Each of the fifteen numbered apertures in the crossgirt leads only to the corresponding pin in the front air pin block, for matrix-case location. The pins here, with the stop pin and the unit shift provision (06.09.03), make it possible to obtain any one of the seventeen rows. With no lettered perforation to raise a pin in the rear pin block, to give a selected crossbearing, its stop will dictate that only the end-position of the row is reached.

.03 Similarly, air supplied from any single aperture lettered *A* to *I* in the crossgirt will position the matrix case to give the character at the top of the selected column.

.04 *S* air (the aperture for this is situated between the E and F apertures) is the signal for the introduction of a justified space. The pipe leads by way of the space cut-out valve box ② (12.19.05) to the cylinder of the pin block ③ where it raises a piston to engage, and so set in operation, the train of mechanism described in 10.10.02 3. *S* air is cut off by *BC(T)* air (see 12.17.03) or by *L* air (see 12.19.05).

12.16.00 Matrix-column selection

.01 The primary duty of each of the air-streams lettered *A* to *J* is to raise the corresponding pin in the rear pin block (5) for cross-location of the matrix case (to select the required column), but they have additional functions, for which purpose the pipes are branched, to reach multiple destinations. Special duties have also been allocated (see 12.19.04–8) to the remaining lettered air-streams.

.02 Whereas there are twenty columns in the matrix case, from which one must be selected, there are only ten air-streams, *A*–*J*, to do the work. Each of them is led to the signal-combination valve-box (4). In addition, the *A*–*I* air-streams supply various branch-lines on the way (as detailed in subsequent paragraphs) and the *J* air is taken direct to its air pin, as well as to the valve-box.

.03 It will be seen that, in normal conditions, when any one or more of the *A*–*I* streams is operative, it is led away from the valve box to its air pin for matrix-location or for duty in combination. But the arrival of *J* air drives both the cylindrical valves upwards, causing all of the in-flows to communicate with a different set of out-flows. For example, whereas *C* air previously entered and left as *C* air, it now emerges as *CJ* air, following a fresh route to a fresh pin – the *CJ* pin – also in the rear pin block. Note that it is still actually *C* air, but because it has been diverted by – though not mixed with – the *J* air, it is convenient to refer to it, from there onwards, as *CJ* air. So, at the pin block we have the nine streams *A*–*I*, plus the nine streams *AJ*–*IJ*. Add the unaffected *J* stream, and the stop pin, and we have control over the twenty positions, as required.

12.17.00 Other simple combination signals

.01 It will be realised that all air-streams start at the same moment from the perforations in the paper ribbon, but only one can be described at a time. The references to 'right' and 'left' assume the operative to be standing at the right-hand side of the filmsetter, and agree with the diagrams.

.02 *AC* air is the signal for setting the coarse justification rack before a fresh line of matter is exposed. *A* air is piped from the air-tower (1) to the right-hand chamber of the character kill valve box (6) where, if there is no other air-flow, it is blocked by the right-hand cylindrical valve. *C* air on arrival at the same valve box passes round the left-hand (character-kill) valve and, unless there is also an *L* signal (12.19.05), it reaches the top of the right-hand valve which it presses down against the action of its return-spring. This allows *A* air to emerge as *AC* air (i.e., *A* air diverted by, but not mixed with, *C* air), a branch of which goes to the double justification valve box (7) (12.18.02). Another branch of *AC* air operates a piston to cause the coarse justification rack to be lifted for re-location (3); details are given in 10.06.02 4. The other application of the *AC* stream must be delayed by the timing device constituted by the lower signal timing box (8), which now provides *AC(T)* air. One lead of this is taken to the centre of the light-mask control (9) where, acting through two pistons in tandem, it closes the light-path. The second lead of *AC(T)* air goes to the end of another control box (10) governing the latch of the unit drive lever (10.02.04). Here are three operational pistons in tandem (the other two being impelled by *BC(T)* air and *M(T)* air respectively) and, for their return, a spring-loaded plunger on the far side of the control lever. In the lower signal box assembly, note that a pin projects to the right of the *AC* lever. This is to enable the *AC* signal to re-set the corresponding *BC* lever – see 12.17.04.

.03 *BC* air is the signal for setting the fine justification rack and also for 'line kill'. *B* air is piped to the right-hand chamber of the character kill valve-box (6) where (as in the case of *A* air) it can be released only by *C* air, so that it becomes *BC* air, and does for the fine justification rack what the *AC* air does for the coarse one (3). Another branch of *BC* air goes to the double justification valve box, (7), where, normally, it passes round the valve, to travel on to the lower signal timing box (8). From here the signal continues at the required moment as *BC(T)* air to perform three duties. First, it is led to a point near the front end of the light-mask control (9) where, through a train of three pistons, it closes the light-path; note how this arrangement enables the effect to be produced by three air-streams (*BC(T)*, *AC(T)* and *M(T)*) in one cylinder without the streams being confused with one another. Secondly, it goes to the space cut-out (2) where it cuts the *S* air from the air tower so that this is not able to introduce the justification main drive; in this respect, *L* air can produce the same result as *BC(T)* air. Thirdly, *BC(T)* air goes to the control for the unit main drive (10), disconnecting this; here again, two signals, *AC(T)* and *N(T)* can also have the same effect.

.04 Operationally, it is desirable that the *BC(T)* signal shall persist to effect the line kill function, and, for this reason, its lever is equipped with a small bell crank. When the lever rises, the foot of the bell crank engages with an adjustable stud which therefore causes the lever to be held up even when the support of the latch is removed and the *BC* signal is not repeated. Clearance is effected by the pin on the adjoining lever – see 12.17.02 – tripping the bell crank clear of the stud; in other words, *BC(T)* is re-set by *AC*.

.05 *GH* air is the signal that brings the quadder – see 05.07.00 – into operation for suspending the paper-feed for five or ten revolutions. Leads of both the G and H airs are taken to a valve box (11). If *H* air alone is present, its progress is

stopped by the valve; if *G* air alone is present, it simply raises the spring-loaded valve. When both are present, the valve is lifted and *H* air emerges as *GH* air which is piped to a second valve box ⑫ where, if *M* air (12.19.06) is also present, the flow is stopped. In the absence of *M* air, *GH* air is taken to the quadder cylinder ⑬ to raise a piston and so put the repetitive action into effect.

12.18.00 More complex signals

.01 Once the principle of causing one air stream to divert another, for the performance of a third task, has been accepted, it would appear that there is vast scope for multiplying the functions that could result from combining more and more air-streams. However true in theory, such procedure would produce an impossibly complicated machine. Only the most useful functions are therefore catered for, and, in deciding upon their controls, sight has not been lost of the effects of the individual components of the complete signal.

.02 *ABC* air is the signal that governs the line-end sequence. The first and most important task is to suspend the progress of the paper ribbon to prevent a new signal arriving before completion of the various duties that the situation entails. How the *AC* and *BC* combinations are individually formed has already been described (12.17.02–3); when the three perforations, *A*, *B* and *C* are presented simultaneously, both *AC and BC* are produced. The *AC* line to the double justification valve box ⑦ now drives the valve upwards, so that the *BC* air no longer goes to its piston in the lower signal timing box ⑧, being diverted to emerge as *ABC* air. This stream is branched, part going to the *ABC* piston in the lower signal timing box to await timed release, and the other part going direct to the small cylinder of the paper lock ⑭, where it raises the piston to prevent paper-feed (05.09.00). This is not restored until the film-feed operation is complete (12.14.02). At the lower signal timing box, the *ABC* piston, lever, cam-operated bar, latch, valve and constant air combine to give, at the correct moment in the camshaft cycle, the *ABC(T)* air-stream. This operates two controls – first, movement of the piston in the film-feed trip actuates ⑮ the lever that has been holding the pawl (on the gear shaft disc) clear of the rotating ratchet (11.03.02), and second, movement of another piston throws a spring loaded electrical switch ⑯ (mounted on a plate in the rear control panel (14.09.05)) so that current is cut from the magnetic clutch (11.05.00), allowing the unencumbered return of the mirror bar to zero.

.03 *GHN* air is the signal that stops the electric motor at the end of the run. It is also perforated by the keyboard operator to notify the filmsetter operative that some change of setting, details of which will be found written on the spool, is required; a different face or size may be called for. Formation of the *GH* air ⑪ has already been described (12.17.05), and its liability to cancellation by *M* air ⑫. From the line leading thence to the quadder ⑬, a branch is taken to a third valve box ⑰ in the same group, where the flow operates a valve to deflect *N* air (12.19.07) from its normal course, so producing *GHN* air. This forms one of two alternative feeds (the other is constant air, released by the safety device ⑱ (10.02.05)) to a small valve box ⑲. In this is a ball; when either of the feeds is operative, the ball is blown across to seal-off the other, so that the air can pass only to the cylinder ⑳ containing the piston which operates the stop-switch for the motor.

12.19.00 Auxiliary signals

.01 Listed here are signals which do not involve the interaction of air-streams, but each has a modifying effect on the result of the principal signal which is received simultaneously.

.02 *D* air is the signal for an additional line-feed of 6 (or 5½) points. It raises its air pin in the rear pin block for matrix-location and also attempts to lift a piston in the valve box ㉑ adjoining the film feed shaft, and so rock a lever. But this lever is retained by the interrupted ring cam on the shaft, so that there is no further result unless an *ABC* signal has set the line end mechanism into operation. Then the cam rotates and releases the lever, which opens a valve to admit constant air (which becomes *D(T)*) to the pipe leading to the external cylinder of the automatic variable line-feed mechanism ㉒ (11.07.00).

.03 *E*, *F*, *G*, *H* and *I* airs are the signals for reducing by 1, 2, 3, 4 or 5 points respectively, the 6 pt (or 5½ pt) additional line-feed instituted by the *D(T)* air. These streams raise their respective air pins for matrix location, and a branch from each line goes to the automatic variable line-feed mechanism, where it attempts to raise its piston. As all the pistons are held down by the locking plate, described in 11.07.07, no action can result until the *D(T)* air (itself dependent on the availability of *ABC* air) has freed the locking plate. Thus the full signals and their effects are: *ABCD*, 6 or 5½ points; *ABCDE*, 5 or 4½ points; *ABCDF*, 4 or 3½ points; *ABCDG*, 3 or 2½ points; *ABCDH*, 2 or 1½ points; *ABCDI*, 1 or ½ point.

.04 *K* air is the signal for unit shift. For a given position of the unit rack, it advances the position of the film matrix case by one row (06.09.03–4). This air-stream travels only to the lower signal timing box ⑧ (12.12.02). The resultant *K(T)* air lifts the unit shift piston ㉓, raising the draw rod so that its head enters the alternative – the upper – seating in the matrix jaw.

.05 *L* air is the signal that tilts the optical flat (09.12.00) for mathematical settings and the construction of chemical formulae etc., to produce a character in the inferior position, the matrix case providing only a matrix of that character in the superior position. For this purpose, the air is taken to the upper signal timing box ㉔ for timing. Emerging as *L(T)* air, the signal passes to a cylinder ㉕ at the back of the prism box where it raises a piston to rock a spring-loaded lever; this is carried by a spindle which passes into the prism box and there rocks the optical flat.

L air (untimed) also fulfills two other duties. First, to prevent an unwanted film-feed resulting from the chance presence of the *A*, *B* and *C* perforations in a trial line, a branch of *L* air (untimed) is taken to operate the left-hand valve in the character kill valve box ⑥, to depress the valve and so to cut off the flow of *C* air; therefore neither *AC* nor *BC* can be formed. Second, to prevent mirror-bar feed resulting from a space signalled in the course of a trial line, *L* air (untimed) is taken to the base of the space cut-out valve box ② (12.15.03); here, it raises a piston to raise a second piston (operated by *BC(T)* air) to close the valve in the *S* air line. Valve and pistons are subsequently returned by a spring.

.06 *M* air is the signal for character delete. Its principal duty is the closure of the light-path at the time when the unwanted character would appear. *M* air is therefore carried to the upper signal timing box ㉔. The resultant *M(T)* air goes to the rearmost of the three pistons (the others are operated by *AC(T)* and *BC(T)* airs) in the light mask control box ⑨, causing the mask to obstruct the light-path. *M* air (untimed) is also used to seal off *GH* air ⑫ (12.17.05) which would otherwise set the quadder in operation as a result of these perforations in a trial line.

.07 *N* air is the signal to produce double-exposure by preventing mirror-bar movement. From the air tower ①, it is led to the motor stop valve box ⑰, where, in the absence of *GH* air (12.18.03), it passes round the valve and emerges unaffected to travel to the upper signal timing box ㉔ for timing. Now, as *N(T)* air, the signal is carried to a position behind the leading piston in the control box for the unit drive ⑩, where it operates to disconnect the latch and so prevent the mirror-bar feed which would normally follow the exposure of the character.

.08 *Q* air is the signal for increasing the size of the aperture above the shutter when a 0·4 in × 0·2 in (10·16 mm × 5·08 mm) matrix is to be exposed; the perforation is automatically made at the keyboard whenever one of these over-size characters is tapped. *Q* air travels direct from the crossgirt to the upper signal timing box ㉔ where the mechanism produces *Q(T)* air. This goes to a cylinder block ㉖ adjoining the matrix-case seating on the shutter housing, where it presses outwards a piston. The piston impinges on an operating lever (3), held in contact with it by a spring (5). Attached near the front end of the lever, and projecting to the left in the alignment of the light aperture, is a horizontal metal slide (1). Towards the left-hand end of this is a window which normally restricts the aperture to 0·2 in × 0·2 in (5·08 mm × 5·08 mm) to prevent stray light entering the system, but, when *Q(T)* air causes the strip to move, an opening of 0·4 in × 0·2 in (10·16 mm × 5·08 mm) is revealed. The spring restores all components when the air-pressure is cut off.

.09 *L*, *M* and *N* airs together provide for character kill. The functions of the three air-streams (already described) are carried out independently of each other, but they occur so frequently as a trio that they are liable to be regarded as a combination signal. The duties applicable to the character-kill objective are: *L* air cuts off both the *S* air to the justification drive trip (in the same way as *BC* air does) and also the *C* air supply, preventing the formation of *AC* and *BC*; *M* air closes the light-path and cuts off the *GH* (quadder) signal, and *N* air trips the latch of the unit drive.

12.20.00 Summary of air-duties

.01

A, *B*, *C*, *D*	6 pt or 5½ pt extra line-feed
E, *F*, *G*, *H*, *I*	Matrix column selection; Reductions of extra line-feed
J	Diversion of *A*–*I* for additional matrix-column selections
K	Unit shift (directs draw rod head to alternative seating)
L	Low alignment (tilts optical flat), cuts out *S* air and *C* air
M	Character delete (closes light-path)
N	Double-exposure (eliminates mirror-bar movement)
Q	Double-size aperture for 0·4 in × 0·2 in (10·16 mm × 5·08 mm) matrices
S	Introduction of justified space
(T)	Suffix to an air-stream signifying that its effect is mechanically timed
AC	Engages coarse justification rack shift
BC	Engages fine justification rack shift
GH	Quadder (for suspending paper-feed)
ABC	Line-end
GHN	Machine stop
LMN	Character kill
1–15	Matrix-row selection

SECTION 13

Film matrices and case

13.01.00 Film matrices

.01 Each film matrix, when placed correctly in the path of the light from the condenser lens, constitutes the illuminated 'object' to cast an image on the film where it is permanently recorded. Each film matrix, therefore, is an accurate representation of a character which is transparent, with an opaque background. The size of the normal film-matrix image is approximately 8 pt irrespective of the resultant image-size, and its material is photographic film accurately positioned in a protective carrier of moulded plastic. Carriers of direct-reading film matrices are black while those for reverse-reading matrices are grey. Every matrix carrier is marked with its series number and a symbol to denote the point-range it is designed to cover. Matrices for special signs and non-latin characters are also denoted by their reference numbers marked in red on the opaque part of the film. The ratios used in focusing the optical equipment are based on the optimum size of face normally appearing on that particular point-body. Note that the term 'film matrix' is commonly used to mean the assembly of the character-bearing film in its carrier, and care must be taken therefore when it is necessary to distinguish between the part and the whole.

.02 Two sets of film matrices are usually required to cover the range of sizes 6–24 pt and Didot, though, for certain designs of face, three sets are needed, to maintain typographic standards. The 'A' set is normally applicable to 6- and 7 pt and Didot, and the 'B' set to 8–24 pt and Didot, but, in the case of Bembo (for example) the 'B' range is up to 12 pt and Didot, and the 14–24 pt and Didot sizes are provided by a 'C' set. On the other hand, only the 'A' sets are required for Univers and some other faces. There are further exceptions:

.03 Sizes below 6 pt are designated for the specific size to be reproduced e.g. 126–5, meaning Series 126, 5 pt. They are normally arranged to be set at 6 pt focus.

.04 The A set of matrices for Spartan will give 6 pt or 6 Didot images, *but 8 pt or 8 Didot focusing bars must be used for this size*. 'B' matrices will give 12-, 18- or 24 pt or Didot in conjunction with the normal focusing bars for these sizes.

.05 In some founts there are limitations to the size-range, e.g. Univers Expanded, the largest size of which is 20 pt or Didot.

.06 Certain special supplementary founts are also available. Here the size of the matrix-image is modified. These matrices can be arranged in a matrix case together with those of a normal fount so as to provide, simply by signal, a fount of larger (or smaller) characters without the need to change focusing bars. This avoids a separate setting which would require subsequent assembly of the films by make-up procedure. Production-time is therefore saved at two stages, but it will be appreciated that special keyboard equipment is necessary. These supplementary founts are designated to show first the image-size and then the focus at which this size will be obtained – e.g. 334 – 10/8 will reproduce as Series 334, 10 pt, with the focusing arranged as for 8 pt.

.07 Standard-sized film matrices measure 0·2 in × 0·2 in (5·08 mm × 5·08 mm) but for certain mathematical work involving brackets, root-signs etc. which are to embrace two lines of formula, and for two-line initials etc., some special matrices are made, to give double-depth images. These matrices measure 0·4 in × 0·2 in (10·16 mm × 5·08 mm) and provision is made for a number of these to be carried in a matrix case, replacing twice as many of standard-size, and also for an enlarged light-aperture (09.04.01) when they are being exposed. For the alignment of characters, see 13.05.01.

08. As in the case of metallic matrices for hot-metal casters, the film matrices are arranged in their cases in rows and columns which agree with the lettered and numbered air pins raised by the air admitted through the perforations in the paper ribbon. Generally, the scheme of arrangement is based on the principle (as shown in the illustration) of placing the widest characters in the bottom row and graduating them to the narrowest at the top, though the double-exposure provision enables any desired number of units to be given to any selected character, either above or below the normal allocation to the row affected. It will be recalled (06.09.01 and 10.02.01) that the unit rack (and therefore the width allocation given by the unit selector) is dependent on the position to which the matrix case has been moved – i.e. which row has been selected – subject to 'Unit Shift' (06.09.03).

13.02.00 Matrix case

.01 The matrix case is a steel frame designed to retain the assembly of matrices in their correct sequence and alignment, to enable them to be protected from dust and other dirt, and also to ensure that each, on selection, occupies precisely its appointed position relatively to the whole optical system. For each matrix, therefore, there is a cell in the steel grid which forms a permanent part of the film matrix case (unlike the comparable members of a hot-metal matrix case). Recesses in the upper faces of the wall of each cell constitute sockets into which fit lugs on the lower side of each film-matrix carrier. Normally, 340 cells are provided; where double-size matrices have to be included, some intermediate cell-walls are eliminated.

02. Each of the two sides of the matrix case has a continuous projecting flange which is supported in a corresponding slot in the sliding frame. At one end of the case is a short tail to carry the aligning tenon; a longer tail at the opposite end carries a further tenon and embodies a machined hook.

This connects with the cross slide (which receives motion from the matrix jaws (06.10.02)) and allows transverse movement in agreement with that of the sliding frame.

.03 In the under-face of the matrix case are the V-grooves which register with the sprung and fixed V-bars on the shutter housing to finalise the position of the matrix case (and therefore of the selected matrix) before exposure is made.

.04 The upper faces of the assembled film matrices are protected from dust and other dirt by a transparent plastic cover, kept in place by a grid cover plate; this is secured at each corner by a counter-sunk screw socketed for an Allen key. Always carefully inspect every matrix case before using it; one that has been out of service a long time may have a cover that is discoloured so as to impede the passage of light. If this is so, remove and clean the cover with carbon tetrachloride or trichlorethane ('Genklene') to restore its clarity; use only a small quantity of the liquid and wipe the cover dry immediately afterwards. Be sure to replace the cover and plate correctly – i.e., with the mesh of the cover plate and the corresponding indentations in the cover coinciding with the walls of the cells below. Otherwise, the transmission of light will be obstructed.

.05 During use, the transparent dust cover becomes indented by the film-matrix carriers, so that its resilience is lessened and movement of the carriers becomes possible. This leads to wear and an aggravation of the condition. The film is jolted loose in its carrier and its correct alignment can no longer be guaranteed; therefore, immediately a dust cover begins to show signs of wear, and consequently ceases to hold all the matrix carriers securely, a new one must be substituted.

13.03.00 Cleaning film matrices

.01 Dust, which is always present in the atmosphere, is an enemy of good photographic reproduction, but, with the simple precautions recommended, it can be readily prevented from having ill effects. Film matrices are most exposed to dust when the case is opened to make a change, and we therefore strongly recommend that the work should be carried out as follows:

.02 Lift off the cover plate after withdrawing the four retaining screws, and place it on a clean surface. Lift off the transparent dust cover and make, as detailed in 13.04.03–5, any necessary changes.

.03 Lay the cleaning mask in the position previously occupied by the dust cover and, holding it in position by hand, pass the small nozzle of a domestic-type vacuum-cleaner over the mask to draw out any dust that may have settled on the matrices. Clean the transparent dust cover with a 'Selvyt' cloth and quickly substitute it for the cleaning mask. Then replace the cover plate so that it is correctly registered with the film matrices, and secure it with the four screws. Finally, turn the matrix case over and apply the nozzle to its underside. If it is not required for immediate use, store it at once in the dust-proof box.

.04 A film matrix that has been long stored, as well as one in constant use, may acquire some specks of persistent dust that do not respond to the vacuum-cleaning treatment. Almost certainly the dust particles are being caused to adhere to the surface by a thin film of grease which can be removed as follows: Remove the film-matrix carrier as detailed in 13.04.03; hold it with the tweezers and agitate it for a few seconds in carbon tetrachloride or trichlorethane ('Genklene'). Then remove the film matrix from the fluid and dry it thoroughly in a warm air-stream. Experience has shown that this procedure is easily carried out, and that the results are entirely satisfactory. Note that the use of other cleaning fluids may dissolve the opaque red varnish and destroy the matrix.

13.04.00 Changing a film matrix

.01 While the substitution (or introduction) of a special sort is done easily and quickly, remember that it can also be done incorrectly and that this may lead to permanent damage to the carrier or the negative. It is therefore highly desirable that the work should be done *exactly as detailed*.

.02 By taking out the four screws at the corners of the matrix case, release the cover plate and the transparent dust cover. Place these on a clean sheet of paper, noting which way up and which way round the dust cover had been fitted, so that it may be returned to the same position at the conclusion of the task.

.03 Working (preferably) on a light-table, insert the special tweezers provided into the film-matrix carrier to be removed. You will probably have been notified of the row and column in which this is to be found; time and trouble in finding this location can be saved by laying the plastic positioning plate (supplied with each machine) on the matrix case, as this immediately gives all the cross-references. Be sure that the chamfered corner of the plate agrees with the chamfered corner of the matrix case. Allow the tweezers to expand and carefully raise the matrix; the lift must be truly vertical, or the part will bind against its neighbours, being a very close fit. The lugs at the bottom of each carrier must be thus safeguarded against all strains.

.04 Now check the identification of the substitute film matrix, engraved on the outside of the wall.

.05 Do not attempt to insert the new film matrix using your fingers only, as pressure so imparted may be one-sided;

there is also risk of grease etc. being picked up. Use the tweezers as before, ensuring that the film matrix enters its space vertically, with its identification marking on the side towards you, when the matrix case has its longer tail to your right for reverse-reading or to your left for direct-reading. Push it down gently, so that the four lugs projecting from the underside fit snugly into their sockets in the walls of the cell. Any application of force is liable to damage the seating of the carrier and so impair the quality of the fit.

.06 When the change has been completed, carry out the cleaning and re-assembling routine described in 13.03.03. If the matrix case is not required for immediate use, replace it in its wooden case without delay, and make sure that the displaced matrix also is properly housed for storage.

13.05.00 Position of film-matrix image

.01 The film-matrix image is carefully located relatively to two imaginary datum lines, one vertical and one horizontal. The horizontal datum line (A) is termed 'standard alignment' and is at a fixed distance from the top of the film carrier: the bottom of the x-height is located on this standard alignment, so that, by conforming to this, all characters preserve accurate horizontal alignment relatively to each other. The vertical datum line (B) is termed the 'standard' and is at a fixed distance from the left-hand outer face of a direct-reading (black) film carrier, or the right-hand outer face of a reverse-reading (grey) film carrier, as seen – in both cases – with the lugs towards the observer, and the character upright.

.02 The area between the 'standard' and the inner face of the film-carrier wall is provided to accommodate the kern of characters such as the italic lower-case 'f'. Kerning into this area also occurs with some non-latin scripts.

.03 For technical reasons, some 'exceptional' series (e.g. Spartan and Univers Expanded) do not conform to this 'standard'; the characters are closer to the carrier's side wall. Consequently, it is not practicable to intermix these matrices in the same matrix case with those of any other series, as the vertical alignment will not be the same for both. However, at the make-up stage, matter set in any of the 'exceptional' series can be assembled in register with matter set in another.

SECTION 14

Electrical system

14.01.00 Operative's limitations

.01 The first essential information on the electrical system that every operative must acquire is the realisation that the following instructions fall into two categories. Firstly, there is the set of controls which must be actuated to maintain the working cycles of the machine, a warning light, and a low-voltage projection lamp which is the subject of Section 08.00.00; these matters concern him. Secondly, what does *not* concern him are **the motor and the elaborate electrical system of connections, transformers and relays; these can only be dealt with by a qualified electrician who will also attend to the fuses.** Interference based on hope and good intention, rather than on knowledge and understanding, can lead to expensive damage to the machine, and constitutes a personal risk to the welfare of the adventurer; electricity doesn't do things by halves and there is no reduced penalty for a 'first offender'.

