TECHNICAL INSTRUCTION
F.4

Auricon Cinevoice 16-mm Motion-picture Camera

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AMENDMENT RECORD

Amendment Sheet No.	*Initials*	*Date*	*Amendment Sheet No.*	*Initials*	*Date*
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AURICON CM-72 CINEVOICE 16-mm MOTION-PICTURE CAMERA

SECTION 1

INTRODUCTION

The Auricon CM-72 Cinevoice camera as used within the BBC is a cine camera using 16-mm stock running at 25 frames per second, with a fixed exposure time of 1/50 sec approximately; it has also facilities for recording a combined magnetic sound track. The camera and associated equipment is light, and readily transportable. It uses 400-ft film magazines, and operates from a d.c. supply at 12 volts. The camera has a three-lens turret for standard C-mount lenses, and a parallax-corrected turret viewfinder is normally fitted. The finder is an integral part of the side door of the camera, but this door can be replaced by a plain door when a lens which has an integral viewfinder arrangement is used. The sound apparatus is battery-operated, and housed in a single box which has a shoulder strap so that the equipment can be operated at hip level.

The equipment is normally carried in two cases, one housing the camera and magazines, and the other the sound equipment and miscellaneous items. The items comprising a complete channel are listed in the Appendix.

The camera as at present used by the BBC has been extensively modified, and differs appreciably from the basic camera. Use is sometimes made of similar cameras obtained from other organisations, and these cameras may differ somewhat from those owned by the Corporation. A survey of the development of the successive modifications to the basic camera is given below, and this indicates the other versions of the camera which may be met.

The Cinevoice camera as manufactured is designed to operate with 100-ft daylight-loading spools which are housed within the body of the camera. The motor is designed for operation from 117-volt a.c. power supplies; 50-c/s and 60-c/s versions of the motor are fitted according to requirements. Additionally the motor may be of the constant-speed or synchronous type as required. Operation from batteries is obtained by means of a portable power supply unit (PS-14), four versions of which are available to suit inputs at 6 or 12 volts and provide outputs at 50 c/s or 60 c/s. The basic version of the camera can be obtained for single-lens mounting or with a three-lens turret. The sound system may be combined optical variable-area, combined optical variable-density or com-