.02 Consequently, no filmsetter operative should attempt to handle any of the items mentioned after paragraph 14.04.09, **as all the subsequent information is intended only for the guidance of the electrician whose services should be obtained in the event of an electrical fault or for maintenance of the electrical equipment.** The operative will, however, profit by reading the whole of this section as he will then be in a better position to anticipate the enquiries of the electrician, who may not be familiar with all the names and locations of the filmsetter components he has to tend. The following descriptive matter assumes a 3-phase supply – the most usual.

14.02.00 Front lower control panel

.01 Through the front of the panel a switch knob (2) projects. It is the constant-voltage-transformer-control switch, more convenient for frequent operation than the isolator switch on the wall; when the machine is not in operation, it must be turned off. All the time current is being fed into the box and the circuits are operative, a neon warning light at the front of the upper control panel is illuminated. It will go out, and the machine will stop (i) if there is an over-load, (ii) if the projector lamp or its circuit fails, (iii) if the mirror bar over-runs (travels a distance representing more than 60 ems) and mechanically breaks the circuit, or (iv) if the fuse in the primary side of the constant-voltage transformer fails.

.02 Also on the front of this control panel is a 'stop and re-set' button (3); if the machine has stopped because of over-load, turn the hand wheel one revolution and then press the button. If the circuit breaks again, find and rectify the cause, if possible, or call in the electrician.

14.03.00 Front upper control panel

.01 The operative's electrical control panel is mounted at the front of the machine, above the hand-wheel. Facing him are the neon warning lamp (1) mentioned above, the START and STOP buttons controlling the electric motor, and the rotary control switch (4). For testing the LAMP and CLUTCH circuits individually, turn the arrow to the appropriate word; for normal operation, turn the arrow to point downwards.

.02 On the right-hand side of the panel box are the control knob (6) and scale for adjusting the current to the projection lamp, and consequently its brightness – see 08.04.07 – by means of an internal rheostat. The pointer to the scale indicates a guide figure rather than a specific measurement.

14.04.00 Advice to operatives

.01 Compared with other filmsetter components, the projection lamp has a short working life. Do not hesitate to change the bulb when its brilliance has been appreciably lessened (08.03.02b). If it fails completely or its fuse is 'blown', this is one of the most likely causes of involuntary machine stoppages and in such an event it should be the first item to be checked; the simple act of replacement may prevent a prolonged investigation.

.02 From time to time, check that the driving belt does not appear to be slack, resulting in slipping and lowering the machine-speed. In addition to slowing production it will also lengthen the exposure-time, giving rise to discrepancies in film-density. To adjust, slacken the two knurled nuts (1 and 2) on the adjusting screw (3) so that the weight of the motor and the base on which it is mounted tensions the belt. Tighten the adjusting nut (1) until it just touches the bracket, then slacken it off one-and-a-half turns. Finally tighten the lock nut (2) so as to nip the base against the adjusting nut. This should be done as a matter of routine one month after the filmsetter has been installed or a new belt fitted, and thereafter at six-monthly intervals as a precaution.

.03 When a general check is made on the tightness of bolts, nuts and screws, do not forget to include those securing the electrical components to the mechanical parts, but this instruction does NOT include the testing of electrical connections.

.04 At the conclusion of working hours, always remember to switch OFF the constant-voltage transformer control switch, as, due to its special nature, this type of transformer absorbs approximately the full-load current whether loaded or unloaded.

.05 What may appear to be an electrical fault may have a different origin. For example, make sure that the air signals are efficiently operating the stop and the clutch-control switches, before blaming the electricity.

.06 Similarly, before looking far a-field for the cause of a stoppage, verify that the mirror bar is not operating its limit switch, and press the RE-SET button.

.07 When the warning lamp on the upper control panel becomes blackened and dull through age, replace it by unscrewing its cover and then unscrewing the bulb itself.

.08 When everything is working correctly – *leave well alone.*

.09 Operatives should remember that the remainder of the Section is not for them to act upon.

14.05.00 Installation

.01 In different areas, the main supply of electricity is available in different voltages and other characteristics. As these will have been specified when the filmsetter was ordered, the wirings of the motor and other primary components will have been arranged to suit, but check that the details shown on the machine data plate (located on the left hand end of the lower control panel cover) agree with what is actually available. The usual ranges are:

190–260 volts, 3-phase, 50 cycles per second
200–220 volts, 3-phase, 60 cycles per second
340–380 volts, 3 phase, 50 cycles per second
400–440 volts, 3-phase, 50 cycles per second

In addition, equipment to suit 200–260 volts, single-phase, 2-phase and other varieties of AC supply are also available. Note that, in the case of the 340 to 440 volt supplies, the neutral conductor must be available in order to supply the auxiliary single phase circuit. Should any change in the supply take place subsequently, as notified by the Local Authority, the information should be passed on at once to a representative of The Monotype Corporation Limited.

.02 At the time of installation, an isolator switch must be fixed to the wall as close as is conveniently possible to the filmsetter, and wired in to the mains. Local Authorities have their own Regulations regarding connections and their requirements should be fully observed in providing for the current to be taken from the isolator switch to the access point at the back of the front lower control panel. This component is the square container below the handwheel at the front of the machine. Efficient earthing is essential; the correct connections are shown in the wiring diagram. There are two principal circuits, one for the motor (3-phase) and one for the auxiliaries (single-phase).

.03 With the isolator switch OFF, remove the cover of the motor starter in the front lower control panel (14.07.01) and fill the dash pots (2) with the oil provided – use no other. As the pistons and dash-pots are matched, these components must not be interchanged. Adjust them in accordance with the details given in the supplementary leaflet supplied with the starter.

.04 Remove the driving belt from the motor pulley; for replacing this after testing the motor, see 14.04.02, but this should be done only by the mechanic responsible for the installing.

.05 Before switching on, make sure that all covers have been properly replaced and that the machine can be turned by hand without obstruction. While the motor can be started by pressing the START push-button, it will only continue to run if the rotary switch (4 Fig. 14.03.04) is in either of the two LAMP ON positions. Note the direction of rotation it must be CLOCKWISE when viewed from the pulley end of the armature shaft.

14.06.00 Motor matters

.01 The 3-phase driving motor is rated at ¾ h.p. Its speed is 720 r.p.m. or 840 r.p.m. if the supply is at 60 cycles per second; pulleys of the appropriate size are fitted to give the correct machine-speed. The motor is of the squirrel-cage, induction type. It should need little attention, but every two years (or more frequently, according to the hours operated), to compensate for normal wastage, the grease cups should be filled with Shell Alvania grease or its equivalent, and completely screwed down.

.02 The 3-phase starter, located in the lower control panel (14.07.01), is also rated at ¾ h.p. Electro-magnetically operated, it is equipped with electro-magnetic over-load trip coils in two of the 3-phase lines. Note that the 3 phase supply does not feed and activate the operating coil in the starter which is in the constant-voltage transformer (secondary) circuit – see 14.07.03.

.03 The coil of the circuit-relay switch, in the centre of the lower control panel, is fed by 2-phase conductors of the 3-phase supply by the motor starter when this is operated

14.07.00 Auxiliary circuit – lower control panel

.01 Before opening the front lower control panel, make certain that the wall-mounted isolator switch is OFF. Then take out the hexagon-headed screws in the back of the bottom left- and right-hand corners of the box and lift off the cover.

Overlying the area of the transformer and relays is the INSULATING SHIELD which screens the exposed terminals and wiring from the metal cover. It carries a diagram showing the whole of the wiring layout and the relative positions of all the components concerned. Be sure to replace the shield before restoring the cover.

.02 FUSES of the cartridge type protect the auxiliary circuits

as follows: Constant-voltage transformer primary (8), 3 amps. Constant-voltage secondary 0.5 amp. Lamp transformer secondary, 5 amps. Coloured dots adjacent to the fuse-holders denote the respective positions of the fuse-carriers. In the case of 3-phase circuits, up to 260 volts, where 2-phase conductors are used to provide the single-phase supply for the constant-voltage transformer, a double-pole fuse is fitted in the C.V.T. primary circuit. Should a fuse have to be replaced, the reason for the fault should be ascertained and cleared. In the event of a correct fuse not being available for the C.V.T. input or output, a fuse of higher rating may be put in temporarily, but in no case should any fuse of more than 5 amps be used. Substitute a fuse of the correct rating as soon as possible.

.03 CONSTANT-VOLTAGE TRANSFORMER of 190–260 volts single-phase input, controlled by a double-pole switch, supplies the whole of the auxiliary circuit with an almost unvarying single-phase supply at 230 volts. Note that meters of the rectifier type do not accurately measure the output circuits of this unit.

.04 PROJECTION LAMP TRANSFORMER input is 230 volt, single-phase, and the nominal stepped-down output to the lamp is 15 volts. For further details of this lamp, see Section 08.00.00.

.05 LAMP RELAY SWITCH, single-pole. The contacts are connected in the contactor-operating-coil circuit, while the relay coil is in series with the primary circuit of the projection-lamp transformer. Any failure in the circuit (e.g. burnt-out filament etc.) will therefore de-energise the starter-contactor coil, and shut down the machine. The contacts should never be filed or dressed; only if very dirty, they should be cleaned with a little contact cleaning fluid. Adjust them so that the relay just operates positively when the brightness control is set at minimum – i.e., turned fully anticlockwise.

.06 CIRCUIT RELAY SWITCH. The coil of this relay is activated by the starter – see 14.06.02. The single-pole contacts are connected in the feed to the running position of the rotary control switch (14.08.02). This interlocks the motor circuit with the auxiliary circuit, and so ensures a complete shut-down if the supply fails or if there should occur one or more of the faults for which either circuit provides. The contacts should never be filed or dressed; only if very dirty, they should be cleaned with a little contact-cleansing fluid. Adjust the relay so that the contacts operate positively at nominal voltage less 15%, but separate at approximately 50% of nominal voltage.

.07 OVERLOAD PUSH-BUTTON RESET SWITCH is constructed integrally with the motor starter, but it is connected in the contactor-operating coil circuit.

.08 CONTACTOR OPERATING COIL, rated at 230 volts, is situated in the motor starter, but it is not connected electrically to the motor circuit.

14.08.00 Auxiliary circuit – upper control panel

.01 When servicing any of the switches in the upper control panel, first see that the isolator switch is OFF. To gain access to the panel, first release the collet-type clamp of the variable resistor knob by slackening the Allen screw at its centre. Note the angle of the 4-position rotary switch and remove the handle after slackening the small cheese headed screw in its end recess. Take out one hexagon screw from each corner at the back of the panel. Withdraw the front cover sufficiently to allow the two warning lamp wires to be released from their terminals, following which it will be completely free. After reconnecting the wires and replacing the cover, restore the rotary switch handle at the correct angle and see that when the indicator of the variable resistor is at zero, the control itself is in its extreme anti clockwise position

.02 4-POSITION ROTARY SWITCH gives, for test purposes, the selected positions of LAMP or CLUTCH and the running position of CLUTCH AND LAMP as well as the OFF.

.03 START/STOP SWITCHES provide remote push-button control for starting and stopping the motor; they are connected in the starter-operating-coil circuit.

.04 STOP SWITCH is operated either by constant air, when triggered, to stop the machine in the event of a mechanical fault, as mentioned in 10.02.05 and 12.11.03, or by *GHN* air at the end of a run (12.18.03). It is a single-pole switch, connected in the starter-operating-coil circuit. The contacts should never be filed or dressed; only if very dirty, they should be cleaned with a little contact-cleansing fluid.

.05 WARNING LAMP, neon-filled, consumes 0·5 watt at 230 volts. It has an Edison-screw fitting. It glows to indicate that the constant-voltage transformer is switched on and that the mirror-bar limit switch is closed.

.06 VARIABLE RESISTOR is provided with an external hand-control knob to regulate the brightness of the projector lamp – see 08.04.07. Of either 1- or 2-ohms resistance, it is in series in the lamp circuit.

14.09.00 Auxiliary circuit – rear control panel

.01 As its name implies, this assembly is situated at the back of the filmsetter. Its functions concern the mirror bar – its progress and its limitations. Before removing its cover, make sure that the isolator switch is OFF.

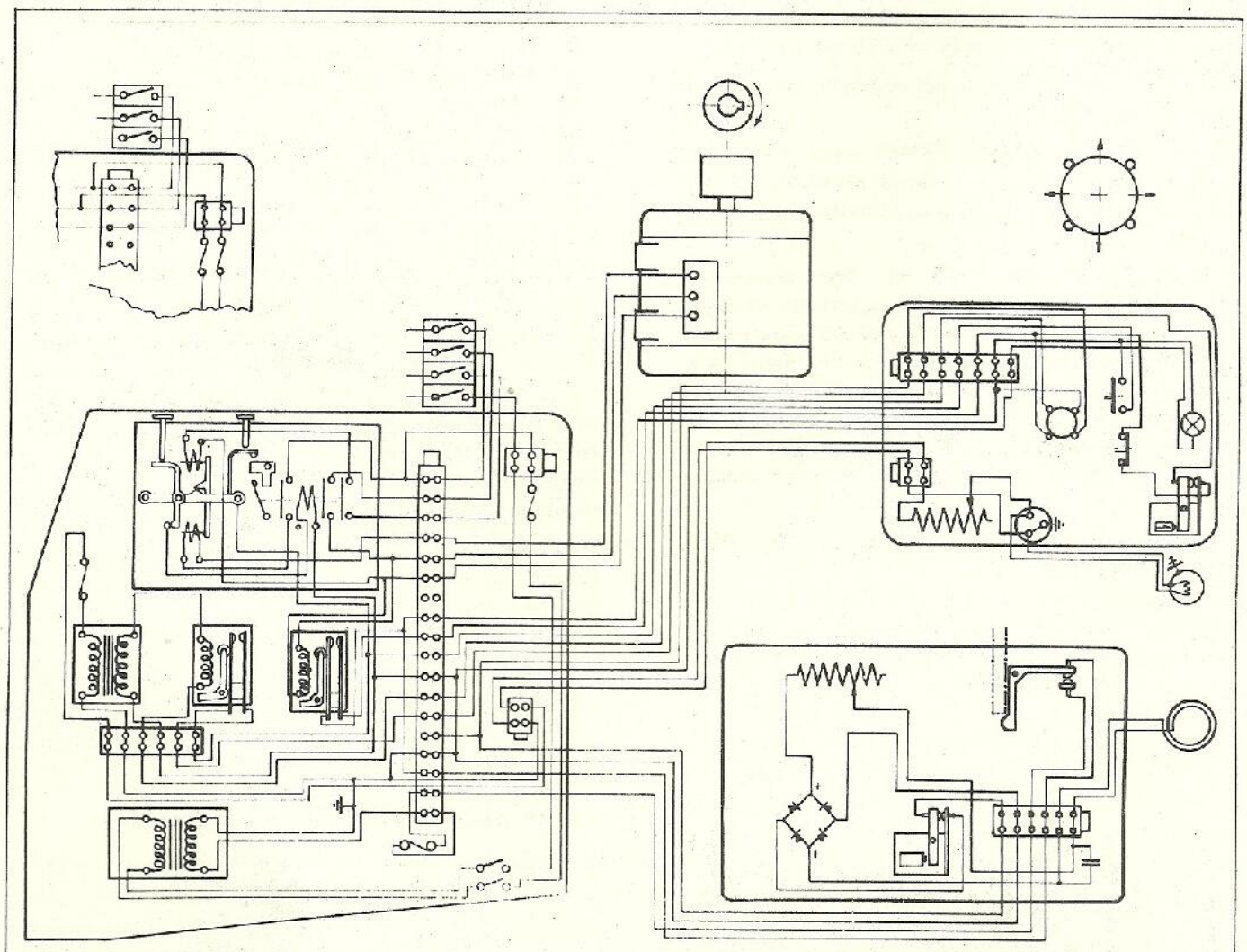
.02 RECTIFIER is of the selenium metal type, with a single phase input of 230 volts and an output of 180 volts, 0·15 amps, D.C.

.03 RESISTOR, rated at 1252 ohms, 40 watts, is connected in series with the clutch field coil; pre-set to reduce the pressure to 90 volts, it should not need adjustment. The voltage of this circuit must not exceed 95 when the clutch field has reached normal working temperature.

.04 ELECTRO-MAGNETIC CLUTCH, when energised, has as its duty the conveyance of motion between the gearbox and the mirror bar. Its electrical components are the field and armature units. It is rated at 90 volts, 9 watts D.C., the voltage being regulated by the resistor – see 14.09.03.

.05 CLUTCH CONTROL SWITCH is operated by an air-piston impelled by *ABC(T)* air (12.18.02), the line-end signal (timed). Breaking the clutch circuit, it allows the mirror bar to return to the front of the machine, rotating its driving pinion (in the reverse direction to its feed), without transmitting the motion back to the gearbox. When servicing this single-pole switch, do not file or dress the contacts; only if they are very dirty, clean them with a little contact-cleansing fluid.

.06 MIRROR BAR LIMIT SWITCH is mechanically operated by the rear end of the mirror bar exceeding its normal travel. The switch controls the output of the constant-voltage transformer. Special attention should be given to the correct adjustment and tightness of this single-pole switch assembly, as failure may result in severe damage to the filmsetter mechanism. Adjust the switch so that it opens before the mirror-bar reaches a point at least $\frac{1}{8}$ in (3mm) from the mechanical limit of its travel, having regard to the continued availability of the 60-ems measure. Service the contacts as described in 14.09.05.



The complete wiring diagram.

SECTION 15

Materials and product

15.01.00 Materials

.01 While it is easily assumed that the material to be mounted on the film drum of a filmsetter must be film, sight must not be lost of the use of photographic paper as an alternative. Operatives should keep abreast of current developments in manufacture, as many improved materials have been introduced in recent years, and continued progress may be confidently forecast. It is therefore advisible to study articles in the trade and technical Press describing the characteristics, processes and possibilities of new films and papers and the chemicals used with them.

.02 Attention may well be given (for some classes of work) to the material classified as 'Stabilisation Paper'. This has reasonably good constancy of dimension and offers such advantages as low purchase price, excellent black-and-white definition and rapid processing which avoids a great deal of conventional darkroom technique by the use of a special inexpensive processor. Where text has to be patched up with art-work, the repro-proof standard of the positive Stabilisation Paper product commends its use in many printing establishments. Special literature, and instruction on the use of this paper, are available.

.03 'Lith' type film or paper may be used on a 'Monophoto' machine. Most modern films have good dimensional stability, but specially stable film bases, such as polyester, are particularly suitable for retaining accurate size. With good processing conditions, the variation of size should not be greater than 0.005 in (0.13 mm) across 60 pica ems on any two pieces of the same 'lith' film, and with 'estar' base the error should not be more than half this amount.

.04 Stripping film is less stable than other kinds, but it produces remarkably accurate results if it is handled under controlled conditions of temperature and humidity.

15.02.00 Grey-scale matrices

.01 To enable the operative to maintain accurate control over the quality of the exposed film, a 'test negative' based on the grey-scale step-wedge principle is used. Various steps in this scale are supplied in the form of individual matrices for insertion into the matrix case.

.02 The matrices may be placed in standard matrix cases wherever there are spare positions. Unit-row values can be ignored, because the keyboard operator will provide for a quad space between the items of the scale to prevent overlapping of exposures, even if the matrices are accomodated in the 4-unit row.

.03 It is a simple routine for the keyboard operator to provide perforations for exposure tests, provided that he knows the positions occupied by the matrices concerned.

.04 Adequate control of development can be obtained with only two or three grey scale matrices in the case, and the preference of individual printing houses may dictate the selection of matrices appropriate to their class of work, either consecutively numbered or alternately numbered.

.05 Many may find that, for normal working conditions, the two matrices, Nos. 2 and 3, will be adequate. The process of development is viewed, and stopped when No. 2 is opaque and No. 3 half-black. A more accurate control may be obtained by having No. 5 available also, stopping development as soon as this becomes visible. However, the fewer test matrices used, the more fount spaces remain.

.06 When required for their specialised checks, individual matrices for the alignment 'cross' and the sizing quad are also inserted into the matrix cases.

SECTION 16

Maintenance and lubrication

16.01.00 'Combined operations'

.01 Apart from outside matters over which he has no control – such as the constancy of the electricity supply – a filmsetter operative's livelihood depends on the continued efficient working of two machines, the filmsetter itself and the compressor plant which provides the air to activate so much of its mechanism. It is therefore essential for him to obtain the best possible service from both of these, without interruptions to his production routine. The manufacturers have done their utmost to ensure a smooth continuity, but they cannot do more than ease the operative's path; it is up to him to follow it conscientiously, carrying out the scheduled maintenance with a precision matching that of the engineers who built the machines. This regular attention is your best safeguard against exasperation at what may be a critical moment. For the sake of everybody's reputation and satisfaction, therefore, we ask for your fullest co-operation in the matter of maintenance.

.02 While the filmsetter is the principal consideration, it has got to be somebody's job to give the compressor the little attention it needs. Anybody can quickly learn and perform the drill for daily operation, but because other maintenance is required only at comparatively long intervals, it is liable to become nobody's duty. The remedy is obvious. Refer to 12.02.00 and keep, near the compressor, a record sheet of lubrication and other maintenance work done.

.03 To re cap, briefly, the needs of the compressor plant – do not neglect the air-intake filter, water temperature, air-out-flow filter, cylinder-head disc-valves, oil-reservoirs and wick feeds, crankshaft bearing and belt-tension.

16.02.00 Cleanliness

.01 Ideally, the filmsetter room should be kept like a hospital's operating theatre. Air-conditioning is probably too much to ask for general application, so atmospheric dust must be controlled. It settles everywhere, but – preferably – do not disturb it with a brush as this merely re-distributes a large part of it. Remove it with a vacuum-cleaner from the filmsetter, floor, bench, cabinets and anywhere else it is liable to accumulate. When dealing with the prism box, focusing bars, matrix cases and the containers of spare sorts, act on the principle of 'box open – box closed', in quick time.

.02 The other bogey to be avoided is excess oil. Lubrication is the art of preserving a film of oil or grease between moving surfaces that would otherwise be in contact. The advantage of a thick film is only rapid automatic repair in case the film gets torn by the loading of excessive pressure and speed, conditions that are unlikely to arise on a filmsetter. For the great majority of its lubrication-points, therefore, a minimum quantity – a single drop – is sufficient at any time, to make good the losses of drainage and evaporation. But, as both of these are continuous, replenishment must be regular and fairly frequent, as detailed. *Excess oil is dirt* that can be spread from machine to hands and tools and from them to anything; if the 'anything' is part of the optical system, time and care must be applied to restoring it to a spotless, smearless condition – see 09.15.00. 'Little and often' is the best policy with the oil-can; an alert eye to detect surplus lubricant and an immediate hand to wipe it off are the best way to put it into practice.

.03 Hands and tools must be kept clean and dry at all times except when actually dealing with components that require an oil-film for their efficient working. Make sure that wipers and cleaning rags are not of the kind that will shed fibres either as loose strands or as eroded fluff.

16.03.00 Adjustments

.01 Details of adjustments that may become necessary are given in those parts of the Manual where they apply. Many represent work that the operative should do, but he should beware of attempting anything that is scheduled for the attention of a qualified engineer or electrician.

.02 Screws and nuts should be nipped up tight but – especially with the smaller components – avoid undue force which will impose an undue strain on the uniting member, will make it more difficult to undo next time and, if constantly repeated, will strip the thread. As a full set of screwdrivers is in the tool-kit, always use the one suitable for the job in hand. Spanners are designed with a length of arm appropriate to the nut, screw or bolt they fit so that the application of a hammer or supplementary 'struggling bar' should never be necessary for undoing, and, for doing up, they are prohibited.

.03 Novices, who may be accustomed to handling heavier articles, should try to develop the more delicate approach to focusing bars, matrix cases etc. which they can observe to be the practice of experienced operatives. Force is unnecessary and is almost certain to cause damage.

16.04.00 Lubrication – compressor

.01 The compressor plant's requirements have been mentioned already – 16.01.02 – so that there is no further need to deal with them under this heading.

16.05.00 Lubricants for filmsetter

.01 Any of the following oils is suitable for use on a filmsetter, whether as part of its semi-permanent supply or as contents of the oil-can for application by hand:

Alexander Duckham Ltd	FEP80 Extreme Pressure Gear and Bearing Oils
Castrol Industrial Ltd	Hyspin 140
Esso Petroleum Co	Teresso V 78
Gulf Oil (G.B.) Ltd	Gulf Harmony 61
Mobil Oil Co	Compound BB Oil
Power Petroleum Ltd	BP Energol HL175
Shell Mex and B.P. Ltd	Shell Macoma Oil 33

.02 Any of the following is suitable for use on a filmsetter where grease is specified:

Alexander Duckham Ltd	Admax 1 3
Castrol Industrial Ltd	– Spheerol AP3
Esso Petroleum Co. Ltd	Beacon 3
Mobil Oil Co	Mobilux 3
Power Petroleum Ltd	– B.P. Energrease LS3
Shell Mex and B.P. Ltd	– Alvania 3 or Alvania RA

16.06.00 Lubrication – cams

.01 A detachable tray below the camshafts provides an oil-bath into which most of the cams dip at every revolution; the others receive oil by splash. This provides adequate lubrication for the bearings of the rollers at the feet of the cam levers, but not for the bearings of the camshafts themselves – see 16.08.11 and 12. On machines up to, and including, No. 91073, a small open trough, near the rear end of the oil pan, served as an oil-level indicator. On later machines, a window-type level-gauge is provided, to the centre of which the level must be restored with a fresh supply of oil as soon as any shortage is noticed. Examine it weekly.

16.07.00 Lubrication – layshaft and gearbox

.01 Forced-feed lubrication is provided for these components. Spigotted in to the rear end of the driven camshaft is a short spindle terminating in a worm. This engages with teeth cut spirally on the centre of a double-ended piston, which is thereby caused to rotate. The upper face of the piston, set at an angle to its axis, bears against a fixed pin projecting inwards from the cylinder-wall; it is held up by a spring below the bottom face. Consequently, as the piston revolves, it is caused to reciprocate axially. In certain positions, ports in the piston are brought into alignment with ports in the cylinder walls, giving valve-action, so that the whole assembly forms a force-pump.

.02 A suction pipe from the lower part of the gearbox enables oil that has accumulated there (see 16.07.05) to be drawn into the pump. The delivery pipe from the pump feeds into distribution passages in the top plate of the gearbox. These supply oil under pressure direct to the three guides for the selector drive shafts, the three bearings for the selector shafts and the two bearings of the unit layshaft.

.03 Passages in the unit layshaft allow oil to reach the journal and thrust bearings of the tubular fine and coarse justification layshafts.

.04 Oil released from these bearings collects in a recess under the unit layshaft spur gear, and is conducted into the upper half of the gearbox (into which some has already drained from the selector shafts and drive shafts). Here it collects to form a bath approximately $1\frac{7}{16}$ in (36 mm) deep. This bath floods the bearing surfaces of the anvils and the operating linkage for turning the lock- and feed-rack shafts of the selectors, and then over-flows into the lower half of the gearbox.

.05 Normal oil-level in the lower half of the gearbox is up to the centre-line of the differential shaft; it can be checked at any time by examining the window-plug in the front end of the gearbox, and should be maintained to ensure that the suction pipe leading to the pump (16.07.01–2) is always submerged. The shaft bearings, pinions, racks and differential gears are thereby fully lubricated.

.06 Three months after the filmsetter is installed, and thereafter at six-monthly intervals, all the oil in the gearbox circulating system should be drained off and a fresh supply substituted. To do this, withdraw the drain plug from the front end of the base of the gearbox and the overflow pipe leading from the upper to the lower half. The top of this pipe is slotted to receive a screwdriver which can be inserted from the rear after the oil splash guard has been released by the removal of its two retaining screws.

.07 Above the clutch, the hole occupied by the large horizontal hexagonally-headed screw (see illustration 16.08.16) acts as a filling orifice and level gauge for the 'final' drive lubricant. Oil should be kept up to the level of the bottom of the thread.

16.08.00 Lubrication-points

.01 The following illustrations show how systematic hand-oiling of the filmsetter is classified in area-groups, with these symbols to indicate the frequency and nature of the attention required:

○ = oil daily ● = oil weekly ■ = oil sparingly weekly ▲ = grease sparingly.

Unless the machine has been stationary for some days (in which case, oil may have drained from the surfaces to be lubricated) it is not necessary to defer the start of work until the daily oiling has been completed, provided that this is done immediately running has begun. An early 'Monotype' instruction book warned against treating the oil can as though it were a 5-gallon watering-can. We repeat – 'Little and often'. But in the case of the electric motor (14.06.01), it is 'Little and seldom'.

SECTION 17

Trouble-shooting

17.01.00 Classification

.01 Defects in a filmsetter's performance may be divided into two main classifications: (1) those which are revealed only when the film has been developed and (2) those of a mechanical nature, identifiable by obvious signs such as unusually noisy operation, rough running, seizures or the sight of a broken part. In general, each of these main groups may be sub-divided into (a) those faults caused by operational errors such as using the incorrect lens-settings, set gears, matrix cases or selector assemblies etc., and (b) those caused by mechanical or electrical malfunction not apparent or audible, and not of such a nature as to stop the filmsetter.

.02 The purpose of this Section is primarily to help operatives to identify these possible defects and to indicate the probable remedies. Having diagnosed and located a fault, the operative should attempt to correct it himself, provided he is a trained and experienced man. *On no account should he attempt any of the work preceded by the spanner symbol unless he is also a fully qualified engineer.* As a matter of permanent policy, the operative should always be alert for any unusually noisy running or any serious break in the normal rhythm of the machine. In such circumstances he should stop the filmsetter immediately and try to find the cause, but he should strongly resist any temptation to carry investigation further than the limits of his certain knowledge and ability; he must not attempt purely experimental investigation, as this can very easily increase the trouble considerably.

.03 The Monotype Corporation Limited cannot accept any liability for any fault or malfunction arising from the incorrect application, by operatives or supervisory staff, of any instruction.

.04 The camshafts should always be turned *by hand* when checks are being made.

.05 When no action is recommended, it is expected that a 'Monotype' technical representative will be called in; he will be assisted in his preliminary work if the investigation that has led to his visit has been intelligently carried out in accordance with the following notes.

.06 All faults should be examined with great care to identify the general area of the suspected defect and, primarily, to establish whether it arises from the machine or the keyboard. In almost all cases of 1b trouble (see 17.01.01), it is essential to check the perforations in the paper ribbon to eliminate the possibility of a keyboard fault before the filmsetter is examined. To do this, find a line of perforations that have resulted in an error on the film. A careful check must be made of all the keyboard functions concerned, such as measure, stopbar case, justification scale, keybar frames, keybutton banks and *S* bar valve settings. Having done this, the operator should carefully tap out the whole affected line of copy in its correct form, including the justification perforations. Over the correct version lay the suspected line, and check it carefully for any differences. If there is none, clearly the fault is not with the keyboard, and attention may confidently be directed to the filmsetter.

.07 It is emphasised that careful and conscientious maintenance will be a powerful defence against the origin of faults. For example, if the optical system is scrupulously kept in a dustless, oil-free condition, at least one cause of out-of-focus, fogged characters is virtually eliminated, and the risk of pistons sticking and piston blocks corroding or clogging will be reduced to a minimum if the air system is blown through regularly with cool, dry air.

.08 Remember that various faults can develop if an adequate air pressure is not maintained. We recommend that the supply from the tank should be set at 17lbf/in^2, as defects arising from sluggish air pins and pistons can occur at lower pressures. The sluggish operation of an air pin or piston may be due to a partly blocked air pipe; check by feeling the air jet against a finger after disconnecting the pipe at the nearest practicable point to its destination.

17.02.00 Defects revealed in developed film

.01 Wrong characters appearing.

a) Sluggish air pins, front and/or rear. Strip, clean and reassemble block(s) concerned.

b) Matrix case. Check correct layout is being used. Screws holding matrix grid loose. Check condition of threads. If satisfactory, refit screws. Otherwise, clean up threads or replace damaged items. If appropriate, have case modified to 4-screw pattern.

c) Draw rods. Adjustment may be faulty. Check in accordance with 06.11.02, and lubricate V-bars with light grease.

d) Sliding frame draw rod. Excessive end-play may be present. Check articulated joint for wear.

Replace if necessary. Adjust in accordance with 06.11.03.

e) Unit Shift. Failure of Unit-shift piston to lift draw rod into upper position, or failure of the draw rod to drop into lower position. Check draw rod yoke and yoke pin for free movement and verify that spring is not broken; check free passage of air from air tower to timing control box, and thence to piston.

f) Matrix-case hook, cross slide or locking bar mechanism. Components worn due to lack of lubricant or faulty adjustment. Damaged components must be replaced by new.

g) Matrix jaws and/or pin jaws. Incorrectly adjusted.

Readjust system. Attempt this only if you are thoroughly familiar with the procedure outlined in 06.13.05–6.

h) Jaw tongs mechanism. Incorrect positioning of matrix case can be caused by excessive wear of ball studs or upper or lower spring box rods. Check these and allied parts.

Replace any that are worn or damaged. Reassemble and adjust in accordance with 06.13.05–6.

j) Matrix-case position. Incorrect through scoring of double-spring-box abutments, due to poor lubrication. Strip to remove abutments. Relieve scores. Ensure correct lubrication with correct grade of grease. Adjust in accordance with 06.13.04. For correct grease, see Monotype card F857 Rev. 6/63.

.02 Characters fogged, out of focus, ghosted, varying in size or density.

a) Optical flat. Oil seeping from mainstand. Clean glass element and reassemble with special care. Make sure prism box top is free from oil and prevent it accumulating there in future.

b) Other optical surfaces. Oil smear or finger mark on lens, prism or mirror surface, or backs of prisms dirty. Remove and clean optical components, using only a 'Selvyt' cloth or, if necessary, a spirit lens-cleaner, but this must *not* be applied to the mirrors. Take care to reassemble correctly. Check the sharpness of image and the light output.

c) Optical system. If lens or a prism has received a shock, or has been clamped too tightly, all character images may be continuously distorted.

If the state of the component has permanently changed, it may have to be replaced and/or the lengths of the focusing bars need attention.

d) Mirror bracket housing. Light may be entering between mirror bracket housing covers. After removing prism box, check abutting faces of both covers; a skilled man will remove any burrs. Refit front cover first as this is dowelled; then slide rear cover into contact and tighten its six screws before replacing prism box.

e) Matrix-case seating delayed. If this settles during exposure, a double image results. Check draw rod adjustment in accordance with 06.11.02. Lubricate V-bars. Check carrying frame for free movement by operating the bridge lever by hand; examine guide rods for score marks (which a skilled man will be able to remove) and grease lightly before replacing.

f) Matrix-case positioning faulty. May be due to broken leaf spring under V-bar. Replace damaged parts.

g) Matrix case. Worn carriers, allowing movement within the case. Replace damaged or worn matrices. Ensure matrix-case dust cover and back plate are in good condition.

h) Shutter. Exposure too early, or too late. Shutter incorrectly timed. Check timing and if necessary rectify in accordance with 18.02.05E.

j) Loose lens element. Lens click stop, operating iris diaphragm, may be damaged, causing change of light-spread to affect apparent size of image.

Fit new assembly, then re-adjust and test complete optical system.

k) Mirrors dirty or badly scratched. Clean with a 'Selvyt' cloth, or remove and wash in plain warm water if necessary, or fit a new pair of matched mirrors.

l) Prism box. Lens or a prism-holder may have been mispositioned during a change of point-size. Reposition it.

m) Light source. Bad electrical connection causing varying power to projection lamp. Isolate supply, and check all terminals between transformer and projection-lamp holder, including soldered joints on rheostat.

n) Film processing. Process a sample of the job by hand to confirm whether or not fault lies with filmsetter.

.03 Faulty setwise alignment. (Characters are sometimes crowded at beginning of lines).

a) Mirror bracket housing. Play in coupling between mirror feed bar and mirror bracket due to wear or absence of ball. Examine and, if necessary, replace ball. Substitute new parts for any that may be broken or damaged by indentation, especially coupling spring and plate.

b) Mirror feed bar. Springs for mirror feed bar plunger collapsed. Polish plunger shaft and fit new springs.

Re-adjust shaft bearing housing for clearance between rack and pinion (10.19.08).

c) 'Final' drive. Loose key in set gear shafts or worn set gear keyways.

Replace worn or damaged parts.

d) Gearbox. Play or end-float at point of contact between 'final' drive gears.

Adjust in accordance with 18.09.00.

e) Gearbox. One of the three feed ratchet pawls (coarse, fine or unit) may fail to engage regularly, due to wear.

Check all pawls and adjust as necessary in accordance with 18.09.00.

f) Gearbox. Lock and/or feed racks may require adjustment.

Proceed in accordance with 10.12.00.

g) Air system. Sluggish return of piston operating unit

drive lever latch, causing loss of setwise feed. Strip, clean and reassemble piston block.

Reset latch in accordance with 18.11.07A.

h) Matrix case incorrectly positioned. Refer to 17.02.01e–h. Lubricate V-bars and matrix-case locating tenons, flanges and hook.

j) Matrix case worn. Check for undue wear of locating V-grooves on underside of matrix case. Check draw rod adjustments in accordance with 06.11.02. Substitute a new matrix case if necessary, and lubricate V-bars, locating tenons, flanges and hook of matrix case.

k) Oil leakage may have allowed clutch-slip.

Take off clutch in accordance with 18.10.01A and clean faces of armature and rotor. Note that friction ring must not be proud of its recess; take off oil seal retaining plate and fit new oil seal. Detatch mirror feed bar and rack and then replace clutch; check for elimination of slip by energising clutch and making vertical pencil markings across peripheries of armature and rotor at three places; energise clutch; hold START button engaged for up to five minutes while periodically looking for any separation or creep of pencilled lines. Continued slip may be due to dirt between faces of bearing block and gearbox extension, or bent dowel.

.04 Faulty bodywise alignment of horizontal rules or characters.

a) Matrix-case seating and positioning mechanism. Check for undue wear of locating V-grooves on underside of matrix case and see that they are lubricated. Check draw rod adjustments in accordance with 06.11.02. Jaw tongs mechanism may be worn or out of adjustment. If so, replace any damaged or worn parts; reassemble and adjust in accordance with 06.13.00.

b) Optical system. Loose or incorrectly clamped optical components. Check from condenser lens to mirrors.

c) Mirror bracket guide plunger(s) sticking. This condition allows bracket to wander from side to side between the guide bars. Remove mirror bracket from its housing (18.07.05A). In the case of machines up to and including No. 91049, clean and free plungers, and carefully reassemble; ensure that top surfaces of support bars are free from dirt, congealed lubricant, wear and other damage. In the case of machines No. 91050 and upwards, see that the V-bars and bearing balls are free from dirt, congealed lubricant, wear and other damage.

d) Low alignment. Sluggish return of optical flat can cause unwanted displacement of characters exposed immediately after its use. Ensure that it can turn freely in its support and that return spring and plunger are in good working order.

N.B. This equipment also comes into operation during character kill signal.

.05 Erratic alignment of characters.

a) Bridge. Lamp cover fouls abutment of carrying frame raising spring, due to incorrect positioning. Reposition lamp cover and run machine to check satisfactory clearance.

.06 Diagonally staggered characters during unwanted line-end sequence.

a) Film feed mechanism. Film feed pawl has not disengaged from ratchet after film feed shaft has completed one revolution, due to trip lever, or its operating piston, sticking. Ensure that trip lever can move freely about its fulcrum pin and clean trip lever operating piston.

If necessary, carefully stone pawl tooth.

.07 Introductory characters of line not exposed.

a) Shutter. Shutter mask remains closed. Make visual inspection of pistons and push rods in timed air control box while running test spool. If they do not operate freely, strip and clean in accordance with 18.10.08.

b) Shutter mask operating pistons. Check for freedom of operation. Clean pistons and bore if necessary, in accordance with 18.11.07A.

.08 Exposure between lines and over certain characters.

a) Air system. Sticking *AC* air piston not operating shutter vane during justification. Clean auxiliary shutter mask operating pistons and/or timed air control box pistons.

.09 Double exposure.

a) Feed mechanism. Unit drive lever latch out of adjustment, failing to engage after justification or character-kill signal. Run a test spool to flick latch up and down on alternate machine revolutions. Check movement.

Adjust if necessary in accordance with 10.03.04 7.

b) Clutch contact switch. If defect follows a film feed, a sluggish piston (operated by *ABC* air) may be responsible. Clean piston and inspect piston-bearing suface of contact plate pivot arm; this can become indented. Invert plate or replace it with a new one. Apply a smear of grease to piston head before re-assembling.

.10 Characters missing.

a) If first few characters in line are missing, sluggish mechanism of timed air control box may be holding shutter mask closed. Inspect control box pistons *(AC* and *BC)* and push rods while a test spool is running. Clean pistons and rods if necessary.

b) Shutter mask pistons sticking, obstructing light path. Clean these pistons.

c) Character deletion signal operating when not required. Sluggish return of *M* piston will cause extra character to be deleted. Clean this piston.

engage in ratchet, renew its weak spring. Ensure that ratchet pawl is free to move on its fulcrum screw and that this is not bent.

If ratchet and pawl are worn, substitute new parts.

b) Film feed mechanism. If an irregular number of camshaft revolutions (more than four) are required to complete one revolution of film feed shaft, ratchet pawl is slipping out of engagement with ratchet. Check for worn components.

Substitute new components if necessary.

c) Air tower. Punched perforations in paper ribbon not aligning with spur wheel holes, causing reduction in air available for multi-perforation signal. Check back to keyboard for alignment. Examine also movement of paper feed mechanism on air tower. Adjust in accordance with 05.04.00.

.17 Excess film feeds.

a) Film feed mechanism. Pawl not released from ratchet after disc revolution. Adjust pawl-to-ratchet engagement to secure a clear release. Replace pawl fulcrum screw if this has been bent under strain.

If necessary, stone the pawl tooth to achieve clear release.

b) Air system. Film feed signal remaining operative from timed air control box. Clean pistons or push rods if necessary.

c) Film feed trip lever. Sluggish return of lever due to dirty fulcrum pin or operating piston. Clean where necessary.

d) Paper lock. Paper lock not released by signal from timed air control box below film feed shaft cam, after completion of four camshaft revolutions. Check position of cam in relation to 'paper release' lever and air-flow to paper lock valve box. Check also paper lock valve box pistons for correct assembly.

e) Insufficient clearance between ratchet and disc on inclined ratchet shaft, so that friction overcomes ratchet pawl spring and trip lever spring, resulting in irregular line feeds.

To correct, slacken screws securing upper bearing to film feed bracket about one turn and use soft-metal drift to tap bearing up from its seating, so raising shaft and ratchet. Introduce packing between ratchet and disc (but not directly under shaft); slacken ratchet lockscrew; partly retighten bearing screws to press shaft further through ratchet. Withdraw packing and fully retighten bearing screws. Check for a minimum of 0·005 in (0·13 mm) between ratchet and disc and finally tighten lock screw. (See also 18.06.01C).

.18 Film drum jumping (possibly allowing stray light to enter).

a) Film feed mechanism. Film drum feed shaft cam may be loose on shaft. Check key; if in good condition, refit cam.

Substitute a new key for a worn one.

b) Film feed and feed-and-lock racks not meshing correctly with film drum, due to teeth being out of alignment when at rest.

This will necessitate re-adjustment of the automatic variable line feed control box in accordance with 18.12.08E.

c) Film drum feed rack or feed-and-lock rack rising too high on engagement, so lifting whole drum housing.

Re-adjust rack in accordance with 18.06.02E.

.19 Inability to obtain automatic variable line feed.

a) Film feed mechanism. Feed-and-lock rack not released due to insufficient movement of control box plunger. Check air pressure of *D* air signal beneath its piston. Clear any blocked air lines, and ensure that there are no leaks from pipe connections.

b) Valve box out of position.

Adjust automatic variable line feed valve box in accordance with 18.10.10E.

.20 Only 6 pt extra line feed obtainable.

a) Air system. Moisture or paper dust causing sticky pistons or clogging air lines. Clean automatic variable line feed valve box.

Adjust the valve box in accordance with 18.11.08B.

.21 Erratic extra line feed.

a) Air system. Water, dirt, or paper dust in automatic variable line feed piston block, causing air pins to stick. Remove this valve box and blow out air lines. Strip, clean and reassemble box. Replace in machine and adjust in accordance with 18.11.08B. Endeavour to find cause of any water content, and cure.

b) Air system. Pistons may be sluggish, due to low air pressure. Check for loose connections or blockages in the lines. See that air pressure at machine is 17 lbf/in^2 (1·20 kgf/cm^2) minimum and that at least 15 lbf/in^2 (1·06 kgf/cm^2) is obtained on the delivery side of the air lubricator; if necessary, re-adjust the venturi plug of this in accordance with 12.10.02. Avoid allowing too much lubrication.

c) Film feed mechanism. Excessive spring-pressure for return of *D(T)* air lever on film feed timed air control block. Check action of spring against *D(T)* air piston.

d) Diamond-shaped block on *D(T)* air lever. Check that this block is not damaged or fouling its ring cam.

e) Film feed mechanism. Eccentric bush or detent plunger on automatic variable line feed valve box may have been damaged when changing from ½ pt to 1 pt range, without *D(T)* air being operative. Fit new parts as required and adjust valve box in accordance with 18.11.08B.

17.03.00 Defects visible or audible

.01 Quadder mechanism erratic or failing.

a) Air tower. Ratchet wheel pawl not feeding correctly owing to slack friction spring washer or sluggish piston operation. Re-tension spring washer and clean operating piston.

Check adjustments in accordance with 05.06.00.

.02 Matrix case and/or cross-slide unduly worn.

a) Faulty matrix case positioning. Refer to 17.02.01 for checks and adjustments. Ensure that V bars, matrix case tenons, flanges, hook and cross-slide have a light application of grease.

If the degree of wear is not acceptable, substitute new components where necessary.

.03 Pin jaws out of adjustment.

Jaw tongs mechanism. Spring rod crosshead ball plug and/or jaw tongs bell crank ball socket may be loose or worn. Jaw tongs bell crank ball studs may be loose in bell cranks.

Substitute new parts and adjust where necessary in accordance with 06.13.05–6.

.04 Machine running below 190 r.p.m.

a) Belt-drive from motor too slack or tight – check in accordance with 14.14.02.

.05 Machine stops but will not restart.

a) Stop switch. Operating piston sluggish or contact points fouled.

Clean piston and points. Adjust spring-tension if necessary.

b) Projection lamp. Lamp filament fractured but breaks circuit only occasionally. Change lamp for a new one. Check light output and adjust control as required.

.06 Machine stops.

a) Mirror feed bar limit switch. Mirror feed bar over-feeds. Pull mirror bar forward by hand to allow circuit to be completed, and re-run previous two lines.

b) Paper ribbon. If fault continues, check that *ABC* signal has been correctly punched.

c) Check that other *ABC(T)* functions are being correctly carried out, especially release of film feed ratchet pawl. If not, examine timing air valve box for correct response to *ABC* perforations and then, if necessary, trace individual *ABC*, *AC* and *BC* pipe lines to locate fault.

.07 Machine seizures.

a) Unit or justification selector assembly seized on shaft.

Press out shaft. Stone seizure areas and polish to ensure future freedom. Fit new shaft if necessary.

b) Driving camshaft seized in auto-lock housing (pulley driving locking plate housing). Dismantle and dress burred or damaged areas, replace parts where necessary. Lubricate regularly.

c) Air bar seized. Free all associated parts and examine for scoring; ease away any such area and reassemble with new sealing washers, checking for free movement at every stage.

.08 a) 'Fail-Safe' persistently operating. This is warning of serious obstruction.

Maladjustment of and/or wear on jaw tongs bell crank studs (upper or lower), spring box ball plug and ball socket or spring box lower rod and ball socket, can all cause mis-positioning of unit and justification racks and therefore of selector barrels. Spring rod lock nut or spring rod crosshead ball plug lock nut may have worked loose, causing mis-positioning of jaw and racks, leading to damaged selectors. Check jaw tongs and unit and justification drive mechanism throughout. Fit new parts where necessary, and adjust. Caution: Lock all nuts up tight, remembering that filmsetters run at 190 r.p.m. Reset 'Fail-Safe' mechanism, and check all adjustments. Special check: See that there is clearance between head of operating plunger and valve operating plate when camshafts are at 285°; otherwise the plate is continually being tapped by the plunger, causing constant air to build up in the control box. This results in a machine stoppage without the plungers having operated as intended.

b) 'Fail-Safe' persistently operating. A collapsed spring on Unit-shift articulated draw rod can contribute to draw rod head being trapped between matrix jaw sockets. Consequently, two selector lugs are presented to anvil and follower simultaneously. Check condition of spring.

Replace spring if necessary. Reset 'Fail-Safe' mechanism, check all adjustments and carry out special check in accordance with 17.03.08A.

.09 Damaged unit of justification selector lugs.

Causes are probably similar to those listed in 17.03.07. Correct accordingly and reset 'Fail Safe' mechanism. Any damaged selector lug must be replaced by a sound one.

SECTION 18

Strip and rebuild

18.01.00 General

.01 First, we should repeat the warning given earlier. Information set out to the normal column measure or tabulated describes work that can, and should, be undertaken by a trained operative of 'Monophoto' filmsetters, especially if he has had instructions on the Mark 4 model. Work which is not detailed is either so simple and obvious as not to require instructions or, on the other hand, it is sufficiently involved to need **the attention of the manufacturer's own personnel who can apply special equipment.** The distinction between these two categories will be readily recognised.

.02 Information signallised by the adjoining symbol is intended only for the guidance of experienced engineers (or electricians) whether or not they are also regular machine operatives.

.03 As far as possible, the numerical sequence of details conforms to the order in which the work should be done, but it will be seen that letters are appended to many of the paragraph references. 'A' paragraphs relate to removal operations and they are followed by 'B' paragraphs covering the replacement of the same sub-units; this arrangement enables illustrations to be readily available when either half of the task is undertaken. Where a sub-unit is itself to be dismantled, a 'C' paragraph is added, with a 'D' for the corresponding re-assembly. Where a special fresh adjustment is required because of the dismantling, an 'E' paragraph appears as well.

.04 Where instructions are given to carry out work in a preceding range of lettered paragraphs (e.g. 18.02.06A–9A) it will be obvious that the intervening paragraphs with other letters (e.g. 18.02.06B etc) are not to be read as included in the sequence.

.05 **A general safety precaution before starting any dismantling is to cut off the electrical power** [E] **at the mains and the air-supply** [A] **at the control cock**; otherwise there could be an accidental 'short' or an unrestrained air pin could be flung some distance from its cylinder, with regrettable consequences. Gearbox mechanism is protected by the use of **the wooden wedge** [W] (18.02.02).

.06 Three precautions will facilitate all the work. Use the correct tools, including the right size of screwdriver, and suit the tightness of screws etc. to the size of the component; spanner shanks have been designed to give sufficient leverage to deal with the nuts they fit without undue force being applied. Secondly, before starting to detach any component, ensure that there is adequate space to allow it to lie where it will not be accidentally disturbed, and in reasonable relationship to other parts that have been, or will shortly be, taken down: this will be a great advantage when re-assembly is in progress. Thirdly, before re-assembly, see that every part is clean; all mating surfaces should be immaculate; adjacent moving surfaces must have a film (at least) of the appropriate lubricant.

.07 Apart from the Allen screws, 'Monotype' components have special threads, and only damage can result if any attempt is made to use nuts with other threads on any screwed component. The description $\frac{1}{4}$ in 24 (for example) relates to a diameter of $\frac{1}{4}$ in with twenty four threads per inch.

18.02.00 Top mechanisms

.01 Sound-deadening, dust-excluding covers protect the majority of the components above the main stand. For most of the following work, it is not essential to detach the hinged cover, but we recommend that this should be done (by taking out the two hexagonal bolts securing its bracket to the main stand) as the removal improves accessibility to the top mechanism. Arranged so that they may be mechanically efficient and yet economical of space, the assemblies present an appearance of considerable complication which is, however, resolved if the stripping down of the machine is carried out strictly in the order detailed.

.02 Before starting work on the group, **use the wooden wedge** [W] provided in the tool kit to prevent the possibility of damage to the gearbox. Insert the wedge between the operating piston and the arm of the unit trip lever to hold the latch firmly out of engagement.

.03 After components of the top mechanism have been replaced, do not immediately put back the covers – turn the camshafts by hand with the machine in this condition and then run it under power for about the first half-hour. Meanwhile, look carefully for any parts that do not appear to have been properly retightened, and immediately rectify. Such oversights are possible with even the most experienced men, but there is no need for disaster to follow.

.04A BRIDGE – REMOVING. Refer to 18.01.05. Take out the bridge lever link pin (1) and the matrix case. Swing back the hinged cover over the matrix case lever (if not already detached), and separate the paper 'basket' from the air tower. Slide off the cover over the tongs after releasing its hand-grip nut. Undo the three screws holding the bridge cover, and remove it, being careful of the washer of the top screw, behind the inspection plate. Unscrew and detach the lamp lead plug (2), and release the cable from its spring clip. Turn the camshafts to a position between 310° and 0° to open the matrix jaws fully. Release the two screws and post securing the bridge to the main stand. Pull to the left the retaining plate over the articulated draw rod so that the head of this rod can be lifted clear of the pin block mechanism and released over the plate. Now lift off the

bridge. At any time when the bridge is detached, access is provided for the removal of the enlarged aperture control box so that its piston can be taken out for cleaning (18.11.01 and 18.12.02A).

.04B BRIDGE – REPLACING. Turn the camshafts to between 310° and 0°. Clean the feet of the bridge and the corresponding area on the main stand. The replacement procedure is a reversal of 18.02.04A.

.04C BRIDGE – DISMANTLING. With the bridge on the bench, detach the clip retaining the lamp lead and withdraw the lamp-holder after slackening the knurled pinch screw at its side. By releasing its three screws, take off the lamp holder and then the condenser holder (three more screws) with the condenser. To remove the sliding frame (8), first take out the split pin and fulcrum pin at the top of the fulcrum rod, but do not disturb the latter; then, supporting the frame, take off the two hexagon nuts at the tops of the guide rods, at the same time restraining the assembly of the bridge lever and cross beam which are under spring-pressure (a third hand will be helpful). Note carefully the correct position of the cross beam for re-assembly, to avoid the need for re-adjustment. Lift off the springs and abutments. Turn the bridge on to its side and mark the carrying frame (9) to ensure that it is correctly replaced later, as it *appears* to be symmetrical. Detach the fibre stop by unhooking its spring, to avoid straining it. Then centralise the sliding frame in the carrying frame so that both can be removed without interference from the foot of the bridge. **It is recommended that the vertical bushes should not be disturbed as their re-adjustment requires special procedure with which only Works representatives are familiar.**

.04D BRIDGE – RE-ASSEMBLING. Basically, re-assembly is a reversal of the dismantling routine, but care must be taken at several points. Lightly lubricate the carrying and sliding frames with vaseline. Assemble the carrying frame to the sliding frame so that the latter is central, with its draw rod beside the leg of the bridge that has the channel (6) for the shutter drive cable. Attach the spring of the fibre stop to its post. See that the recesses in the fibre stop are centralised to the holes for the guide rods, and enter these into their bushes. Keeping all components in their places, turn the bridge right-way-up and fully raise the frames. Add the springs, with their top abutments and the cross beam assembly, checking that the bridge lever is in the yoke of the fulcrum rod. Fit and fully tighten the nuts at the tops of the guide rods. Check the mechanism for free movement; it should spring up readily when the bridge lever has been depressed and released. Release the fibre stop to verify that it is not binding. If there is any suggestion of cross-locking, slacken off the cross beam nuts and the nut at the base of the fulcrum rod; then operate the bridge lever by hand, enabling the parts to take up free positions, after which the nuts should be retightened and a further check made. Replace the fulcrum pin and its split pin. The condenser housing can now be restored to position (7) and secured; clean the condenser before replacing this also, with its convex face downwards. When refitting the lamp-housing, note that the large washer is intended for the front screw and that all three screws should not be more than finger-tight, pending final adjustment on the machine (08.03.02C). The bulb and holder can now be added and secured with the pinch screw. Secure the lamp-lead with its clip and do not forget to plug it in when the bridge is replaced on the machine. It is desirable that, before the filmsetter resumes work, the optical system should be checked with the light meter (08.04.06–10 and 08.04.12–16).

.05A SHUTTER – ACCESS TO. Take off the bridge (18.02.04A). Take out the six screws securing the shutter housing cover (13) (one of them is also the spring post (19)). Remove the circlip from the pivot post (17) of the enlarged-aperture mechanism, and insert two of the cover screws in the threaded holes (21) adjoining the dowels, to jack up the cover – this must be done evenly. Then lift off the cover and be sure to take out the lifting screws. At this stage, the final shutter drive can be lubricated by inserting vaseline on a thin screwdriver tip through the shutter aperture, without disturbing the timing. At 12-monthly intervals, lift out the shutter disc, clean off the old vaseline, and re-lubricate. Unscrew the base plug of the piston block and insert, from the plunger end, a bent probe of soft wire to press out the three pistons for cleaning (see 18.12.07A). **Turn on the air temporarily** and operate each of the three air-ways *(AC(T), BC(T)* and *M(T))* to clear the cylinder, by moving the valves by hand. The light mask can be lifted off after removal of the circlip on its pivot. Now, if necessary, the return plunger and its spring can be withdrawn to the right.

.05B SHUTTER – REPLACING. Insert the pistons in their correct sequence (see illustration 12.17.03); after each, press in with a pencil to check for free return of the mask under spring pressure, and then replace the end plug. Turn the camshafts to 248° and re-mesh the shutter gear in such a way that the aperture exactly aligns with the one below it, in the base of the shutter housing. Checking that the two jacking screws have been taken out, and that the mating surfaces are clean, add the cover and secure it as before. Replace the spring and circlip of the enlarged-aperture control. Replace the bridge and re-time the shutter as detailed in 18.02.05E.

.05C V-BAR, SPRUNG – DETACHING. With the spring of the enlarged aperture control disconnected, withdraw the two retaining screws and the change-over screw for the reverse/direct control. Lift out the sprung V-bar (24) and the two springs which lie below it.

.05D V-BAR, SPRUNG – REPLACING. After cleaning and greasing the mating surfaces, replace in the reverse order of detaching.

.05E SHUTTER – RE-TIMING. Without a matrix case inserted, but with the bridge in position, place the optical test rig on the mirror bracket housing (09.14.02). To facilitate checking, set the optical system as for 24pt. Switch on 'LAMP', and turn the camshafts to 227°. Undo the three screws in the lower (large-diameter) cover of the shutter driving gear, and remove the gear casing still attached to the outer cable. As the driven bevel gear is slowly turned clockwise by hand, it will be seen on the ground glass screen that the shutter-opening appears to move from right to left. Position the gear so that the exposure is just beginning (at the right-hand side). Retaining this position as accurately as possible, re-mesh the gears, and temporarily secure the gear casing in its working position with one of the screws. Give the camshafts a few turns by hand, and then proceed very slowly and carefully until the exposure begins, as before. Note the camshaft angle, which should be 227°—4°. If this is not the case, remove the temporary screw and re-mesh the gears one tooth in the required direction. When it is found that the adjustment has been made correctly, replace the remaining two screws and tighten them all. Switch off the lamp and replace the optical test rig in its box.

.06A PIN JAW TONGS SPRING ASSEMBLY – REMOVING. Check that the unit drive trip lever is held in its highest position by the wooden wedge [W]. After taking out the bridge link pin, swing up the hinged cover and remove the main stand top cover. Detach the short (rear) and long (front) (10) links joining the assembly to the tongs and unscrew the nut from the pin jaw tongs spring bell crank stud. On machines up to and including No. 91,100, lift off the spring assembly, complete with its bell crank. In the case of later machines, undo the nut on the pin jaw tongs lever stud, so that the lever can be lifted off with the spring.

.06B PIN JAW TONGS SPRING ASSEMBLY – REPLACING. In the case of machines No. 91,101 and up, place the pin jaw tongs lever on its stud, where it will be retained by its washer and nut, and, on all machines, thread the bell crank of the assembly on to its stud and secure it with its washer and nut. Attach the plate at the rear end of the spring to its pin in the left-hand end of the lever. Connect the longer link between the free end of the bell crank and the pin on the front pin jaw tongs. Supporting this link with one hand, connect the shorter link between the pin in the free end of the lever and the pin in the rear pin jaw tongs. Replace the covers and the link pin, and withdraw the wooden wedge.

.07A PIN JAW TONGS, REAR – REMOVING. Take off the bridge (18.02.04A) and pin jaw tongs spring assembly (18.02.06A). Then turn the camshafts to about 260° and remove the two nuts and washers holding the tongs to their studs and the two smaller nuts and washers holding the tongs to the pin jaws (28). The tongs may now be lifted clear.

.07B PIN JAW TONGS, REAR – REPLACING. With the camshafts at 260°, locate the tongs so that their links are threaded over their respective studs and, at the same time, their driving ends must be over the studs in the pin jaws, all these points being lightly lubricated. Manipulate the tongs into their working position and secure them with their four washers and nuts. Note – one washer and nut may still be on the buffer assembly if this has been removed (18.02.09A). The rest of the work is covered by 18.02.04B and 18.02.06B.

.08A MATRIX JAW TONGS, REAR – REMOVING. Remove the bridge (18.02.04A), pin jaw tongs spring assembly and rear pin jaw tongs (18.02.06A–7A). Turn the camshafts to 235°. Press the lock slides to the left (i.e., towards the centre of the machine) to open them and remove the nut and washer from the stud (29). The rear matrix jaw tongs may now be lifted clear.

.08B MATRIX JAW TONGS, REAR – REPLACING. With the camshafts at approximately 260°, place the tongs so that their links are threaded over their respective studs; at the same time, their driving ends must be over the sockets in the matrix jaws, all these points being lightly lubricated. Manipulate them down to their correct seatings, and pull the lock slides to the right into position to retain their free ends in the matrix jaws (30). Add the washer at the top of the foremost stud, and tighten down its nut. The rest of the work is covered by 18.02.07B–6B and 18.02.04B.

.09A CROSS SLIDE, BUFFER AND GUIDE – REMOVING. Remove the bridge, pin jaw tongs spring assembly, rear pin jaw tongs and rear matrix jaw tongs (18.02.04A and 18.02.06A–8A). Use one of the small nuts and washers to compress the cross slide buffer spring (31), and take out the two large and two small screws (three in early models) retaining the buffer (32). This sub-assembly may now be lifted clear. At this point, the rear matrix jaw (30) may be removed, if necessary. Next, take out the four screws locating the cross slide guide. Detach the cross slide and guide by moving the guide towards the shutter, and lifting it clear; with the remaining matrix jaw fully forward, the cross slide also

can be freed by manipulating it clear of the matrix jaw.

.09B CROSS SLIDE, BUFFER AND GUIDE – REPLACING. With the front matrix jaw in its foremost position and the rear matrix jaw in its rearmost position, locate the cross slide into its slot in the pin block. Manipulate the cross slide guide, with a smear of lubricant, into engagement with the under side of the cross slide and after moving it into its correct location, lightly tighten its four screws. Check for accurate alignment by traversing the slide through its entire travel and then *fully* tighten the four guide plate screws. Replace the buffer assembly and evenly tighten down its four screws (five in early models); again test for free movement of the cross slide. The rest of the work is covered by 18.02.08B–6B and 18.02.04B.

.10A PIN AND MATRIX JAWS, REAR – REMOVING. Remove the bridge, pin jaw tongs spring assembly, rear pin jaw tongs, rear matrix jaw tongs and the cross slide, buffer and guide (18.02.04A and 18.02.06A–9A). Take the lock nut from the pin jaw guide rod stand (rear) and unscrew its bolt (39). Slacken the clamp nut from the pin jaw guide rod stand (front) (41); the guide rod (40) may now be slid out to the rear, liberating the pin jaws (28), but take care of the washer at the front of the rear stand. To remove the matrix jaw stop rack (42), detach the gearbox oil splash guard, by taking out its two screws and turning the cam shafts to 260°, when the rack and rear matrix jaw can slide out. The front matrix jaw can now be taken off.

.10B PIN AND MATRIX JAWS, REAR – REPLACING. Put in position the matrix jaws and matrix jaw stop rack, noting that the lower flange of the front jaw is appreciably thinner than that of the rear jaw, to enable the cross slide to be added (18.02.09B). Now slide the stop rack and rear matrix jaw into position. Slide the guide rod through its rear stand and add the pin jaws, keeping the thin washer adjacent to the stand; note that the pin jaws are positioned on either side of the stop rack lug and that the groove of the rod aligns with the hole through the two halves of the clamp. Screw in the clamp bolt and add its lock nut; tighten the nut of the pinch bolt in the forward stand. Check that the pin jaws slide freely on their rod. Replace and secure the gearbox oil splash guard. The rest of the work is covered by 18.02.09B–6B and 18.02.04B.

.11A AIR PIN PLATE, REAR – REMOVING. Remove the bridge, pin jaw tongs spring assembly, rear pin jaw tongs, rear matrix jaw tongs, cross slide buffer and guide and the rear pin and matrix jaws (18.02.04A and 18.02.06A–10A). Then check that the air supply is OFF[A]. Take out the four screws holding the plate, and insert, in the threaded holes adjacent to the taper pins, two of the screws taken from the cross slide guide, to jack up the plate from its seating; be careful to keep it level. This gives access to the air pins of the rear pin block, with their springs and seating rings; these should be taken out and cleaned one at a time, so that each can be replaced in its own bore. Be sure to remove and restore extracting screws from the plate which would be strained and imperfectly seated if replaced with them still in position.

.11B AIR PIN PLATE, REAR – REPLACING. Having checked that the parts are all in good condition, and that the extreme rear pin (the 'stop pin') is the one that has the short spring *underneath* it, locate the air pin plate by its taper pins and lightly tighten its two long and two short screws; with a soft-metal drift, very lightly tap the taper pins to give a secure hold, and finally tighten the four screws. Now check each air pin for pressure after placing on the air tower a paper ribbon with all the *A–J* positions perforated, and see that all the pins drop smartly when air pressure ceases. The rest of the work is covered by 18.02.10B–6B and 18.02.04B.

.12A PIN JAW TONGS, FRONT – REMOVING. Remove the bridge and pin jaw tongs spring assembly (18.02.04A and 18.02.06A). Turn the camshafts to 260°. Remove one of the nuts and washers holding the tongs to a pin jaw, and use this to compress the spring of the front buffer. Take the split pin and washer from the right-hand matrix jaw buffer stud; remove the buffer spring rod screw and clip from the left-hand buffer. The spring, rod and right-hand buffer can now be lifted off complete. Take the remaining nut and washer off the other pin jaw, also the nuts and washers from the pin jaw tongs studs. The pin jaw tongs may now be lifted clear.

.12B PIN JAW TONGS, FRONT – REPLACING. This is done in reverse order of removal with the camshafts at 260° and the bearing surfaces lightly oiled.

.13A MATRIX JAW TONGS, FRONT – REMOVING. Remove the bridge, pin jaw tongs spring assembly and the front pin jaw tongs (18.02.04A, 18.02.06A and 18.02.12A). Unhook the left-hand end of the retaining plate spring. While holding the spring with the left hand, take out the spring post and slide the retaining plate clear to the right. Remove the nut and spring anchorage arm from the remaining matrix jaw tongs stud; this arm can be conveniently held clear by the stud in the air bar operating arm of the air tower. With the camshafts at 220°, and the matrix jaws central to the pin block, press the lock slides to the rear and lift off the tongs (58).

.13B MATRIX JAW TONGS, FRONT – REPLACING. Turn the camshafts to 260°. Place the tongs so that their links are threaded over their respective studs, noting that arrows

connecting link, press it in to compress the spring and, at the same time, slide it to one side to disengage. To re-assemble with the new spring, smear the replacement part with grease and insert it in its socket in the link. By means of the vice, compress the spring into its socket, gripping it in such a way that half the head projects above the vice jaw. The yoke of the locking bar can now be placed over the projecting part of the head; when the vice is released, the spring will be retained, and it is easy to bring the bar and the yoke into correct alignment.

.18E LOCKING BAR ADJUSTMENT. See 06.06.03-4.

.19A JUSTIFICATION RACKS – REMOVING. To provide clearance for the removal of these racks, first remove the bridge (18.02.04A). Take off the layshaft cover held by seven Allen screws (two large above and five small below). This discloses the unit and justification rack pressure roller assembly and the rack guide (79); remove the former by withdrawing the three Allen screws. The guide is secured by two screws and two taper pins, of which the front one can be tapped out from below; then, with protection above and below the racks to prevent accidental damage, raise and remove the guide so that the racks can be withdrawn; standing at the right-hand side of the machine, lift the outer end of the fine justification rack (86) and, while turning it slightly counter-clockwise, pull it towards you; alternately raising and lowering the rack lever arm (74), you can free the rack. The coarse justification rack (85) must be turned slightly clockwise, but in other respects it comes out in the same way.

.19B JUSTIFICATION RACKS – REPLACING. The racks may be replaced in the reverse order of removal, but take care that each is in its correct relative position and that the teeth marked on the front face of the 'fine' rack and the rear face of the 'coarse' one mesh with the correspondingly marked teeth of their respective gears. When the guide and roller assembly are again secured in place, check that there is 0·0015 in (0·04 mm) clearance between each roller and the top of its rack. If not, refer to 18.02.19E. The remainder of the work is a reversal of 18.02.19A.

.19E UNIT AND JUSTIFICATION RACKS – ROLLER ADJUSTMENT. To adjust the rollers of the justification racks (86), it is first necessary to remove the roller of the unit rack (87). For this purpose, insert a $\frac{1}{8}$ in – 40 screw in the spindle of this roller and then slacken off the small Allen grub screws of the unit, fine and coarse justification roller shafts. Using the inserted screw as a handle, withdraw the unit rack roller and its shaft. This gives access for a screwdriver to reach the front end of the fine justification roller shaft (89) and turn it; as the shaft is eccentric, the required clearance of 0·0015 in (0·04 mm) can be obtained. The eccentric for the coarse justification rack roller should be similarly adjusted. Lock the fine and coarse justification roller shafts by retightening their grub screws. Engage the fine and coarse justification rods with the matrix case holder lever while the camshafts are at 15°, and ensure that complete freedom of movement is achieved over the whole travel of the racks. If not, slightly re-adjust to achieve the 0·0015 in (0·04 mm) clearance at the tightest spot. Replace the unit rack roller and its shaft, and adjust the eccentric to achieve similar clearance over the whole travel of this rack also.

.20A UNIT RACK – REMOVING. First, take off the bridge (18.02.04A), pin jaw tongs spring assembly (18.02.06A), buffer assembly (18.02.09A), front pin jaw tongs, front matrix jaw tongs and the front matrix jaw shoe (18.02.12A - 14A). Turn the camshafts to 40°, bringing the matrix case holder lever (14) to the top of its stroke. Take off the guide (92) for the unit rack and space bar (two screws) and the guide (94) for the space bar (two screws). The unit rack (87) can now be withdrawn to the *left* of the machine, to the rear of the matrix case holder cam lever.

.20B UNIT RACK – REPLACING. The rack may be replaced in the reverse order of removal, but take care that the tooth marked on its front face meshes with the correspondingly marked teeth of its gear. Check that there is 0·0015 in (0·04 mm) clearance between the roller and the top of the rack. If not, refer to 18.02.19E. The remainder of the work is covered by 18.02.14B–12B, 18.02.09B, 18.02.06B and 18.02.04B.

.21A SPACE BAR – REMOVING. First, take off the bridge (18.02.04A), pin jaw tongs spring assembly (18.02.06A), buffer assembly (18.02.09A), front pin jaw tongs, front matrix jaw tongs and the front matrix jaw shoe (18.02.12A - 14A). Take off the unit rack and space bar guides (92 and 94) Withdraw the split pin, washer and the link pin at the junction of the space bar (93) with its spring box, and swing this box clear, to the left of the machine. The space bar may now be drawn slightly to the left, its left-hand end raised and then the whole bar can be lifted out to the left.

.21B SPACE BAR – REPLACING. This is a reversal of the removal procedure, but be certain that the leading end of the bar is correctly located in the forked end of its release and that the transverse pin is held in the top of the operating lever. Ensure that, after re-assembly, the space bar and unit rack move perfectly freely.

.22A UNIT RACK LOCKING PIN STAND – REMOVING. Detach the bridge (18.02.04A), pin jaw tongs spring assembly, rear pin jaw tongs, rear matrix jaw tongs and the cross slide (18.02.06A–09A). Disconnect the spring from the space bell crank lever (99). Then take off the prism box

(18.07.02A) to enable the two taper pins (100) locating the locking pin stand (95) to be tapped out, but see that each can be relocated in its own hole, and replace the prism box door at once to exclude dust. Tap out the two taper pins with the dowel punch and identify them also for replacement. Take out the horizontal hexagon-headed screw and the three cheese-headed screws holding the stand; release the space rod by detaching one end of the retaining plate (98) on the matrix case holder lever (14), enabling the locking pin stand to be lifted away.

.22B UNIT RACK LOCKING PIN STAND – REPLACING. Locate the stand in position and insert in the front screw hole the shorter of the two large screws. Add the other three screws, all finger-tight only. Tap the taper pins home and then fully tighten all four screws. The remainder of the replacement process is a reversal of the work listed in 18.02.22A.

.23A JUSTIFICATION CENTRING TOOTH – REMOVING. Remove the bridge (18.02.04A), pin jaw tongs spring assembly, rear pin jaw tongs, rear matrix jaw tongs, cross slide and unit rack locking pin stand (18.02.06A–09A and 18.02.22A). Take off the layshaft cover and the roller bracket and guide plate of the unit and justification racks; this enables the justification racks to be removed (18.02.19A). Obtain access to the rear screw holding the centring tooth (76) by raising the fine justification bell crank lever. When this screw and the corresponding front one are removed, the tooth can be lifted away.

.23B JUSTIFICATION CENTRING TOOTH – REPLACING. This is a reversal of the foregoing instructions; be particularly careful to see that the marked teeth of the racks and gears are correctly mated and take the other precautions detailed in 18.02.19B.

.24A JUSTIFICATION AIR PIN BLOCK – REMOVING. Remove the bridge (18.02.04A), pin jaw tongs spring assembly, rear pin jaw tongs, rear matrix jaw tongs, cross slide and unit rack locking pin stand (18.02.06A–09A and 18.02.22A). Take off the other components listed in 18.02.23A except the centring tooth and its screws. Remove also the front pin and matrix jaw tongs (18.02.12A–13A), the locking bars and their bell crank (18.02.18A). After driving up the two taper pins locating the pin block (103), take the two large hexagon nuts from the lower part of the stud and the bolt which project down through the mainstand; these are reached through the aperture at the rear. Access to them is obstructed by the two justification rack lever springs secured to their bracket by small screws and hexagon nuts. These must be released before a tubular or box spanner, measuring $\frac{7}{8}$ in (22·2 mm) across the flats is used to release the large hexagons, one of which also retains the bracket; if necessary, remove the drip tray and work through the intermediate stand aperture. After this, withdrawal of the four cheese-headed screws at the top of the block will release it.

.24B JUSTIFICATION PIN BLOCK – REPLACING. This is a reversal of the removal procedure, but be sure that the bracket below the mainstand is squarely aligned with its springs.

.25A AIR TOWER – REMOVING. Note that this is only necessary when some major attention is required, as most of the components can be detached with the tower in its operating position. To give access to the front holding down screws, first remove the jaw tongs spring box and bell cranks (18.02.17A). Take off the air tower operating rod by withdrawing the stud from the eye at its lower end. After slackening its lock nut, take out the grub screw with its nut and leather washer, handling the latter with particular care. Slide the air pipe connection off the air bar shaft, again being careful of the washer at the inner face of the connection, and take off the air bar shaft distance collar. As the air pipe cover at the right-hand side of the air tower has been taken off, all the six holding-down screws are now exposed. When these are withdrawn, the tower can be lifted away, and it should be placed gently on its side with a piece of oiled paper to seal the air-ways. Treat the seating on the main stand similarly.

.25B AIR TOWER – REPLACING. Check the mating faces of the main stand and the tower to see that they are clean and dry; as they have to make an air-tight joint, examine them carefully for any small burr caused accidentally. Every such blemish should be delicately rubbed down with a fine carborundum stone – harsh handling here will greatly aggravate the fault. After giving a thin smear of fresh oil, replace the air tower in the reverse order of removal. It is desirable to give an all-signals test, and to smear the junction of the air tower to the main base with oil to detect any possible leakage. Finally, replace the jaw tongs and bell cranks (18.02.17B).

18.03.00 Cam levers

.01 As a preliminary to the removal of any cam lever, take **all the safety and technical precautions** A F W detailed in 18.01.05–6. Turn the camshafts to 320°, lower the oil tray, slide the pan out carefully as it may be very full, and place it aside; wipe off the excess oil. Detach the camshaft oil guard (one long screw also securing a wormshaft bearing cap, and one short screw with washer). To prevent possible damage to the selector mechanism (except when the matrix case holder lever, the jaw tongs lever, or the air tower lever is to be extracted), disconnect the gearbox lock and

are etched on the upper faces of these tongs to distinguish them. At the same time, their driving ends must be over the sockets in the matrix jaws. All bearing faces must be lightly oiled. Manipulate them down to their correct seatings, and pull the lock slides into position to retain their front ends. Replace the anchorage arm (of the spring for the paper take-up spool) on the fixed link stud with its bend upwards, where it acts as a washer, and add the nut, noting that the spring comes between two pipes. Slide the left-hand end of the draw rod retaining plate into its recess in the top of the support block. Pass the end of the spring post approximately $\frac{1}{4}$ in (6 mm) into the front of the support block and there pass it through the *round* eye of the retaining plate spring which must be held so that its off set eye is uppermost; then insert the post fully and tighten it. Engage the free end of the spring with the short post on the underside of the retaining plate. The rest of the work is covered by 18.02.12B, 18.02.06B and 18.02.04B.

.14A MATRIX JAWS, FRONT, AND STOP RACK – REMOVING. Remove the bridge, pin jaw tongs spring assembly, front pin jaw tongs and the front matrix jaw tongs (18.02.04A, 18.02.06A and 18.02.12A–13A). Withdraw the screw from the right-hand matrix jaw shoe packing block cover (if supplied), and remove the cover. Take out the horizontal hexagon-headed screws in front of the right-hand end of the shoe and behind its left-hand end. Undo also the two cheese headed screws at the right- and left-hand sides of the top of the shoe, which may now be detached with its packing blocks (left and right). The matrix jaws and also the stop rack can now be removed, but ensure that the unit rack (87) is not moved to the left any further than under normal working conditions, when the left-hand matrix jaw is in position. Loss of engagement between the teeth of this rack and its spur gear can occur if the rack is not held by its locking pin (97). In such a case, the layshaft cover would have to be removed (18.02.19A) to expose the engagement markings for correct meshing.

.14B MATRIX JAWS, FRONT, AND STOP RACK – REPLACING. Replace the stop rack and then the matrix jaws, ensuring that the head of the unit rack and the lug of the stop rack are between the two jaws. Place the matrix jaw shoe packing blocks in position, the square one on the left, flush with the left-hand end of the pin block. Over them place the matrix jaw shoe and secure it with its four screws, namely the short cheese-headed screw at right-hand side, top; long cheese-headed screw at left-hand side, top; small hexagon headed screw horizontally into the right-hand end; large hexagon-headed screw horizontally (from the rear) into the left-hand end. All of these should be done up only finger-tight before any of them is fully secured. Replace the right-hand matrix jaw shoe packing block cover (if supplied) and secure it with its screw. The rest of the work is covered by 18.02.13B–12B, 18.02.06B and 18.02.04B.

.15A PIN JAWS, FRONT – REMOVING. Remove the hinged machine cover (18.02.01), bridge, pin jaw tongs spring assembly, front pin jaw tongs, front matrix jaw tongs and the front matrix jaws (18.02.04A, 18.02.06A and 18.02.12A–14A). Release the separator plate by removing the screw and under-lying separator plate support from its right-hand end, and the screw from the left-hand retaining plate support block (59). Slacken the clamp screw (63) in the right-hand pin jaw guide rod stand and take out the screw (65) clamping the left hand end of the guide rod (64). Withdraw the guide rod to the left, releasing the pin jaws (53) and their two abutment collars (60 and 61).

.15B PIN JAWS, FRONT – REPLACING. Pass the pin jaw guide rod through its left-hand stand and assemble on it the pin jaws with their collars, the narrow one to the right and the wide one to the left, ensuring that the jaws are on either side of the stop rack lug. Press the rod into its left-hand abutment so that its groove aligns with the lower half of the clamp; the upper half of this can now be added and the screw (65) tightened. Tighten the clamp screw (63) in the right-hand stand, and check that the jaws slide freely on their guide rod. Replace the separator plate and secure it with its two screws, the right-hand one passing through the separator plate support below the plate, and the left-hand one holding also the retaining plate support block above the plate. The rest of the work is covered by 18.02.14B–12B, 18.02.06B and 18.02.04B.

.16A AIR PIN PLATE, FRONT – REMOVING. Take off the bridge (18.02.04A), pin jaw tongs spring assembly (18.02.06A) front pin jaw tongs, front matrix jaw tongs (18.02.12A–13A) and front pin jaws (18.02.15A). Check that the air supply is OFF[W]. Withdraw the four screws holding the air pin plate and insert in the threaded holes adjacent to the taper pins two screws, taken from the cross slide guide, to jack up the plate from its seating; be careful to keep it level. This gives access to the air pins of the front air pin block, together with their springs and seating rings, and the unit shift piston; these should be taken out and cleaned. Be sure to remove the two screws used for raising the plate, and retighten them in the cross slide guide.

.16B AIR PIN PLATE, FRONT – REPLACING. Having checked that they are all clean and in good condition, re-assemble the seating rings, air pins and their springs, noting that the extreme left-hand pin (the 'stop' pin) is the one that has the short spring *underneath* it. Insert the unit-shift piston with its own seating ring and spring. Locate the air pin plate with its taper pins and lightly tighten its four screws; with a soft-metal drift, very lightly tap the taper pins to give a secure hold and finally tighten the four screws. Now

check each air pin for pressure after placing on the air tower a paper ribbon with all the numbered and *K* positions perforated, and see that all the pins drop smartly when air pressure ceases. The rest of the work is covered by 18.02.15B, 18.02.13B–12B, 18.02.06B and 18.02.04B.

.17A JAW TONGS SPRING BOX (DOUBLE) AND BELL CRANKS – REMOVING. Detach the hinged machine cover by undoing the two hexagonal bolts holding its bracket to the main stand. **Insert the wooden wedge W**, and take off the main stand top cover (rear), the bridge, pin jaw tongs spring assembly, rear pin jaw tongs and the rear matrix jaw tongs (18.02.04A and 18.02.06A–8A). Also remove the front pin jaw tongs and the front matrix jaw tongs (18.02.12A–13A). Remove the right-hand air pipe cover from the air tower (three small screws, taking precautions against their being dropped). Release the two air pipe unions (*ABC* and paper-lock release) at their air-tower ends to enable the paper-lock control box to be removed (with the pipes) when its two retaining screws have been withdrawn. Take off the large nut and washer from the jaw tongs bell crank fulcrum stud (66). Slacken (half-a-turn only) the two hexagon-headed clamping bolts holding the jaw tongs spring box ball extension in the top of the cam lever. Engage the justification and space lifting rods, and hold them in position while turning the camshafts to 60°. The whole assembly can now be lifted so that the cranks are clear of the fulcrum stud, and the ball extension clear of its lever, and then withdraw clear to the right.

.17B JAW TONGS SPRING BOX (DOUBLE) AND BELL CRANKS – REPLACING. With the camshafts at 60° and the justification and space lifting rods engaged, pass the double spring box to the left between the air tower and the bridge lifting lever bracket. Locate the bell cranks over their fulcrum stud, and the ball extension over its socket at the top of its cam lever; lower both simultaneously into their working positions. Replace the washer and nut on the fulcrum stud, and tighten the nut firmly. Tightening the two hexagon-headed bolts in the cam lever will hold the spring box ball extension, but verify that the square on this part aligns with the movement of the spring box and is fully down – for adjustment here, see 06.13.02 3. Replace the paper lock control box on the front of the air tower, noting that the longer screw occupies the left-hand position, as it has also to hold the quadder piston block; for adjustment, refer to 05.08.00. Reconnect the two air pipes and replace the cover on the side of the air tower, using a cloth as a safeguard for a falling screw. Except for re-attachment of the top cover and the hinged bracket of the machine cover, which may conveniently be left to a later stage, the rest of the work is covered by 18.02.13B–12B, 18.02.08B–6B and 18.02.04B. Remove the wooden wedge.

.18A LOCKING BARS AND JUSTIFICATION AIR PINS – REMOVING. Take off the bridge, pin jaw tongs spring assembly, rear pin jaw tongs, rear matrix jaw tongs, front pin jaw tongs, front matrix jaw tongs and front matrix jaws and stop rack, jaw tongs spring box and its bell cranks (18.02.04A, 18.02.06A–8A, 18.02.12A–14A and 18.02.17A). See that the camshafts are at 220°. Remove the retaining plate of the locking bar bell crank link pin by withdrawing its Allen screw, and extract the link pin. Take the split pin from the rear locking bar link pin, and withdraw this pin also. Lift off the justification rack lever arm spring plate, with its springs attached. Release the set screw (70) holding the bell crank fulcrum pin (72) which can now be slid towards the air tower, freeing the three small bell cranks; lift these away. Take out the cover plate screws (two long and one short) from the justification pin block, and remove the two overlying cover plates, gaining access for the removal of the third locking bar bell crank link pin. The justification air pins are also exposed and may be given any necessary attention. Withdraw the rear locking bar. In order to free the locking bar bell crank, the side block holding the tongs stud (on the justification air pin block) must be removed; take out the Allen screw and the hexagon headed bolt securing the side block. Detach the block with its dowels by inserting the Allen screws in the tapped holes provided for the purpose. Turn the camshafts to 60°. Now push the front locking bar fully forward and lift off the bell crank, enabling the front locking bar (78) to be taken out.

.18B LOCKING BARS – REPLACING. With the camshafts at 60°, put the front locking bar and bell crank in position and insert one of the short link pins. Replace the rear locking bar in position; turn the camshafts to 220° and connect the locking bar operating rod with its bell crank by means of its link pin (also short). Now connect the rear locking bar to the bell crank by its link pin (long) and secure it with a split pin. Replace the side block, tightening the one hexagon and two Allen screws; note that the lower of these also holds the plate which retains the second of the above link pins in position. Add the intermediate and upper justification air pin plates (the upper one forms a retainer for the link pin of the rear locking bar), tightening the one short and two long screws. Insert the bell crank fulcrum pin into position while threading on the three bell cranks in their correct sequence and secure the pin with its set screw. Replace the spring plate and connect the springs to their levers. The rest of the work is covered by 18.02.17B, 18.02.14B–12B, 18.02.08B–6B and 18.02.04B.

.18C FRONT LOCKING BAR SPRING – CHANGING. Having detached the locking bar, grip it in a vice with the spring seating face flush with the end of the vice jaws. Holding the

feed mechanism by taking out the yoke pin linking the operating rod to the actuating lever extension (see drawing below). Tie the rod forward and move the actuating lever to the left-hand position. When the work (as detailed later) is complete, reverse the procedure and then rotate the camshafts by hand to ensure that there is no accidental obstruction, before switching on the motor.

.02A MATRIX CASE HOLDER CAM LEVER – REMOVING. First take off the cover to this lever; its bracket is secured by two hexagon headed bolts. Then detach the bridge (18.02.04A), the oil splash-guard (two screws) shielding the camshafts, and the small plate on the matrix case holder lever retaining the heads of the lifting rods. Detach the rear top cover and lift off the justification rack lever arm spring plate, with its springs attached. Release the set screw holding the bell crank fulcrum pin, which can now be slid out towards the air tower, so that the three bell-cranks can be taken out. Remove the set-screw locating the matrix case cam lever shaft. Then turn the camshafts to approximately 60°; to give working clearance, remove the nut of, and gently tap out, the air tower lever stud. Withdraw to the rear the matrix case holder cam lever shaft; the lever will now fall slightly to the right. Release the small guide screw from the side of the locking pin stand sufficiently to allow the locking pin to be completely withdrawn upwards. With this removed and the camshafts turned to approximately 260°, the matrix case holder lever can be lifted clear.

.02B MATRIX CASE HOLDER CAM LEVER – REPLACING. This must be done in exactly the reverse order of dismantling, namely, with the camshafts at approximately 260°, replace the lever, which will fall slightly to the right; this enables the locking pin to be re-inserted and the guide screw replaced. Engage the fork of the lever with the yoke of the locking pin. Supporting the lever with the left hand, turn the camshafts to 60°, i.e. when the air tower operating arm is at its maximum height. Now insert the shaft. Replace the locating screw and the stud and nut in the air tower lever. Replace the lifting rods in their recess in the lever, and secure them with their retaining plate. Replace the bell cranks with their fulcrum pin (to be secured by the grub screw), the justification rack lever arm spring plate, with its springs, the oil splash-guard and finally the bridge and cover.

.03A GEARBOX FEED AND LOCK CAM LEVER – REMOVING. First remove the matrix case holder cam lever (3) (18.03.02A). Now release the ball joint at the top of the gearbox feed and lock cam lever (2) by slackening its lock nut and then using a C spanner to undo the locking ring. With a tommy pin, slacken the hemispherical plug and lift the socket from the ball. After taking out the washer and the pin connecting the spring box yoke (18) to the space bar, swing the spring box outwards. Turn the camshafts to 40°, where all the cam lever rollers will be free to come away. Remove the two bearing caps (22 and 23) (now with three screws only) of the cam lever fulcrum shaft, so that this can be lifted clear with the feed and lock cam lever and also the space cam lever; both levers will slide off the shaft.

.03B GEARBOX FEED AND LOCK CAM LEVER – REPLACING. See that both this lever and the space cam lever are in position on their fulcrum shaft, and that the camshafts are at 40°. Noting that the positioning screw hole in the shaft is vertical, replace the sub-assembly in its working position. Add the front bearing cap with the positioning stud off-set to the rear of the screw holes, and insert and tighten the inner screw only. Fit the rear bearing cap, securing it with both screws. Connect the lock and feed rod by replacing the socket over the ball with a little lubricant; after adjusting the hemispherical plug with the tommy pin to take out all appreciable play, tighten the lock ring with a C-spanner. Lock the connecting rod to the plug with the hexagon nut. To reconnect the space bar cam lever, turn the camshafts to 330°, swing over the spring box to the right to engage with the space bar yoke; insert the pin and secure it with washer and split pin. Finally, replace the matrix case holder cam lever (18.03.02B).

.04A SPACE BAR CAM LEVER – REMOVING. As this lever shares a fulcrum shaft with the gearbox feed and lock cam lever, carry out the instructions detailed in 18.03.03A.

.04B SPACE BAR CAM LEVER – REPLACING. Carry out the instructions detailed in 18.03.03B.

.05A JAW TONGS CAM LEVER – REMOVING. Take off the hinged cover (18.02.01). With the camshafts at 60°, disconnect the air tower operating rod from its levers at top and bottom, by withdrawing the studs from the eyes. Remove in sequence the bridge (18.02.04A), the pin jaw tongs spring assembly (18.02.06A), the rear pin and matrix jaw tongs (18.02.07A–08A), the front pin and matrix jaw tongs (18.02.12A–13A) and the double spring box with its bell cranks (18.02.17A). After turning the camshafts to 30°, take out the locating screw (27) in the bracket supporting the jaw tongs cam lever shaft; after this shaft has been drawn out to the front, the cam lever (28) can be extracted.

.05B JAW TONGS CAM LEVER – REPLACING. Check that the camshafts are at 30°. With the clamp bolt heads towards the rear of the machine, position the lever in its fulcrum bracket. Align the positioning hole in the cam lever shaft with the horizontal screw-hole in the rear supporting bracket and then insert and tighten the locating screw. The remainder of the work is a reversal of the instructions detailed in 18.03.05A.

.06A AIR TOWER CAM LEVER – REMOVING. First turn the camshafts to 60° and disconnect the operating rod from the lever (7) by withdrawing the stud from the lower eye (25). Now turn to 318° so that the split pin and washer can be taken from the front end of the rear cam lever shaft (24); also take out the hexagon headed locating screw from the adjoining boss. Move the shaft to the rear by first levering it from the front and then, when it projects sufficiently, gripping it from the rear, but only take it far enough to free the lever; one end should remain in the supporting bracket. The lever can now be manipulated out.

.06B AIR TOWER CAM LEVER – REPLACING. With the camshafts at 318°, place the lever in position and move the cam lever shaft forwards until the locating hole is visible in the corresponding screw hole in the casting. When they register, insert and tighten the hexagon-headed locating screw. At the front end of the shaft, add the washer and split pin, but the latter should not be opened as it would be difficult to extract on a future occasion. If the jaw tongs cam lever has been detached also, see that this is replaced before the air tower cam lever is reconnected to its operating lever by insertion of the stud.

.07A UNIT AND JUSTIFICATION DRIVE CAM LEVERS AND SPRING BOXES – REMOVING. Start by taking off the belt guard (18.04.02A) and the belt. After undoing its two screws (one washer), remove the cam lever guard. Turn the camshafts to about 205° - 210°, withdraw the pin connecting the operating rod (of the gearbox feed and lock rack mechanism) to the extension of the actuating lever (see 5, Fig. 10.12.02), and, if there is insufficient clearance to ensure that the yoke on the operating rod does not foul the lever extension, detach the rod by undoing (below the main stand) its hexagon-headed fulcrum screw. With string or wire, secure the lever extension in its left-hand position to avoid possible damage in the gearbox. Take out all the selector assemblies and their shafts; the unit selector requires only the raising of its shaft, but, to free the shafts of the justification selectors, remove the layshaft cover (five Allen screws) and the thrust plate (four screws) which it concealed (see 18.08.01A). Detach the small oil pipe leading from the underside of the drip tray. Take out the drip tray which is held by two bolts, and the four cam lever latch springs together with their two posts. Release the three air pipe unions from the unit drive control box and detach completely the small air pipe connections from the fail-safe valve box. Having turned the camshafts to 270° to position the unit and justification drive cam levers conveniently, take out the four yoke pins (secured by split pins backed by washers) at the ends of the corresponding spring box assemblies; supporting the two operating yokes in their raised position, by means of suitable blocks under their operating sleeves, withdraw first the unit and then the justification spring box to the left-hand side of the machine and to the rear of the swinging plate, in the space made accessible by the detaching of the air pipes. Disconnect the air tower rod from its cam lever (7). Turn the camshafts to 205° - 210°. From the front end of the lever's shaft (24), also, remove the split pin, washer (which may stick to the air tower lever boss) and the hexagon headed locating screw; withdraw this shaft sufficiently to clear the air tower cam lever and the justification (8) and unit (9) drive cam levers, allowing all three of these assemblies to be lifted away to the left of the machine.

.07B UNIT AND JUSTIFICATION DRIVE CAM LEVERS AND SPRING BOXES – REPLACING. If the spring boxes have been disturbed, they must now be restored to position and their inner ends attached to the lifting levers; note that the justification spring barrel is slightly the shorter and this must be replaced first. In each case, a pin, washer and split pin are required, the pin-heads being towards the front of the machine. See that the camshafts are at 205°–210° and insert the cam lever shaft, from the rear, partly into its rear supporting boss. Lay the levers side-by side on the bench to check their correct relationship – this allows a gap of about $\frac{1}{64}$ in (0·4 mm) between their bottom ends. If they are incorrectly placed, the gap is about $\frac{1}{2}$ in (12 mm). Offer up first the unit drive lever assembly (to occupy the rearmost position), pressing the cam lever shaft (24) forward into its boss for support. Similarly, add the justification drive assembly and the air tower cam lever, passing the shaft right through to establish the position of the location drilling (26); with this at the top, press the shaft as far to the front as necessary, carefully avoiding turning it. Add the washer and split pin at the front end (but do not open the split pin, which would make it difficult to extract again), and then replace the locating screw, ensuring that it is tightened down in its recess in the shaft. The air tower rod may now be re-attached to its cam lever. Replace first the justification and then the unit spring box; with the head of its yoke pin towards the front of the machine, connect each to its swinging plate while this is unlatched and in its inward position, but move the plate outwards for the addition of the washer and split pin. Now remove the supporting blocks from the operating sleeves of the operating yokes. Turn the camshafts to 285° and reconnect the air pipes – two to the fail-safe mechanism and three to the unit latch control box. With the cam lever unlatched, replace the latch spring posts and connect the justification return springs; their spring plate pivot holes should be lightly greased first and they must be properly seated in the recesses in their posts. Treat the unit return springs in the same way. Replace the drip tray and attach the oil pipe to its underside. All the gearbox adjustments (18.08.02E–09E) must now be checked and, if necessary, corrected. The selector assemblies and their shafts are the

next to go back into position, followed by their thrust plate. When the operating rod of the gearbox feed and lock rack mechanism has been reconnected, the layshaft cover, the cam lever guard, belt and belt guard are restored to their normal functions.

.08A LOCKING BAR CAM LEVER – REMOVING. First remove all the other cam levers as detailed in 18.03.02A–07A. Then take off the handwheel assembly as detailed in 18.05.01A. It is now possible to turn each camshaft independently so as to give maximum clearance between the jaw tongs cams which are immediately behind the locking bar cams. Slacken (by a couple of turns) the hexagon nut at the rear of the locking bar cam lever fulcrum stud; this will need a special spanner with an opening of $1\frac{3}{16}$ in (30·2 mm). As this stud is a press-fit, give support to the front face of the lever before driving the nut forward with a heavy soft-metal hammer. The lever is free as soon as the hook at the top is uncoupled, and may be lifted out to the left.

.08B LOCKING BAR CAM LEVER – REPLACING. This is simply a reversal of the removal procedure, but check that the camshaft angles are still giving maximum clearance, and support the rear face of the lug until the stud can be drawn into position by its nut.

18.04.00 Camshaft assembly

.01 For general safety precautions, see 18.01.05–06 A F W.

.02A MOTOR BELT GUARD – REMOVING. Slacken the two hexagon-headed screws securing the top and bottom of the guard; swing the lower part counter-clockwise (as seen from the rear) to bring the base bracket clear and then lift the guard off towards you – i.e. away from the rear of the machine.

.02B MOTOR BELT GUARD – REPLACING. This is a reversal of the procedure for detaching, but note that the lower bracket on the guard should be nipped between the distance bush and the washer and that the upper bracket comes between the two washers.

.03A PULLEY AND LOCKING PLATE ASSEMBLY – REMOVING. After removing the motor belt guard (18.04.02A), slip off the belt. Using a special spanner with an opening of $1\frac{7}{16}$ in (36·6 mm), undo the large hexagon nut at the end of the driving camshaft, and take out the four hexagon-headed screws securing the pulley to the locking assembly. Use a wheel-drawer to take off the pulley, after which the locking assembly is free to be slipped off by hand. Now that the protection against reverse-motion has been removed, **ON NO ACCOUNT TURN THE MACHINE BACKWARDS.**

.03B PULLEY AND LOCKING PLATE ASSEMBLY – REPLACING. Lightly lubricate the rear part of the camshaft and add the locking plate assembly with its recesses registering with the pins in the end of the camshaft bearing, but be sure that it only contacts, and is not obstructed by, the leather oil seal and its plate which must be adjusted if necessary (three hexagon screws) to an effective height. Press on the pulley, with the boss to the rear (i.e. outwards) and the keyway carefully aligned to the key. Drive it on with a soft metal mallet, or hammer and wood block, until sufficient thread is exposed for the nut to get a good grip. Tightening the nut will complete. **TURNING THE PULLEY AND LOCKING ASSEMBLY ONLY CLOCKWISE AS SEEN FROM THE REAR,** align the four stud holes with those of the lock and finally add the four hexagon screws which should be fully tightened.

.03C LOCKING PLATE ASSEMBLY – DISMANTLING. When separated from the pulley, the locking assembly may be slid along the camshaft, clear of its two anti-rotation pins, and removed to the bench. Withdraw the central plate, noting (for replacement) which is the outer face; this will expose the rotating disc – the locking plate (4) – with its four peripheral recesses, in each of which is a roller (2) pressed towards the tapering end of the recess by a small coil spring (3); when these are compressed, the rollers can be lifted out.

.03D LOCKING PLATE ASSEMBLY – RE-ASSEMBLING. When replacing, note that the top recess must taper away to the RIGHT (as seen from the rear), or the machine will be capable of reverse motion only. After the springs have been inserted, properly seated in their recesses, compress each with a thin screwdriver to admit its roller, and then pack with grease. Replace the cover plate and check for correct assembly by attempting to turn the plate each way when the outer casing is held stationary; it should move clockwise only.

.04A OIL PUMP – REMOVING. First run off the oil from the lower part of the gearbox into a suitable clean container, by taking out the drain plug, to avoid subsequent loss of lubricant and mess. While the oil is draining, remove the motor belt guard (18.04.02A). Undo the two oil pipe unions to the pump. Turn the camshafts to bring one of the holes in the pulley opposite the left-hand screw (as seen from the rear). To release the pump, take out *only* the two horizontal retaining screws (5) halfway up the pump. The spigoted adaptor plate is attached by four screws. The pump drive is a component screwed into the end of the driven camshaft by a left-hand thread.

.04B OIL PUMP – REPLACING. Refit the adaptor plate (four screws) and the left-hand-threaded driving member (if it has been taken off), and insert into this the tongue of the pump. Re-attach the body of the pump to the adaptor plate, noting that the longer of the two screws must go on the right-hand side, as seen from the rear. To avoid an air-lock

in the oiling system, (i) replace the drain plug and refill the lower half of the gearbox with oil to the correct level, allowing some to escape from the open end of the suction pipe into a container, until bubbles cease to appear, when the pipe may be reconnected to the pump. (ii) Remove the oil splash guard from the rear of the gearbox and disconnect the top end of the oil-delivery pipe (6) from its elbow; provide for some escaping oil and start the machine; when bubbles cease at the top of the pipe, reconnect it to its elbow. Then stop the machine and re-attach the splash guard.

.04C OIL PUMP – DISMANTLING. After removing the pump from the machine, undo the two screws retaining the top cover plate (11) and its gasket to give access to the spring (12). Two more screws (13) are taken out to enable the worm assembly to be detached, after which the piston (15) can be pushed out. The bottom cover plate and gasket can also be removed if desired.

.04D OIL PUMP – RE-ASSEMBLING. Insert the piston, with its angled end towards the stop screw (10), and push it fully home. Checking that the gasket is in good order, add the bottom cover plate – it has a shorter boss than the top one. Insert the spring and enclose it with the top cover plate and gasket. Replace the worm assembly, securing it with its two screws.

.05A CAMSHAFT STAND – REMOVING. Start by detaching the belt guard (18.04.02A) and the belt. Then take out the oil pan carefully, remembering that it is full. Because the camshaft stand assembly weighs quite as much as can be readily handled without the 50lb (23kg) of the levers, swinging plates and their fulcrum shafts, these are taken off first (18.03.02A–07A), except the locking bar cam lever; this is not always easy to detach and may be left in position. The pulley and locking plate assembly are removed next (18.04.03A), followed by the oil pump (18.04.04A). Now take off the wormshaft/handwheel assembly (18.05.01A) with its covers and then temporarily replace this shaft, holding it in its front bearing with the cap borrowed from the rear bearing of the fulcrum shaft of the space bar cam lever; this procedure will give better purchase and control when (later) the camshaft stand is lifted away. As a precaution against damage, disconnect the oil pipe unions so that a section of each pipe-line can be completely detached after their clip (one screw) has been released. Slacken the union of the oil pipe to the drip tray in front of the camshaft locking assembly and swing this pipe clear towards the right of the machine. Check that the isolator switch is OFF. Behind the lower control panel, take the inspection cover off the conduit end box, exposing the cheese-headed positioning screw which must be removed to allow the box to rotate with its projecting conduit. Disconnect the driven end of the shutter drive from its gear casing (one hexagon nut), slip its grommet out of the bracket at the rear of the upper control panel and withdraw the drive casing through the aperture. Unscrew the electrical plug connection and the air pipe union to the elbow. The panel can now be detached from the mainstand (three screws) and lowered, but it must be supported about 6 in (160 mm) from the floor; this will give working clearance. A special tool will be needed to slacken (only) the eight screws holding the camshaft stand to the base and intermediate stand. Not more than seven of these screws can be withdrawn before the services of two extra men are needed – one to support by hand the rear end of the driving camshaft, one to support the front end by means of a sling (under the bosses of the camshaft gears and bandolier-fashion over one shoulder) and one to take out the remaining screw holding the camshaft stand on to the ledge of the base. The total weight of the camshaft stand, without the levers, is 210lb (95kg). Take care not to damage the brass splash guard at the rear of the assembly or to mislay the two brass packing pieces at the top locating faces. Lower the assembly to the floor, with backs kept as upright as possible and the bending done at the knees.

.05B CAMSHAFT STAND – REPLACING. Make sure that all mating surfaces are clean. Then locate the brass splash guard at the rear of the assembly with an all-over smear of grease and retain it in position by inserting two long screws through the casting and the rounded holes of the guard. One man should now be ready to insert and partly tighten the central screw for retaining the assembly in position while two other men raise it into position in the same manner as it was previously lowered; they will be able to rest part of the weight on the ledge of the intermediate stand. Position the two brass packing pieces and insert the screws to hold them. Checking that the weight of the camshaft stand is now fully taken by the ledge, insert the remaining five screws and lightly tighten all of them. Working outwards from the centre, fully tighten each of the eight screws in turn, using the special tool; repeat this operation until it is not possible to obtain any movement on any of them. Replace the supply, feed and drip oil pipes, tightening the unions; restore the upper control panel, the shutter drive and lower control panel (with washers and distance bush), and secure their connections. The cam levers and handwheel assembly can now be re-assembled into position in the reverse order of their removal, but, after each component is added, turn the machine by hand to check for unobstructed movement. Replacement of the oil pump, pulley, belt and belt guard complete the operation. Check the timing of the rotary shutter (18.02.05E).

.05C CAMSHAFT STAND – DISMANTLING. Place the assembly on the bench in an inverted position. Remove the

oil pan from its shelf (four screws and washers at the rear end and two at the front, requiring a special tool). Before removing the bearing caps (two screws each), note their numberings to facilitate replacement. With the caps detached, the camshafts may be lifted out.

.05D CAMSHAFT STAND – RE-ASSEMBLING. The bearings and shafts must be clean and lightly lubricated. Lay the shafts in position and add the bearing caps, noting that they must be correctly paired and positioned; those for the driving camshaft are machined all over; the numbers of all caps must agree with those stamped in the corresponding positions on the camshaft stand; all figures must be the same way up. Lightly tighten the eight inner screws, checking that the outer faces of the rear caps are flush with the fixed bearings and the front caps are in light contact with the gear bosses. Now fully tighten these eight screws and try each shaft for free rotation. From the rear end of the driven camshaft bearing, remove the leather-pad oil seal two screws retain its plate and make sure that the adjoining cap is 0·006 in to 0·010 in (0·15 mm to 0·25 mm) proud of the oil pan shelf casting. Insert the screw in the cap and fully tighten it, after which the oil seal may be refixed. The gap between the inner faces of the oil pan shelf castings must be $14\frac{15}{16}$ in (380 mm) before the front-end screws are tightened to secure the shelf. Clean the locating faces of the shell, and replace it; it can then be secured with its screws, lightly tightened, and their washers. The two brass packing pieces may be attached to the face of the stand by a smear of grease, so that it is ready for replacement on the machine.

18.05.00 Wormshaft/handwheel assembly

.01A WORMSHAFT/HANDWHEEL ASSEMBLY – REMOVING. Turn the camshafts to 260° and then undo the hexagon nut uniting the shutter flexible drive to its gear casing. Withdraw the drive from its socket. Detach the sheet-metal guard (two screws, early models only) and lower gear case (four screws). Take out the hexagon-headed bolt and distance-collar securing the gear cover to the wormshaft bearing, and one screw holding the cover to the camshaft stand. Withdraw the four screws holding the wormshaft bearing cap and lift this off. Lift off, as a complete unit, the handwheel, intermediate wheel, worm, shutter drive gear and the remaining top cover.

.01B WORMSHAFT/HANDWHEEL ASSEMBLY – REPLACING. In the main, this is a reversal of the removing routine but, for safety, first unclip the top of the locking bar cam lever and press the bar towards the centre of the machine. Check that all parts are clean, particularly the bearings and the cap, both of which should be lightly lubricated. Position the camshaft gears so that not only does the zero mark on the worm enter between the two zeros on its wheel, but, at the same time, the arrows on the intermediate wheel mesh with the arrows on the two camshaft wheels. The bearing cap can now be replaced and its four screws tightened down; then check the combination of the three shafts for free turning. The top cover may now be secured by its hexagon-headed bolt with distance collar and also by its cheese-headed screw. The lower half-cover is put on next and held by its four screws. Reconnect the squared end of the shutter drive, and check the timing opening against the angle-scale (18.02.05E). Re-attach the locking bar to its cam lever.

18.06.00 Film feed mechanism

.01A FILM FEED BRACKET ASSEMBLY – REMOVING. Verify that the safty precautions (air and electricity) (18.01.04–05) are effected [A] [E]. Then remove the front cover (protecting the air timing boxes) and the cover over the film drum feed shaft, which is held by two screws and a hexagon pillar. Remove the wormshaft/handwheel assembly (18.05.01A). Mark with tabs (for easy identification on re-assembly) and then disconnect, the four air pipes attached to the signal control box and the five pipes attached to the air timing control box on the bracket assembly; remove completely the short length of *ABC(T)* air pipe to the ratchet pawl trip control box. Release the clip securing the two oil pipes on the right, and remove completely the oil pipe to the film feed shaft rear bearing. Disconnect the air pipes from the automatic variable line feed and paper-release valve box, and detach the box (four screws). Slacken the lock screw holding the bevel gear to the film drum feed shaft, and slide the gear about 1 in (25 mm) forward, to reduce the risk of damaging the teeth when detaching the film feed bracket.

Using an inspection lamp suitably positioned and, from the rear of the machine the long dowel punch, tap out to the front the two taper pins locating the film feed bracket before taking out (with a special tool) the three screws holding it. The bracket is now free to be manipulated counter-clockwise and forwards, with the four lower air pipes slightly diverted to allow it to pass and to be completely withdrawn; take care not to damage the bevel gears in the process.

.01B FILM FEED BRACKET ASSEMBLY – REPLACING. With all the mating surfaces clean, manipulate the bracket past the four air pipes into its working position, and then loosely locate the bracket by means of its two dowels. Insert the three screws, tightening them only lightly. Tap the dowels home and then fully tighten the screws, again using the special tool to obtain complete security. Connect the oil pipe to the rear bearing of the film drum feed shaft and

secure it with its clip. Taking care that the marked teeth of the two bevel gears engage, slide the gear on the film drum feed shaft into full working mesh with its mate, and tighten the lock screw. Replace the valve box (for details of positioning and adjustment, which is critical, see 18.11.10B & E) and reconnect its air pipes. Reconnect the upper air pipes in the correct sequence – first the large constant air, then *K(T)*, *BC(T)*, *AC(T)* and *ABC(T)*. Reconnect also the four lower air pipes and the short length to the ratchet pawl trip control box. Carry out a signals test for all the air pipes that have been affected. Replace the wormshaft/handwheel assembly with the shutter drive and the two covers (18.05.01B).

.01C FILM FEED BRACKET ASSEMBLY – DISMANTLING. Place the assembly on the bench and start by withdrawing the two latch-return spring screws with their springs and two washers each. Remove the two valve push rod operating lever latches and the washer between them after releasing the Allen clamp screw and taking out the latch hinge pin. By means of a thin metal plate, retain the five spring-loaded trip lever plungers in position, with the bell crank of the *BC* valve lever released from its abutment. Take out the two fixing screws and remove the timing control box with the two latch operating bar rods. Remove the two latch operating bars. Withdraw the three hexagon-headed screws at the rear of the film feed bracket, releasing the signal control box. Now detach the four valve push rod actuating levers (*ABC*, *AC*, *BC* and *K*) by slackening the lock nut and taking out their fulcrum pin with its shake-proof washer. To dismantle the ratchet pawl trip mechanism, detach the control box by removing two screws; release the trip lever by driving its fulcrum pin down and out, taking care not to mislay the plunger and its spring. Turn the pawl to expose the spring-anchorage; detach the spring from its post, and the fulcrum screw (4) (held by a grub screw (3)), releasing both pawl and spring. Each of the two friction pads (6), provided to prevent overthrow of the pawl disc (2), is held by a retaining plate secured by three screws at the rear and one at the front (after the covers have been removed); these plates are not interchangeable, the rear one having a cut-away corner; note the two coil springs pressing each pad from its plate. Take off the friction pad bracket, held by four screws. To release the gear shaft, slacken the lock screw (1) in the disc and tap the bevel gear downwards, bringing the shaft clear of the disc (which is now free) and the bearing. To release the ratchet shaft, loosen the grub screw in the ratchet and take out the two screws holding the upper bearing (8) to the bracket. Now tap the under side of the lower cam with a soft-metal mallet to free the tenon of the upper bearing from the bracket; when the bearing and shaft are thus freed, the ratchet will slide off the bottom of the shaft. To separate the shaft from the bearing, support the under side of the worm gear and press the shaft down through it. Detach the cams by slackening the grub screw in the boss of the lower one and, having supported its under side, tap the shaft down with a soft-metal drift till it is clear of both cams.

.01D FILM FEED BRACKET ASSEMBLY – RE-ASSEMBLING. Clean and lightly lubricate the ratchet shaft before inserting it through the cams; note that the lower position is occupied by the 4-lobed cam, with its boss downwards, and that the 8-lobed cam, above it, must have the gradual rise and sudden fall of the lobes to match those of the lower cam, and both cams must register with their Woodruff key, though this must (at this stage) only just enter the lower cam. Insert the top of the shaft upwards through its upper bearing (8), add the worm gear (registered with its key) and press this on till it bottoms on its shoulder on the shaft. The cams may now be pressed up until they give minimum clearance for the bearing between themselves and the worm gear, but check that they allow free rotation before locking the screw on the lower cam. Above the gear shaft bearing, place the ratchet disc in position and, passing the gear shaft through the bearing, register the key and the key way in the disc; with a wooden wedge or similar support between the disc and the under-side of the lower ratchet shaft bearing, tap the shaft into position so that its shoulder contacts the disc. Remove the packing and check this shaft also for free movement, but there should be no perceptible end-play; tighten the lock screw (1) in the periphery of the disc. Place the ratchet, with its larger boss upwards, on the disc, with a thin feeler gauge – minimum 0·002 in (0·05 mm) between the ratchet and the lower ratchet shaft bearing, to ensure working clearance is preserved; then pass the lower end of the ratchet shaft through this bearing into the ratchet, registering the key with its keyway, and at the same time engage the tenon of the upper bearing with its seating in the bracket. This bearing can now be tapped fully into its seating and secured with its two screws. Next, tighten the ratchet grub screw and remove the feeler, before checking for free rotation of the ratchet shaft. Replace the friction pad bracket (held by four screws). The friction pads should now be washed in petrol, then dried and cleaned and, if necessary, roughened; give the two springs of each pad a slight smear of vaseline and place one pad in the rear part of its bracket; insert its springs into their recesses; with the lip of the cover plate (the one with the cut-away corner) over the pad, hold the two parts together to retain the springs, position them, and secure with the three screws; the front pad is treated similarly except that there is only one screw – the left-hand one – the others also serving to hold the guard. When replacing the pawl on the disc, its long arm between the ratchet and the stop post, turn the disc so that the screw hole is aligned with the flat on the

bottom bearing; insert the fulcrum screw (4) (lightly lubricated) and fully tighten it before tightening the grub screw that secures it. Check the pawl for free movement. Now turn the disc and reconnect the spring to its post. Replace and secure the ratchet pawl trip control box (two screws). Dealing with the trip lever – vaseline its plunger spring and replace both spring and plunger; add the lever, noting that it comes between the piston of the control box and the plunger; lightly lubricate the fulcrum pin and tap it up until its shoulder locates against the upper lug; check the trip lever for free movement. Replace the bottom signal selector control box, securing it with its three hexagon-headed screws; for re-assembly of the disturbed components (with special reference to the operating bars), see 18.11.08B. Then turn the worm gear counter-clockwise (as seen from above) and check that all movements are being correctly performed.

.02A FILM DRUM RACK MECHANISM – REMOVING. First turn the film drum feed shaft till the arm carrying the roller projects horizontally to the left. Take off the spring (22) which holds the rollers at the left-hand ends of the feed and-lock rack cam lever (11) and the vertical slide cam lever (21) in contact with their operating cam (10). The complete mechanism can be detached after the six cheese headed screws (one partly hidden by the knurled knob of the lock-and-feed rack which must be freed) have been withdrawn from the front cover, *but do not disturb the hexagon nuts*. Note that the bottom left-hand screw passes through a distance-piece. As the front cover, with all the components, is withdrawn from its dowels, the left-hand ends of the two cam levers must be held apart so as to clear the cross slide crank.

.02B FILM DRUM RACK MECHANISM – REPLACING. This requires the almost simultaneous registering of several points, which is best done with the cam levers spread apart, the top of the casing tilted very slightly towards you and the mobile components pre-placed and held as accurately as can be estimated. First locate the bottom dowel in its hole. Then see that the film feed is set at 24 pt and that the lost-motion mechanism (19) is not only situated, endwise, between its two stop pins, but also in its last-tooth position – i.e. fully to the left. The cover can now be brought into a more upright position, while the cam lever rollers are manipulated (as in removal) past the cross slide crank. Next see that the driving finger of the automatic variable line feed is aligned with, and will therefore enter, its slot in the feed-and-lock rack (15). Check also that the roller of the film feed crank is correctly situated relatively to the slot in the banjo end of the feed cross slide (9). With all of these components in their correct relative positions, the cover may be pressed on to its second dowel and bedded down to its seating. Insert and tighten all the six securing screws, remembering that the long one goes into the bottom left-hand hole and that it requires its tubular distance-piece. See that the knurled knob (12) is free to travel in its slot and connect the two cam levers with their spring (22). Check that the mechanism has been correctly re-assembled by placing the line-feed in the 24 pt position and turning the film feed shaft by hand (NOT by turning the handwheel) to see that both racks operate as intended. Replace the covers, the lower held by two screws and a hexagon stud and the upper by two hand screws.

.02C FILM DRUM RACK MECHANISM – DISMANTLING. This is easily done with the complete assembly on the bench. To remove the feed-and-lock cam lever (11), unscrew its knurled knob at the front of the cover and lift the lever clear. To release the lost-motion mechanism (19), take the screw and spring from inside its setting knob (again on the front of the cover). The film feed rack (13) may now be lifted out, and its two rollers. Next remove the feed cross slide (9) with its three rollers. The vertical slide (16) is now free. To detach the vertical slide cam lever (21), take the hexagon nut and washer (at the front of the casing) from the fulcrum of this lever, which will then come away with its fulcrum screw (14) and spacing collar, and the rollers.

.02D FILM DRUM RACK MECHANISM – RE-ASSEMBLING. Time can be saved and future frustration avoided if, after each step, a check is made on the free movements of the parts just assembled. Re-grease all the rollers, and then replace the vertical slide (16), followed by its cam lever; its rollers must turn freely. Position the feed cross slide – check its rollers also – and secure the cam lever with the nut and washer on its fulcrum screw while pressing it down on to its adjusting screw (17). In the top of the vertical slide place the feed rack (13), making sure that its rollers are free. Put back the lost motion mechanism (19) so that its rollers locate in their grooves in the vertical slide cam lever (21) and the driving head (20) of the lost motion mechanism engages in its recess in the base of the feed rack. Now partially replace the setting post knob (12) temporarily and turn it, noting that in one position the knob is lowered; refit the knob (if necessary) so that when the stud is so lowered, the indicator on the knob is pointing down. Replace the two-part feed-and-lock rack cam lever (11) on its eccentric pivot and secure it with its knurled knob. Add the feed-and-lock rack (15), with its driving slot facing to the rear. Check that there is free movement of the racks, both horizontally and vertically; move the drum feed cross slide (9) by hand through the full length of its stroke and check that it travels readily from 0 to 24 pt. Make sure that all the rollers are correctly positioned, noting that they have different thicknesses, and that their ends are flush with their pins.

.02E FILM DRUM RACK ADJUSTMENTS. To adjust the feed- and lock rack (15) for lift, remove the film drum housing and see that the film drum feed shaft is in the rest position. Slacken the grub screw above the eccentric bearing and also the eccentric lock nut. Turn the eccentric to bring the right hand end of the rack carrier to its lowest point and then add and secure the film drum housing. Having raised and retightened the knurled knob, turn the eccentric carefully just sufficiently to eliminate play with the graduated gear (34). Retighten the grub screw and lock the eccentric by means of its nut. To adjust the feed rack (13) for lift, bring the rack to its raised (feeding) position, with the film drum housing in place. Slacken the lock nuts of the fulcrum screw (14) and the adjusting screw (17). Tighten the adjusting screw carefully, just sufficiently to eliminate play with the graduated gear and then lock both screws by means of their nuts.

.03A FILM FEED SHAFT – REMOVING. Take off the film feed bracket (18.06.01A) and the film drum rack mechanism (18.06.02A). Detach the automatic variable line feed and paper release valve box (18.11.10A). Slacken, evenly, the two Allen screws uniting the halves of the ring cam (24) and slide this forward, clear of its positioning screw. This screw should now be slackened to allow the bevel gear to come 2in (50mm) forward and so to clear the rear bearing (27). Take from this bearing its oiler and cap screws. Mark the cap for correct replacement and detach it; treat the front cap in the same way. The shaft (25), complete with its cams, can now be manipulated clear of its bearings and the mirror-return cam lever roller (23), and extracted.

.03B FILM DRUM FEED SHAFT – REPLACING. Clean and lubricate the bearings, and manipulate the shaft into position, with the bevel gear (still loose on the shaft) behind the paper-release valve box bracket (28). Replace the rear bearing oiler and add the bearing caps strictly in accordance with their markings; insert and tighten their four screws and check the shaft for free rotation. Now replace the film feed bracket (18.06.01B) but not the covers. Engage the driven bevel gear with its key in the film feed shaft while meshing the mating teeth (as marked with zeros) of both gears. Trip the pawl and turn the gears (still engaged) to expose the grub screw of the driven gear; tighten this screw while the engagement is complete. Turn the shaft and check that the markings still agree. With the grub screw again upwards, pass the split ring cam (24) towards the rear, registering the projecting grub screw into its recess; in this position, secure the ring cam with the two Allen screws evenly tightened to equalise the gaps. Turn the shaft to bring the opening of this cam to the bottom; offer up the automatic variable line-feed and paper-release valve box (26), with the diamond of the lever entering the opening in the cam, and attach the box to its bracket by means of its four screws. Rotate the shaft to verify that the levers do not foul the cams; if they do, it will be necessary to withdraw the ring cam slightly from the bevel gear or to move horizontally the bracket (28) carrying the valve box, but be careful not to lose its vertical positioning (see 18.11.10E). The film drum rack mechanism (18.06.02B) and the covers may now be replaced.

.03C FILM DRUM FEED SHAFT – DISMANTLING. Place the shaft in a vice, using soft grips to avoid damage from the jaws. To remove the mirror return cam, take the screw and washer from the rear end of the shaft, when the cam can be tapped off with a soft-metal mallet, leaving the Woodruff key in position. To remove the crank for the cross-slide from the front end of the shaft, release its grub screw and withdraw it, taking care not to lose the roller. Next, pull off the cams for the feed racks and automatic variable line feed which are mounted on the same parallel key as the crank. The split ring cam for the paper-release control is already free on the shaft and may be slipped off. The grub screw securing the bevel gear has already been slackened so that the gear may be drawn or tapped off the shaft, without disturbing its Woodruff key.

.03D FILM DRUM FEED SHAFT – RE-ASSEMBLING. Clean and lightly lubricate the bearing faces of the shaft and slide the bevel gear on to it, with its teeth facing to the rear, but leave it loose for the moment. Add the ring cam, with the split ring towards the front. Next put on the automatic variable line feed cam, located to the key and with its boss to the front; push this cam into contact with the shoulder of the shaft. Now comes the feed-and lock cam, with its boss to the rear abutting the previous cam, and then the cross-slide crank which needs to be secured by its grub screw. With its keyway correctly aligned, the mirror return cam can be replaced; tap it into contact with the shoulder of the shaft. Add the washer and screw which should be fully tightened.

.04C FILM DRUM DRIVING GEAR – DISMANTLING. Place the complete assembly of the drum and its housing on the bench, with the dials upwards. Turn the drum so that zeros are registered on both the point scale (32) and the graduated gear (34); the white line (35) on the shutter will then be central in the gap at the base of the housing. Holding the graduated gear, remove its central screw and washer, and lever off the knurled knob. Pass a knife between the back plate and the housing to break the paint seal. Take out the three screws securing the dowelled gear housing (36), and lift this off. The graduated gear itself can now be removed. Undo three screws to release the gear housing cover assembly, which comes away complete. When the spigoted gear housing cover is taken off, it frees the assembly of two double gears from the spindle that carries them and, in the case of direct-reading drums, the intermediate gear

(41) on its adjustable eccentric spindle (39). Now turn the drum housing on to its base, with the point scale towards you. From the centre of the manual control knob, withdraw the screw and its shake-proof washer, and take off the knob. The eccentric plate that was behind it must now be marked for easy replacement – as it could occupy three positions apart from the adjustment it provides. Detach the plate by first removing its three retaining screws, then press the gear spindle inwards while drawing the plate outwards; when the spindle-end is flush with the plate, both will come away together. If it is necessary to take out the drum itself, a special tool (20,000 F&G) is required to undo the lock nut and nut securing the scale. When this is removed, the front end plate can be detached (four screws) releasing the drum.

.04D FILM-DRUM DRIVING GEAR – RE-ASSEMBLING. Replacement of the drum in its housing is a reversal of the foregoing instructions, but special care must be given to adjusting the scale nut to provide free rotation with total absence of end-play; check punctilliously after tightening the lock nut. When the film drum housing assembly is standing in its normal position on the bench, with the spindle of the manual control flush with the eccentric bearing plate, offer the assembly into position, with the marking on the plate at the correct angle; this will cause the spindle-end to project outwards. Lightly secure the plate with its three screws. Grasp the spindle and turn the plate to eliminate back-lash, but check for free motion by rotating the drum before tightening the three screws. Replace the manual control knob, attaching it with its screw and washer. Place the double-gear assembly (43) on to its spindle in the gear housing and, in the case of direct reading drums, replace the intermediate gear; then add the spigoted cover. If necessary, slacken the grub screw (40) locking the eccentric spindle and turn this to eliminate all back-lash from its meshing with the spring-loaded double gear, and then retighten the grub screw. Turn the drum assembly on to its end so that the driving mechanism is uppermost. Position the double-gear assembly on the end plate and lightly secure it with its three screws. With the film drum scale at zero and the second white line (counting from the shutter) centred to the base slot, offer the graduated gear to the double gear with the zero in the lowest position. While holding the graduated gear stationary, enmeshed only with the fixed (upper) gear, use a small screwdriver to press the sprung (lower) gear counter-clockwise so that its teeth align with those of the fixed gear; this enables the graduated gear to be pressed down into mesh with both. Now press the gear housing towards you and to the right to compress both the spring-loaded meshings; secure the housing in this position with the exposed screw. To tighten the other two screws, take off the graduated gear and subsequently replace it as before, that is, using a small screwdriver to facilitate meshing with the sprung gear, but be sure that the dial registers zero. Replace the cover over the graduated gear and secure it with its three screws. Now check the assembly for smooth motion and absence of backlash in several drum-positions but, in the case of a Cicero drum, do not turn it more than one revolution in either direction, or a slight discrepancy in the zero position will appear.

.04E FILM-DRUM DRIVING GEAR – ADJUSTING. If re-adjustment is required, remove the cover and graduated gear (34), slacken the three housing screws; to give greater clearance, move the housing (36) slightly to the left and away from you, and vice versa. Complete the re-assembly of this sub-unit and again check for satisfactory operation. Finally, add the knurled knob, with its washer and screw.

18.07.00 Optical system components

.01 At the risk of being accused of repetition, we again stress the importance of keeping all optical surfaces clean, in the photographer's sense rather than in that of the engineer who generally approves the presence of a film of oil or grease. Failure to observe strictly a filmsetter's requirements in this respect leads to diffused images because of light dispersal and to under-exposures because of obstructed passage.

.02A PRISM BOX – REMOVING. By releasing its two hand-screws, detach the front cover over the air timing boxes, and lift off the prism-box hinged door. Undo the union of the air pipe for operating the low-alignment piston. Take out the prism and lens focusing bars. Next, remove the prism holder stop. Using a $\frac{1}{4}$ in 24 nut with a suitable distance-piece, withdraw the taper pin (4), and then undo the four screws (2 and 3) holding the prism box to the intermediate stand. Detach the spring post. Not until this has been done should the light cut-out blade be removed by undoing its fulcrum screw. To safeguard the mirrors, immediately cover the aperture with a piece of masking tape. To remove the box, slide it to the right of the machine i.e., towards you, and tilt the bottom outwards before lowering it. **This box is heavy – 72½ lb (33 kg).** Keep your back as upright as possible, and bend at the knees. Re-hang the door as soon as possible to exclude dust.

.02B PRISM BOX – REPLACING. Ensure that the mating surfaces of the box are clean and then remove the door. Tilting the top of the box slightly inwards towards the centre of the machine, offer it up into position and at once remove the masking tape and replace the light cut out blade complete with its fulcrum screw, spring and post to avoid the risk of anything falling on to a mirror; then insert the four

retaining screws, doing them up finger-tight only. Insert the taper pin and, with a drift, tap it home. After this, the two lower screws are to be fully tightened and then the upper pair. Replace the holder stop for the prism focusing bar, attaching it by its screw. Re-hang the door and re-connect the low-alignment air pipe union. Finally, replace the front cover over the air timing boxes.

.03A MIRROR BRACKET HOUSING COVERS – REMOVING. First take off the prism box (18.07.02A), and then the cover over the film drum feed shaft (two screws and the pillar with the knurled knob). To avoid jamming, remove the *rear* mirror bracket housing cover next – it is secured by six screws. Then withdraw the eight screws retaining the front housing cover which is located by two dowels. Do not risk burring an edge by levering up the cover, but, if necessary, borrow two screws ($\frac{3}{16}$ in 32) from the camshaft gear cover and insert these in the threaded holes to act as jacks; they must be tightened down evenly. After raising the front cover, be sure to replace the borrowed screws without delay.

.03B MIRROR BRACKET HOUSING COVERS – REPLACING. Care must be taken to obtain a light-proof joint between the adjoining edges of the covers. Position the rear cover and retain it with its six screws not more that lightly finger-tight. Replace the front cover on its dowels and secure it with its eight screws. Then, pressing the rear cover forward to make continuous contact with the front one, fully tighten its screws. Finally, replace the prism box and the film drum feed shaft cover.

.04A MIRROR BRACKET UPPER GUIDE BARS – REMOVING. Note: *These instructions relate only to machines numbered 91,000 to 91,049; instructions for later machines are given below.* Take off the prism box and the mirror bracket housing covers (18.07.02A 03A). Undo the two screws retaining the upper right-hand guide bar (10), meanwhile taking full precautions against possible accident to the mirrors by moving them to the opposite end of their travel. Raise the front and then the rear end of the bar carefully, anticipating that the spring-loaded plunger (8) in the mirror bracket will be ejected as soon as the restraint of the bar is withdrawn. Deal with the rear end of the bar in the same way. No plunger is involved when the upper left-hand guide bar (15) (two screws) is detached similarly.

PLUNGER HOUSING SUPPORT BAR – REMOVING. Note: *These instructions relate only to machines numbered 91,050 and upwards; instructions for earlier machines are given above.* Take off the prism box and the mirror housing covers (18.07.02A 03A). Undo the two screws retaining the plunger housing support bar (17) (to the left of the mirror bracket). Taking precautions against loss of the spring-loaded plungers in the lower faces of its projections, lift the bar out.

.04B MIRROR BRACKET UPPER GUIDE BARS – REPLACING. Note: *These instructions relate only to machines numbered 91,000 to 91,050; instructions for later machines are given below.* Place the left-hand upper guide bar in position and, safeguarding the mirrors as when detaching it, secure it with its two screws. Place the spring-loaded plunger in its recess in the rear part of the bracket and carefully locate it so that it is retained by the rear end of the upper right-hand guide bar, which is still free at both ends. Without allowing the plunger to escape, partly lower the front end of the right hand guide bar, press the front plunger into the bracket, complete the lowering of the guide bar, and then secure it with its two screws. Apply a slight smear of grease to the tracks of the pads and plungers on the upper guide bars.

PLUNGER HOUSING SUPPORT BAR – REPLACING. Note: *These instructions relate only to machines numbered 91,050 and upwards; instructions for earlier machines are given above.* See that the springs and plungers are clean and dry before replacing the bar and securing it with its two screws.

.05A MIRROR BRACKET ASSEMBLY – REMOVING. First take off the prism box, mirror bracket housing covers and mirror bracket upper guide bar(s) (18.07.02A 04A). Bring the assembly almost to its foremost position and lift the front bracket until the coupling attached to the rear bracket becomes disengaged from the hook at the front end of the mirror feed bar. As the bracket is raised, the spring-loaded plunger at its base needs attention. In the case of machines up to and including 91,049, encourage it to escape into the housing to avoid risk of its being jammed between the bracket and the lower support bar; it can be recovered after the bracket has been lifted out. In the case of machines 91,050 and upwards, the plunger can be easily withdrawn after removal of the plug in the right-hand side of the mirror bracket housing; when the bracket is lifted out, be careful of the two balls in the top of the fixed V-bar.

.05B MIRROR BRACKET ASSEMBLY – REPLACING. *These instructions relate only to machines numbered 91,000 to 91,049; instructions for later machines are given below.* Apply a trace of oil to the bearings of the rollers and a slight smear of grease to the tracks of the bottom plunger and pad on the lower guide bars and – as a preservative – to the tracks of the rollers on the support bars. A long, thin screwdriver $\frac{3}{16}$ in (5 mm), will conveniently hold the upper part of the bottom plunger in its recess in the bracket while the latter is being replaced (22). This tool should be held by hand between the plunger and the lower guide bar (14), compressing the plunger spring during the whole of the lowering of the bracket, which should be tilted so that the rear is about 1 in (25 mm) below the front. When the rear rollers lie on their support bars, draw the mirror bar to the front

so that its hook over-lies the coupling; the front of the bracket may now be lowered, thus bringing the coupling up into engagement with the hook, and the front rollers on to their support bars. Not until this final stage is reached should the screwdriver be withdrawn from contact with the bottom plunger.

MIRROR BRACKET ASSEMBLY – REPLACING. *These instructions relate only to machines numbered 91,050 and upwards; instructions for earlier machines are given above.* Check that the two balls and the V-bar are clean and dry (no lubrication is required here), and place one ball (24) between each pair of stop pins (20) in the fixed V-bar. Lower the bracket into position; it should be tilted so that the rear is about 1 in (25 mm) below the front. When the movable V-bar rests on the rear ball, draw the mirror feed bar slightly to the front, 1½ in (38 mm) from its rearmost position, so that the hook over-lies the coupling; the front of the bracket may now be lowered, thus bringing the coupling up into engagement with the hook, but, at the same time, working through the plug-hole, locate the spring and plunger (23) in their recess. Ensure that the plunger is properly located against the lower guide bar (28) when the front of the movable V-bar rests on the front ball.

.05C MIRROR BRACKET COUPLING – DISMANTLING. With the mirror bracket on the bench, withdraw the four screws attaching the coupling to it. Slide the U-shaped cage (31) out of the spring, noting that the small associated components consist of two rollers (32), the coupling itself (30) and two small steel balls (29). If a replacement spring is to be fitted, check first that, when the coupling is in its operative position in the spring, the two faces of the latter are parallel, so that, when the hook of the bar is inserted – pressing the balls outwards – they will transmit the thrust to the spring. This provides a buffer-effect for the mirror bracket at the end of its return stroke. Note that on machines No. 91,064 and upwards, a hard steel plate is located on the two upper screws and situated between the rear coupling ball and the spring.

.05D MIRROR BRACKET COUPLING – RE-ASSEMBLING. This is done in the reverse order of dismantling; then re-attach the coupling to the bracket with its four screws.

.06A MIRRORS – REMOVING. First take off the prism box, mirror bracket housing covers, mirror bracket upper guide bar(s) and the mirror bracket assembly (18.07.02A-05A). From the top of each mirror bracket, remove the small stop plate (9) (two counter-sunk screws each). To ensure that the retaining pieces cannot cause the slightest damage to the reflecting surfaces, undo the screws at the back of the bracket arms, and withdraw the four springs and plungers to relieve the pressure. The mirrors can now be carefully withdrawn upwards on the alignments of their brackets. Cleaning-time can be saved if the mirrors are handled by the edges or with a 'Selvyt' cloth to avoid finger-marking their surfaces. In extreme cases, wash with plain warm water only, taking every precaution against scratch.

.06B MIRRORS – REPLACING. Replacement is a reversal of the previous instructions, but note that mirrors are intended to be fitted as matched pairs, with 'concave' (minus) or 'convex' (plus) marked on the side of one balanced by 'convex' or 'concave' marked in the same position on the other. It may occasionally be necessary to fit two concave or two convex mirrors to give perfect re-establishment of line-length over 60 pica ems.

.07E VARIABLE APERTURE – ADJUSTMENT. Take off the bridge (18.02.04A), and slacken the two vertical side screws to allow the plate (35) carrying the two stop pins (34) to slide. The correct distance between the left-hand end of the masking slide and the opposing face of the sprung V-bar on the left-hand side of the light aperture is 0·173 in (4·40 mm) when the slide is engaged with the operating lever and this lever is in contact with the plate. If no slip gauge is available, use a feeler gauge to give this position. Then secure the plate and replace the bridge.

18.08.00 Gearbox mechanism

.01A GEARBOX – REMOVING. As a preliminary to the task, provide a block of wood or similar support measuring 6½ in high × 1 in × 8 in, or longer (165 mm high × 25 mm × 200 mm or longer) to hold the gearbox erect when it is standing on the floor or bench, with its weight resting partly on the clutch mounting bracket. Take the precautions of turning off the air cock and the isolator switch [A] [E]. As an additional safety measure, detach the belt guard (18.04.02A) and belt; this is desirable if the isolator switch could be accidentally turned ON. Swing up the cover over the matrix case holder lever and take off the covers over the bridge and top mainstand mechanism. Remove the matrix case and bridge (18.02.04A). Turn the camshafts to 270° and insert the wooden wedge [W] to hold the unit drive out of engagement; rotate the handwheel to check that this is effective. Remove the rear splash-guard (two screws). Extract the yoke pin uniting the feed and lock rack actuating lever extension to its operating rod; with this 'extension' in its clockwise position (i.e. lock racks engaged), tie it there with a piece of string or wire. If there is insufficient clearance to ensure that the yoke on the operating rod does not foul the actuating lever extension, detach the rod by undoing (below the main stand) its hexagon-headed fulcrum screw. Drain into a suitable container the oil, about 1 gallon (about 4½ litres), from both the lower and upper halves of the gearbox, by taking out their respective drain plugs. Take off the front cover of the gearbox (as seen when standing at the right-hand side of

the machine) fourteen screws and the layshaft cover seven Allen screws. Remove, complete with rollers, the unit and justification pressure roller bracket secured by three Allen screws. Next detach the guide overlying the outer parts of the unit and justification racks; there are two screws and two taper pins, one of which must be tapped up with a soft metal punch from below; the other, an easier fit, will come away with the guide. Detach also the guide (two screws) over the inner end of the unit rack and space bar and, to give access at a later stage, remove the space bar guide (two screws). Having noted that the teeth of the unit and justification racks and their spur wheels are marked for correct re-assembly, remove the racks; the justification racks will come away to the right of the machine if, after their lifting rods have been raised, the fine rack is tilted clockwise and the coarse rack counter-clockwise (as seen from the right-hand side); the unit rack is taken from the left hand side of the machine after the front buffer, pin jaws and matrix jaws have been removed (18.02.09A, 18.02.12A and 18.02.14A), when turning the camshafts to 40° will allow disengagement from the layshaft spur gear. Take out all the selector assemblies and their shafts (2, 8 & 9); the unit selector requires only the raising of its shaft, but, to free the shafts of the justification selectors, remove the thrust plate (5) (four screws). Detach the small oil pipe leading from the underside of the drip tray. Take out the drip tray which is held by two bolts, and the four cam lever latch springs together with their two posts. Release the three air pipe unions from the unit drive control box and detach completely the small air pipe connections from the fail-safe valve box. Having turned the camshafts to 285° to position the unit and justification drive cam levers conveniently, take out the four yoke pins (secured by split pins backed by washers) at the ends of the corresponding spring box assemblies; supporting the two operating yokes (10 & 11) in their raised position, by means of suitable blocks under their operating sleeves, withdraw first the unit and then the justification spring box to the left-hand side of the machine and to the rear of the swinging plate, in the space made accessible by the detaching of the air pipes. As the draining of the oil should now be complete, replace the plug securely in the base of the gearbox before removing the clutch (18.10.01A). Disconnect the union of the supply oil pipe leading from the back of the lower section of the gearbox, and detach completely the delivery oil pipe from the back of the top section of the gearbox. On the right-hand side of the machine, use washers and a nut to withdraw the threaded taper pin (A) forward of the gearbox; to avoid distorting the dowel, this must be done squarely to the face – if necessary, insert extra packing under one side of the washers to ensure a straight pull. If the adjoining screw (B) is removed to facilitate this, it must be replaced, finger tight, after extraction of the dowel – its subsequent support of the gearbox is vital. Now support the unit driving sleeve in its raised position and take out first the retaining screw inside the top rear of the gearbox and then the similar screw under the gearbox. At the rear of the machine, do not disturb the exterior hexagonal nuts (14) of the adjustable locator but, using an Allen key, withdraw the screw (15) inside it while both the front and rear ends of the gearbox are supported; help will be needed. The assistant, at the front end of the unit, should lean inwards to prevent it tilting outwards prematurely as, when released, it will be resting only on the jack block screws. **The gearbox is heavy; it weighs 157lb (72kg)**; when it comes to lowering, both men should keep their backs as upright as possible, and bend at the knees. Without slackening the support, finally take out the remaining screw and lift away the gearbox, tilting the top slightly outwards to enable the levers to clear the casting. Lower the unit carefully to the floor so that it rests on the prepared block as shown in the illustration, making certain that the upper part of the clutch is kept clear, to avoid all possibility of strain. Be equally careful when placing the gearbox on the bench; the block of wood may be used under the front end to give level standing with clearance below the remaining clutch components.

.01B **GEARBOX – REPLACING.** First check and, if necessary, correct the adjustments of the unit drive latch (10.03.03 07) and the justification drive latch (10.14.05) as this work is more easily done before the gearbox is re-attached. After cleaning all the locating faces, offer up the gearbox, using the same physical technique as for lowering. So that part of the weight is taken by the jack screws (NOT their lugs) resting on the intermediate stand, place the washer in the recess surrounding the hole for the top left-hand screw (as seen when facing the gearbox), insert the screw and lightly tighten. Engage and lightly tighten the Allen screw (15) in the adjustment locator. Insert next the other two screws (B) and lightly tighten them also. Place the taper pin in position and drive it home before fully tightening the three screws; only when they are fully secure should the Allen screw (15) be tightened. Replace the clutch (18.10.01B). With the camshafts at 285°, and supports under the operating sleeves, as when removing the gearbox, insert the justification drive spring box assembly from the left-hand side of the machine while lifting the unit drive lever to expose the pin hole; add the yoke pins from the front end and secure them with washers and split pins. Replace the justification spring post squarely, and the two cam lever latch springs. Remove the justification sleeve supports and then check the adjustments of the fail-safe

and stroke mechanisms (10.03.08–10). The unit drive spring box assembly may now be replaced and then the unit sleeve support removed. Replace the unit spring post squarely, and the two cam lever latch springs, and re check the adjustments for the fail-safe mechanism (10.03.08–09) and stroke (10.03.09–10). When these are established, make sure that the springs are not fouling their barrels, by standing at the left-hand side of the machine and making a visual check when pulling the swinging plates outwards. Reconnect the lock and feed rack actuating lever extension yoke; check the lock and feed adjustments (18.08.03E–18.08.09E). The air pipes – three to the unit drive control box and two to the fail-safe valve box – can now be reconnected. The oil drip tray can be restored and its bolts tightened down on to their washers; re-attach the small oil pipe underneath it. **Insert the wooden wedge** ; turn the camshafts to 165° for replacement of the justification selector shafts and their selector assemblies and when these are in position, add the thrust plate (5) but do not tighten it down until the two adjusting screws have been slackened; these should then be re-adjusted to give free turning of the shafts without vertical end-play, and then locked; again check the adjustment. Insert the unit selector assembly and shaft. Before replacing the unit rack, see that it and its seating are perfectly clean and lightly lubricated; turn the camshafts to 40° and slide the rack into position from the left-hand side of the machine until the teeth engage with the unit spur wheel on the lay shaft; replace the guide for the inner end of the rack and the space bar guide which are each held by two screws only. Check these components for freedom of movement. Replace the front matrix jaws, pin jaws and buffer (18.02.14B, 18.02.12B and 18.02.09B). The justification racks can be manipulated into position from the right-hand side of the machine if tilted sideways (as in removal), when the lifting rods are raised; the fine justification rack (it has a sloping face towards the front, with the lug upwards) lies in front of the coarse justification rack; make sure that both are clean and lightly lubricated and that the marked teeth of all three racks are properly meshed with the corresponding teeth of their spur gears. The oil pipes to and from the pump can now be reconnected. Clean the faces of the unit and justification rack guide and lightly lubricate the working surfaces. Turn the camshafts to carry the cross slide fully forward and place the guide over the outer ends of the unit and justification racks squarely in position and press it down evenly to its seating. Check that the racks are still correctly meshed with their gears and then lightly tap both of the guide's taper pins into position, lightly tighten the two securing screws, give final taps to the pins and then fully tighten the screws. Check for free dom of movement. When the locating faces of the roller bracket are clean, place it and its three Allen screws in position; check the bracket for squareness and tighten it down; verify and, if necessary, correct the adjustment (18.02.19E). Examine the gaskets for the layshaft cover and its central screw; if they are in good order, grease and replace them. Oil all the moving parts adjoining the lay-shaft. See that the faces of the cover are clean and then offer it into position. Locate first the two large screws and then, from below, the five Allen screws; all of these should be only lightly tightened before fully securing first the top centre screw and then the others, working progressively from the centre outwards, but leaving the other top screw till last. The front cover of the gearbox (as seen from the right-hand side of the machine) must make a sound oil-tight joint; replace it and lightly secure it with the fourteen screws; then tighten them all progressively, working round and round the perimeter till all are tight. Refill the gearbox carefully with oil till it reaches the centre of the sight plug at the front of the lower half of the gearbox. Replace the oil-level drain plug in the rear of the upper half of the gear-box and continue filling to the top of this plug. Check the cover and drain plug for leakage. Secure the rear splash guard with its two screws. Bring the camshafts to 270° and remove the wooden wedge; check that the 'fail safe' mechanism has been re-set (10.03.12). With the air cock on, turn the handwheel a few revolutions to verify that all parts are correctly adjusted (refer to 10.03.09–10 and 10.12.02–04) and free to operate. Replace the bridge, covers, belt and belt guard. With the isolator switch ON, run the machine under power while listening for any abnormal sound.

.02A **!** UNIT AND JUSTIFICATION DRIVE OPERATING YOKES – REMOVING. The gearbox must first be taken off (18.08.01A). Disconnect the oil-pipe union to the fulcrum shaft of the yokes and take out the Allen screw locating this shaft. Withdraw the shaft to the front, releasing the yokes; take care not to lose the 6 rollers (3).

.02B **!** UNIT AND JUSTIFICATION DRIVE OPERATING YOKES – REPLACING. Replace the assembly in the gear-box, registering the rollers with the coarse and fine justification operating sleeves respectively before temporarily inserting the shaft. Now effect the adjustments (18.08.02E–08E). When these are confirmed, the unit yoke (11) can be replaced; see that the shaft (19) has its flat correctly located to meet the Allen locating screw; insert and tighten this and reconnect the oil pipe. Restore the gearbox to the machine (18.08.01B).

.02C **!** COARSE JUSTIFICATION DRIVE OPERATING YOKE – DETACHING. After removing the yoke assembly (18.08.02A), release the lock nut of the upper Allen screw of this lever and then the screw (17) itself. Remove the

hexagon nut (18) and washer from the stud on the fine justification drive operating yoke, when the coarse justification yoke (6) can be drawn clear.

.02D **I** COARSE JUSTIFICATION DRIVE OPERATING YOKE REPLACING. Place the yoke on the stud and boss of the fine justification drive operating yoke, with its central projection towards the latter, where it should be lightly [illegible] screws, bring the coarse justification yoke (6) to a position approximately central to the stud.

.02E **I** COARSE JUSTIFICATION DRIVE OPERATING YOKE ADJUSTING. This is done only when the adjustments detailed in 18.08.03E 08E are correct. A cigarette paper, which is approximately 0·001 in (0·03 mm) thick forms a useful gauge; when this is gripped between the top of the fine justification yoke (10) and its stop, a similar condition should apply at the top of the coarse justification yoke (6). The adjustment can be made by means of the upper and lower Allen screws (secured by lock nuts requiring a $\frac{3}{16}$ in Whitworth spanner) which pinch a stud projecting from the fine justification yoke, but first slacken the nut (18) at the front end of the stud. Having achieved this adjustment, tighten the nut at the front end of the stud, withdraw the shaft to release the yokes, and tighten the lock nuts on the Allen screws. Replace the yokes and shaft and check that the adjustments have been held, as they represent critical settings. Stroke-adjustment of the coarse and fine justification and unit drive operating yokes is made after the gearbox has been replaced on the machine – see 10.03.09 10 as the procedures there described for 'unit' are also applicable to the justification yokes.

.03E **I** FEED RACK DRIVE YOKES – ADJUSTING. The upper face of each yoke (24) should be $\frac{1}{16}$ in (1·5 mm) below the shoulder of its shaft (27); when adjusting for height, pull the yokes clockwise before locking up their two Allen screws. Dealing first with the *unit feed shaft*, insert a 0·004 in (0·10 mm) feeler gauge between its top and the stop block and secure the shaft in this position (a clamp collar will be useful). With all three selector assemblies in position, adjust the angle of the yoke so that when the feed rack is fully meshed, a 0·007 in (0·18 mm) feeler can pass between each arm of the yoke and the flanged bush, whether the lock or feed rack is engaged. Then deal with the fine justification and finally the coarse justification yokes in the same way. When any of this work has been carried out, it is essential to re-check the feed-rack adjustments (18.08.06E).

.04E **I** LOCK RACKS – ADJUSTING. To check the three lock racks for back-lash, first take out the actuating lever extension yoke pin, and hold this lever so that all racks are as fully enmeshed as possible. If there is more than the slightest play between any one of them and its gear, the gearbox must be detached from the filmsetter (18.08.01A). Then remove the justification drive operating yokes (18.08.02A). Raise all three selector yokes to give a measured clearance of 0·004 in (0·10 mm) between each and its stop block; secure the shafts with collars to maintain this position during the making of the adjustment. Isolate the lock rack mechanism from the connecting [illegible] taching the circlips over the connecting eyes (A and R) and lifting away the complete connection. Operate the locking mechanism by hand to engage all three racks as fully as possible and check that the distances between the centres of the pins in eye (G) and link (L), and between link (L) and eye (P) are both $2\frac{1}{2}$ in (63·5 mm). If the unit lock rack is firmly in mesh while either or both the justification lock racks allow play of their gears (an unlikely condition), release the lock nuts (M – left-hand thread) and (O – right-hand thread) and turn the adjusting stud (N) to give clearance to the unit lock rack. If either of the justification lock racks is not now holding its gear perfectly steady, slacken the lock nuts (H – left-hand thread) and (K – right-hand thread) and turn the adjusting stud (J) to eliminate the play; retighten the lock nuts and check that the adjustment has been maintained. With the justification lock racks held firmly in mesh, turn the adjusting stud (N) to eliminate play from the unit lock rack but do not over-tighten, so as to allow play between the justification lock racks and their gears; retighten the two lock nuts and then check that all three gears can be simultaneously held rigid by their lock racks. When the connection (A–R) is replaced, it will need to be re-adjusted – see 18.08.06E.

.05E **I** ANVILS – ADJUSTING. Anvils are correctly set if each grips a single thickness of paper ribbon simultaneously against the flange of the sleeve (FF) which forms the base of each selector assembly, when the mechanism is in the locked position. The correct adjustment of the lock racks (18.08.03E) in the locked position gives a firm datum for the adjustment of the anvils and feed racks; the relationship between the two is governed by the adjusting stud (F) which must therefore be corrected whenever the lock rack or the anvil/feed rack mechanism has been altered. Consequently, anvil-adjustment requires that the gearbox be first detached from the filmsetter (18.08.01A). Insert a 0·004 in (0·10 mm) feeler gauge between the unit selector stop and the top of the unit selector drive yoke which should then be secured in its uppermost position with a clamp collar at the top of the shaft. Deal with the justification selector assemblies in the same way; they must all remain raised while the anvil adjustments are being made. With the connection (A–R) detached, by removal of its circlips, and the feed-rack mechanism turned fully clockwise (i.e. as when the lock racks are engaged), check whether the

unit anvil (CC) alone is gripping the paper ribbon against the flange of the sleeve (FF), if so, release the two lock nuts (T – left-hand thread) and (V – right-hand thread) and tighten the adjusting stud (U) to give clearance. Now adjust (if necessary) the stud (S) to cause the two justification anvils (Y and AA) to grip the paper simultaneously; re-tighten the two lock nuts and check that the adjustment has been held. While these two anvils retain their clockwise position, gripping the paper, adjust the stud (U) to bring the unit anvil so that it is similarly conditioned; re-tighten the lock nuts and check that this adjustment also is now correct. Now replace the connection (A R) and its circlips; with the whole mechanism in the locked position, check the gears with the lock racks for non-rotation and the anvils for their maintained grip of the paper; any discrepancy can be corrected by adjustment of the stud (F) after its lock nuts (E – right-hand thread) and (Q – left-hand thread) have been slackened. Retighten them afterwards and finally check that the conditions are fulfilled. Should it be necessary to fit a new anvil, it must be supplied complete with a new shaft. When the anvil is in position, the vertical distance between its top and the stop block is 3·473 to 3·474 in (88·21 to 88·25 mm), and for the fine and coarse justification anvils 3·182 to 3·183 in (80·82 to 80·85 mm). To find the difference between the heights of the new and old anvils, it may be necessary to stand both side-by-side on a flat surface and place a straightedge across their top faces; measure the distance with a feeler gauge between the shorter anvil and the straightedge. This difference in dimension must be added to the stop block by means of shims above it, or ground from its upper face i.e. the one without the counter-bore.

.06E FEED RACKS – ADJUSTING. So that the slip gauge (No. 21020G) can be used between the anvils and the selector shafts, all the selector assemblies must be removed. With all the selector drive yokes still held up (as in 18.08.05E) by the collars, check that the adjustments of all the lock racks and anvils are correct. Each of the three feed racks is pinched on to its shaft by two Allen screws; all six of these should be slackened so that the racks can be turned relatively to the shafts. Turn the actuating lever to take the lock racks fully into mesh and turn the *unit feed rack* on its shaft so that it also is engaged. Noting that the bases of the shaft and the rack approximately coincide, slightly tighten the two Allen screws equally but not sufficiently to secure the rack. Whilst holding the unit feed rack in mesh with its gear by finger-pressure, rotate its shaft clockwise until the NOT GO, 0·521 in (13·23 mm), faces of slip gauge 21020G are pinched between the anvil and the selector shaft; then fully tighten the two Allen screws of the unit feed rack and check that the GO faces of the gauge 0·516 in (13·11 mm) pass through the gap but the NOT GO faces do not. Now, by turning the actuating lever through its full range of movement, it should be possible to engage the unit lock and feed racks alternately without any shake of the gear wheel. To adjust the *fine justification feed rack*, slacken its two Allen screws and engage the unit feed rack. Keeping the base of the fine justification feed rack level with the base of the unit feed rack, turn the former on its shaft until it is fully engaged with its gear wheel. If the Allen screws are now tightened, the clamp on the shaft will tend to turn clockwise, bringing the rack slightly out of mesh; to counteract this, see that the unit feed rack is only lightly engaged before firmly engaging the 'fine' rack and tightening its Allen screws. Again make sure that there is no 'shake' in the gear wheel when the feed rack is engaged. Finally, check the accuracy of both the unit and the 'fine' feed rack settings by use of the slip gauge 21020G. The *coarse justification feed rack* is adjusted in the same way as the 'fine'. Finally check that when in either the locked or the feed position, the racks allow no movement of the gears, and they should engage without causing movement.

.07E FEED AND LOCK RACK CONNECTING BAR (W) – ADJUSTING. With all selector assemblies removed, and the yokes still raised to 0·004 in (0·10 mm) from their stop blocks, slacken the lock nuts (Q, left-hand thread) and (E, right-hand thread). Turn the actuating lever to bring the lock racks into full engagement and adjust stud (F) so that slip gauge 21020F will give the correct clearance between the unit selector shaft and anvil; this is GO 0·383 in (9·73 mm) and NOT GO 0·388 in (9·86 mm). Now check that the same result is obtainable between the selector shafts and anvils of the fine and coarse justification mechanisms; if this is not the case, the adjustments of all the lock racks must be re-checked. When all these clearances are correct, retighten the two lock nuts and finally verify.

.08E FEED GEAR PAWLS – ADJUSTING. Each of these can be adjusted independently to eliminate backlash of the differential shaft. *If the gearbox is on the bench*, insert a 0·004 in (0·10 mm) feeler gauge between the yoke and the stop block of each shaft in turn and use the clamp collar to retain the shafts in their highest position. *If the gearbox is on the machine*, disconnect the actuating lever extension by removing the pin from its eye, and turn the camshafts to 160°. Engage the feed rack fully. Slacken the lock nut (39) of the eccentric pivot bolt (37) and turn this bolt until the pawl advances to take out all the play. Partly tighten the lock nut and then gently ease back the eccentric bolt until the pawl can be raised to clear the tooth with which it was engaged. Now fully tighten the lock nut. As a final check, move the feed racks slightly away from their gears and hold all three

pawls out of engagement; by means of a set gear wheel on the rear end of the differential shaft, turn the shaft counter-clockwise (as seen from the rear). Release one of the pawls, turn the gear clockwise and note that the pawl falls into its engaged position. Deal with the other two pawls in the same way.

.09E JUSTIFICATION SELECTOR SHAFTS AND UNIT SELECTOR GEAR – ADJUSTING. (See illustration to 18.08.01A). No vertical end-play is permissible, particularly because of the spiral teeth of the gear wheels. When the thrust plate (5) is to be replaced after dismantling, position first the (thin) lower thrust race of the unit selector, followed by its radial needle bearing and then its (thick) upper race. Slacken off the three screws which adjust this bearing and the two screws for locating the fine and coarse justification selector shafts (2 and 8). The thrust plate can now be added but, before tightening its four Allen holding-down screws, be sure that it provides clearance all round the unit selector shaft retaining sleeve. With the thrust-balls (4 & 7) in position on the tops of the justification shafts, tighten their adjusting screws so that there is no end-play in the shafts but so that they can turn freely. After locking these screws, tighten and finally lock the three adjusting screws of the unit selector shaft thrust bearing; again, there must be perfect freedom to turn but no end-play.

18.09.00 'Final' drive

.01 Although the three points, at which adjustments of the horizontal 'final' drive shaft are made, can be reached without detaching the assembly, it is not possible to check that the work has been done accurately unless there is direct access to the shaft. Irregularities in mirror bar feed – apparent as the faulty spacing of characters – are the most likely cause for removal, examination and correction of the components in the 'final' drive housing, which is attached to the base of the gearbox.

.02A 'FINAL' DRIVE HOUSING – REMOVING. By taking out the drain plug, first drain the oil from the lower part of the gearbox into a suitable clean container for re-use. At the rear of the gearbox, detach the intermediate gear wheel and the swing frame (28). Take off the clutch assembly (18.10.01A). Drain the oil contained in the housing by removing the plug (22), and collect this lubricant also. Withdraw the two threaded taper pins (19) by using a suitable number of washers and the nut borrowed from one of the cross slide buffer studs; be sure to restore the nut as soon as the pins are extracted. Slacken the three Allen screws retaining the housing (21) and take them out while supporting the housing which will come away as a complete unit.

.02B 'FINAL' DRIVE HOUSING – REPLACING. Having made sure that the mating surfaces are clean, offer up the housing into position and insert the taper pins as a push-fit by hand only. Smear the three Allen screws with 'Osotite' (or a similar sealing compound) to prevent oil-seepage and lightly tighten them in their holes. With a soft-metal drift, tap the taper pins fully home and then fully tighten the screws. Replace the set-gear components, the gearbox drain plug and the housing drain plug. The gearbox oil-supply can be replenished through the upper opening, but the plug (18) must be withdrawn from the housing and a force-feed oil can used to bring the oil up to this level. Replace the clutch assembly (18.10.01B). Now turn the machine by hand to check that the mirror bar motion appears to be satisfactory and finally test-run, exposing film, to check that faults of spacing have been eliminated.

.02C 'FINAL' DRIVE HOUSING – DISMANTLING. At the bench, hold the base of the housing in a vice with soft-metal grips for protection. No special instructions are necessary for stripping out the components, apart from removal of the clutch armature (18.10.02A).

.02D 'FINAL' DRIVE HOUSING – RE-ASSEMBLING. This is simply a reversal of the procedure for dismantling, but be careful not to damage the oil-seal.

.02E 'FINAL' DRIVE HOUSING – ADJUSTMENTS. At the bench take off the clutch armature (18.10.02A). The vertical shaft carrying the driven helical gear (2) can now be lifted out; next check the movements of the horizontal shaft (3), turning it by the set change gear wheel. There must be no end-play, but it must turn freely, located between the thrust ball at the front and the flange of the rear bearing which contacts a shoulder on the shaft. If adjustment is necessary, slacken the lock nut (16), turn the adjusting screw (17) as required, retighten the lock nut and then check that the setting is still correct. Avoiding damage to the oil seal, replace the vertical shaft (with the teeth of the two gear wheels meshed in accordance with their markings), and the clutch armature (18.10.02B). Only when this condition is satisfactory can adjustment be made for eliminating back-lash between the gears, by varying the angle of the eccentric sleeve (11) carrying the horizontal shaft bearings. To test, first remove the double set change gear (8) and the oil-seal retaining plate (5). This discloses the two Allen securing screws (4) which pass through slots in the flange of the eccentric sleeve. Replace the double set change gear, and attempt to turn this clockwise while holding the armature stationary; no back-lash should be perceptible at any point of the gears' meshing, but neither must there be any binding. To adjust, slightly slacken the two screws (4) and withdraw the small Allen grub screw (12) adjoining the housing drain plug. With a soft-metal hammer, tap the flat on the flange of the eccentric sleeve (11), to turn it clockwise, so as to carry the whole shaft laterally and bring the two gears

into closer mesh. When there is smooth rotation without back-lash, tighten firmly the two screws (4). Note that this is a fine adjustment without a great deal of movement; when it is exhausted, a Works overhaul of the 'final' drive assembly will be necessary. Apply 'Osotite' (or a similar sealing compound) to the grub screw (12) and tighten it in its hole only sufficiently to nip the front bearing; its duty is to act as a 'steady'. Check that the adjustment is correct before replacing the oil-seal retaining plate and the double set gear. To eliminate end-play of the vertical shaft, refer to 10.19.04, as this adjustment is made after the assembly has been replaced on the machine.

18.10.00 Clutch and mirror feed bar

.01A CLUTCH – REMOVING. Take off the mirror bar guard, secured by one screw and washer. Make certain that **the isolator switch is OFF**[F]; then remove the cover of the rear electrical control panel by withdrawing the four washered hexagon-headed screws retaining it. Release the two wires leading to the clutch; these are the top two on the left side of the terminal block as seen from the rear; release them also from the nylon clip (3), and withdraw them through the short protective cover towards the front of the machine. Slacken (two or three turns) the two Allen screws (5) holding the clutch assembly. Tap the side of the bearing block so that the jarring loosens it and its taper pins, enabling the whole assembly to be eased away. Then take out the Allen screws, completely releasing the clutch together with its two taper pins (6) which are threaded for extraction by nuts and washers if necessary; identify them for replacement in their own holes. Take care not to lose the bottom bearing ball (19).

.01B CLUTCH – REPLACING. Check that **the isolator switch is OFF**[F]. Ensure that the seating faces of both machine and clutch are clean. Apply a little vaseline to the bottom bearing ball – this will retain it in its socket as well as provide lubrication. Pass the twin wires through the protective cover to the rear control box and offer up the assembly into position; before pressing it home, make certain that the bearing ball is properly seated and that the gear is correctly meshed with the rack. If the taper pins have not been disturbed when the clutch was detached, lightly tap the housing into position; tighten the two Allen screws evenly and check for free motion of the shaft. If the taper pins have been extracted from the housing, they should be very gently tapped back into it before it is replaced. Thread both the wires through the nylon clip and secure them with a single knot before connecting one wire into each of the terminals from which they had been taken – the order is immaterial. Make sure that good metal-to-metal contact is made by each terminal screw, and then replace first the panel cover with its four hexagon screws and washers, followed by the mirror bar cover with one screw and washer. Check the adjustment detailed in 10.19.05.

.01C CLUTCH – DISMANTLING. First, for its safe keeping, remove the bearing ball (19) from the foot of the assembly. To release the rotor shaft, use a pair of C-spanners to slacken the lock (7) and adjusting (8) ring nuts, and screw them off. Now withdraw the shaft with the rotor. The field winding and its housing (1) can be detached by undoing the four cheese-headed exterior screws and withdrawing the housing from its spigot mounting. Note the angle of the housing so that it may be similarly replaced.

.01D CLUTCH – RE-ASSEMBLING. Insert the shaft from the top and turn it to check that there is clearance all round the periphery of the rotor, before tightening the four exterior screws to retain the field winding. In the case of a new component, it may be necessary to withdraw the rotor and scrape the bore of the field coil housing to obtain this essential clearance. Replace the two ring nuts, leaving them loose for adjustment (see 10.19.05) after replacing the ball and clutch on the machine. Safe guard the ball until you are ready to do this.

.02A CLUTCH ARMATURE – REMOVING. Take off the clutch (18.10.01A). Remove from the bottom of the armature (14) its central screw with the shake-proof washer. A special tool is necessary to withdraw the armature with its spring plate (27) attached, but before using this, note carefully (for replacement) which are the correct mating faces of the squared shaft-end and the corresponding hole in the armature; these should be already marked. Of the four small cheese-headed screws, take out two that are diametrically opposed and use them to secure a withdrawing tool; when the central screw of this is inserted and tightened, the armature will be drawn off its shaft. Detach the tool.

.02B CLUTCH ARMATURE – REPLACING. With all parts clean, offer the armature to its shaft, ensuring that the squared faces mate as before, and press it up into working position. Replace and tighten the two cheese-headed screws if this has not been done already. Insert and tighten the central screw with its shake-proof washer. Replace the clutch (18.10.01B). Check that there is a clearance of 0·004 in to 0·006 in (0·10 mm to 0·15 mm) between the armature and the rotor all round and see that the locking rings are clear of the mirror bar; if necessary, re-adjust them and the bearing ball to give 0·0015 in (0·04 mm) between the ball and its seating.

.02C CLUTCH ARMATURE – DISMANTLING. At the bench, take out the two remaining cheese-headed screws so that the brass ring can be lifted from its spigot. Carefully detach the brass supporting plate (normally at the top of the as-

sembly) which retains the spring plate in the armature. If it is necessary to renew the spring plate, the eight screws uniting the three parts may now be withdrawn. Wash all the parts in benzine and dry them with an air blast.

.02D CLUTCH ARMATURE – RE-ASSEMBLING. This is a reversal of the dismantling procedure, finishing with the replacement and tightening of the four cheese-headed screws. Make sure that there is good contact all round between the brass support plate and the armature.

.03A MIRROR RETURN LEVER – REMOVING. Take off the belt guard (18.04.02A). Having checked that the isolator switch is OFF [F], work at the right-hand side of the machine. From the junction between the mirror return cam lever (42) and its spring box, withdraw the yoke pin (the split pin first) so that the yoke can be swung clear of the lever. At the left-hand side, slacken (three turns) the lock screw (32) securing the return lever fulcrum pin (44) to the base casting; the fulcrum pin is internally threaded at the bottom so that a $\frac{1}{4}$ in. 24 screw (31) can be inserted from the right-hand side of the machine to facilitate extraction of the pin. The lever can then be manipulated out to the same side.

.03B MIRROR RETURN LEVER – REPLACING. Offer the lever into position with the end of the longer arm below the mirror bar. Working from the rear of the machine, locate the lever between the bosses of the fulcrum pin supports, insert the pin (34) (still with its extracting screw) and raise it fully; tighten the locating screw only lightly till the pin has been moved so that the screw can enter its recess, when it can be fully tightened; then take out the extracting screw. Swing the spring box into position and connect its yoke to the mirror return lever; secure the yoke pin with a split pin. Finally, replace the belt guard (18.04.02B).

.04A MIRROR RETURN LEVER SPRING BOX – REMOVING. For easier access, unhook the auxiliary springs (40) from their posts and remove them. Take out the rear yoke pin uniting the spring box to the return lever, after withdrawing its split pin, and swing the box clear of the lever. At the front of the machine, remove the covers from the air timing control boxes and from the film feed shaft. Having tripped the pawl, turn the shaft clockwise by hand till the yoke pin at the front end of the spring box is visible; take out its split pin and the yoke pin, while supporting the spring box which can then be drawn out to the right-hand side of the machine.

.04B MIRROR RETURN LEVER SPRING BOX – REPLACING. Ensuring that the return lever (42) is at the front end of its stroke, offer the spring box into position from the right-hand side of the machine, with the posts for the auxiliary springs on top. Connect the yoke to the cam lever with its pin, and secure it with a split pin. Turn the film feed shaft to carry the cam lever to its rearmost position, and connect the spring box yoke to the mirror return lever with its yoke pin, and split pin. After restoring the auxiliary springs to position, carry out the adjustment detailed in 10.19.09. Replace the two front covers, taking care to keep the film drum clamping knob exposed.

.04C MIRROR RETURN LEVER SPRING BOX – DISMANTLING. Place the box, with soft grips, in a vice. Unscrew the lock nut and then the yoke from the sprung (i.e. the front) end of the assembly. Then detach the yoke from the fixed (i.e. the rear) end of the tube, allowing for the spring pressure which tends to eject the rod; the hexagonal guide bush remains in the front end.

.04D MIRROR RETURN LEVER SPRING BOX – RE-ASSEMBLING. Pack the spring with grease and insert it in the tube which should be held in the vice. Thread the rod through it till it projects beyond the guide bush, when the lock nut should be screwed on to retain it. Add the rear yoke and fully tighten it. Screw the lock nut further on till enough rod projects from it to fill the corresponding part of the front yoke. Screw this on till the rod is flush with its front face and then tighten the lock nut to the yoke – final adjustment is made on the machine (10.19.09).

.05 MIRROR BRACKET COUPLING – See 18.07.05C–D.

18.11.00 Air valve boxes

.01 It is essential that all valves and pistons should operate freely and yet provide adequate air-tight seals. For this reason, they must be always free from dirt, DRY and without either flat spots or high-spots. To maintain this condition, they must be occasionally stripped for cleaning and this must also be done when one is found to be the cause of a fault in the machine's function. Details are given below of removal of the assemblies from the machine and the methods of stripping each type, together with any special precautions required. As a general rule, when the components are dismantled, each should be washed in benzine, preferably with the use of a brush, and then dried with an air blast. Benzine and a bottle brush are the best methods of dealing with the bores for valves or pistons. To avoid the loss of small components, either spread them out, as they become detached, on a sheet of white paper on the bench, or provide one or two small tin boxes to act as temporary containers. On re-assembly, always be careful to see that each part is the right way up. If there is a trace of a burr or high-spot restricting movement, a skilled man should be able to improve the working by light application of a very fine abrasive, such as an Arkansas stone (for flat surfaces only) or metal polish, but anything coarser will prove detrimental, inducing scratches and consequent air-leaks.

.02A SINGLE-BORE VALVE BOXES – REMOVING. Situated

side by side at the front of the machine are the valve boxes for the quadder (left-hand) (5), motor stop (centre) (6) and character delete (right-hand) (7), attached to the intermediate stand and shielded by the front cover. At the rear of the machine the double justification valve box (10) is the left-hand one (as seen) – the smallest of the three side-by-side and similar in appearance to the first three. To remove, support the box and simply withdraw the four retaining screws, as the air streams are ducted directly into and out of the rear of the box, without external piping. The space cut-out valve box is carried by a bracket between the lock and feed and the space cam levers; it is connected by unions to four air pipes.

.02B SINGLE-BORE VALVE BOXES – REPLACING. Ensure that the mating surfaces of the pipeless boxes are perfectly clean, and check each with a straight edge for burrs or high spots – the latter may, in time, arise round the screw holes and they must be stoned down. Apply a smear of keyboard oil to one of the mating faces and replace the valve box with the cheese-headed screw at the top. In the case of every box, insert and lightly tighten all four securing screws; then fully tighten them all, working evenly and diagonally.

.02C SINGLE-BORE VALVE BOXES – DISMANTLING. Holding the box in soft grips in a vice, remove the large cheese-headed plug at the top (noting that it is a spring-abutment) and the hexagon-headed plug at the bottom; the cylindrical valve and spring can now be pushed out for cleaning (18.10.01). Note that the space cut-out valve box has two separate valves in the one bore.

.02D SINGLE-BORE VALVE BOXES – RE-ASSEMBLING. With all parts clean, and the box (in soft grips) in the vice, insert the hexagon plug in the bottom opening (this is the one nearest the central air duct at the rear of the box) and tighten it. Insert the valve, with its recessed spring-seating upwards. (In the space cut-out valve box, the larger valve occupies the upper position, and the projection of each points downwards.) Add the spring and then the top plug, ensuring that the spring seats correctly in each. When the top plug is tight, it should be possible to hear the valve strike it on recoil when the assembly is bumped down on to the palm of the hand.

.03 TWIN BORE VALVE BOXES. Except for the fact that each valve box has two parallel bores, both of which may need attention, these are similar in general operation to the single-bore valve boxes, and should be treated similarly. As seen from the rear of the machine, the signal combination valve box (8) is the right-hand one of the group of three and the character kill valve box (9) is the central one. Air-connections to both are by way of ducts in the main-stand. When removing a box, note which side is uppermost, and, when dismantling, note which valve occupies each position as they must not be interchanged. On re-assembly, check with the illustrations 12.16.03 and 12.19.05 and ensure that the springs are correctly seated.

.04A FAIL-SAFE VALVE BOX – REMOVING. (The official name of this assembly is 'Justification and Unit Drive Attachment'.) See that the **main air supply is turned OFF** [A]. Take off the constant air supply pipe (18) by undoing the union at the large brass elbow and the union to the valve box. Remove the two hexagon-headed screws holding the bracket, being careful of the washers underneath it. Manipulate the assembly of the valve box and bracket to the left (as seen from the rear) and upwards, to expose the air outlet pipe union (15) which must be disconnected. The valve box, still attached to the bracket and latch, can now be withdrawn to the rear, but handle the latch and spindle with care as they are liable to separate and fall into the machine.

.04B FAIL-SAFE VALVE BOX – REPLACING. Offer the assembly into a position where it is possible to see the connection to the air outlet pipe, attach the union and tighten it. Bring the assembly down on to the supporting pillars, taking care that the spindle is correctly held in its bearing supports, and lightly secure the two retaining screws, noting that each has a washer under its head and another between the pillar and the bracket. Trip both fail-safe plungers (11) into their operative positions. With the drive latches engaged, turn the camshafts to 270°. Now manoeuvre the bracket till there is just perceptible play between the fail-safe latch and the plungers when the constant-air valve (17) is in the right-hand position (as seen from the rear). Now fully tighten the bracket screws. Reset the two plungers and push the constant-air valve to the left (as seen). The mechanism is then ready for service.

.04C FAIL-SAFE VALVE BOX – DISMANTLING. With the assembly on the bench, remove the two screws holding the valve box to the bracket. Hold the box in soft grips in a vice and slacken the hexagon-headed stop screw, and the very short cheese-headed retaining screw (21). Holding the assembly in the hand, remove the cheese-headed screw and the spring (20) (which is under compression). Take out the hexagon-headed stop screw, enabling the valve to be withdrawn. With a probe, push the ball into the valve bore. Note – this ball is very small (about $\frac{3}{32}$ in (2 mm) diameter). The ball can now be shaken into the hand. Carefully wipe this clean and wash the other parts (18.10.01).

.04D FAIL-SAFE VALVE BOX – RE-ASSEMBLING. Offer the valve, dry, to its bore, with one of its smaller recesses registering with the ball hole; insert and tighten the

hexagon-headed stop screw. Holding the valve against this screw, insert the ball and then its spring and the cheese headed retaining screw (21) which must be tightened. Assemble the box to its bracket, doing up the two screws only lightly. Pull the box from the latch to the limit of the oval screw holes and gently press the valve in till it is felt that the ball is locating in the second recess. Advance the box on the bracket till there is just perceptible play between the latch and the valve when the latch is against its stop. See that the box is square to the bracket and then tighten the two screws fully. Finally, check that the clearance has been kept.

.05A ONE WAY BALL VALVE BOX – REMOVING. This is a small brass housing (3) at the front of the machine between the upper control panel and the quadder valve box, and is protected by the front cover. See that the air supply is **turned OFF** [A] and then release the housing by disconnecting the three air pipe unions.

.05B ONE WAY BALL VALVE BOX – REPLACING. This is a simple reversal of the procedure for removing – it does not matter which way round the housing is fitted. Make sure that the pipe unions are fully tightened, and that the housing is horizontal.

.05C ONE WAY BALL VALVE BOX – DISMANTLING. At the bench, remove one of the end unions, noting its internal countersunk seating for the ball; shake the ball out of the housing and undo the other end union.

.05D ONE WAY BALL VALVE BOX – RE-ASSEMBLING. Wash the metal parts in benzine and dry them, but only wipe the nylon ball clean. *Re-assemble the parts without lubricant.*

.06C AIR TOWER VALVE – DISMANTLING. This is readily done on the machine. With the air-supply turned OFF [A], raise the air bar (24) and undo the hexagonal (valve body) plug (28) that forms the base of the valve chamber. Withdraw the plug and the spring (27) which seats in it. Swing the air bar down and catch the valve ball (26) as it falls out. If the valve stem (23) does not follow, it may be pressed out from above with a piece of wire. Be careful of the neoprene ring (25) which forms the ball valve seating; if in good order, it should not be disturbed, but, if faulty, it may be hooked out for a replacement to be substituted. If all the detached parts are to be washed in a benzine bath and dried with an air blast, be careful that the ring is not lost. The valve-chamber also should be cleaned with benzine, by means of a brush and a piece of thin non-fluffy material and a wire.

.06D AIR TOWER VALVE – RE-ASSEMBLING. Check that the neoprene ring is correctly positioned and intact. Lightly lubricate the valve stem with keyboard oil and apply vaseline to the spring. Re-assembly is the reverse of dismantling, but note that it is the smaller end of the stem that contacts the ball.

.07A AIR TIMING BOX (UPPER) – REMOVING. Mechanically operated from the ratchet shaft, the mechanism, which is in two close-fitting sections, is situated at the front of the machine. For access, remove the front cover. Check that **electricity and air are both OFF** [E] [A] before disconnecting the three pipes carrying the *M(T)*, constant and *M* air streams; other air streams are internally ducted. By withdrawing the two long cheese-headed screws (32), release the *front section* (35) of the box which may be pulled off with its dowels. Another cheese-headed screw (34) is thus exposed, holding the *rear section* (33), undowled. Both sections may now be carried to the bench for stripping if necessary.

.07B AIR TIMING BOX (UPPER) – REPLACING. *(Rear section).* Carefully clean the rear locating face of the rear section of the box as this has to make an all-over air-tight joint. Check it with a straight edge and, if necessary, gently apply an Arkansas stone to any visible high-spot. Clean the corresponding face of the machine and give it a thin smear of keyboard oil. Place this section of the box in position and retain it with the single screw, moderately tight. Temporarily insert the other two screws which may be left loose. Turn the camshafts to 40° and check that the left-hand end of each lever is capable of passing both over and under the latch plate (31); when over the plate, and with the right-hand end depressed to a valve, the valve must still have some slight free travel – i.e., it is not bottoming. To achieve this, the rear section of the box can be fractionally moved about its securing screw; obtain the best average position, noting that when the latch is to the left (i.e. camshafts at 280°), it must clear the lever-ends, but the adjustments detailed in 18.11.07E may be required to perfect the setting after the whole assembly has been restored. Tighten the retaining screw and remove the other two before cleaning the front face. *(Front section).* Add the front section of the box, pressing home its dowels and noting that the levers can pass under and over the latch plate, with valve-clearance (as above), before tightening its two long screws. Reconnect the three air pipes and restore the front cover.

.07C AIR TIMING BOX (UPPER) – DISMANTLING. *(Front section).* Take out the grub screw retaining the fulcrum pin. When the pin is withdrawn, the levers are released, but note (for replacement) their relative positions. From the top of the assembly extract the two plungers (41), two springs and two pistons (38). Place the section in a vice, carefully protecting the ground face. Take out the two brass hexagons, noting that one is simply a plug (37). Detach the base plate by undoing its four cheese-headed screws,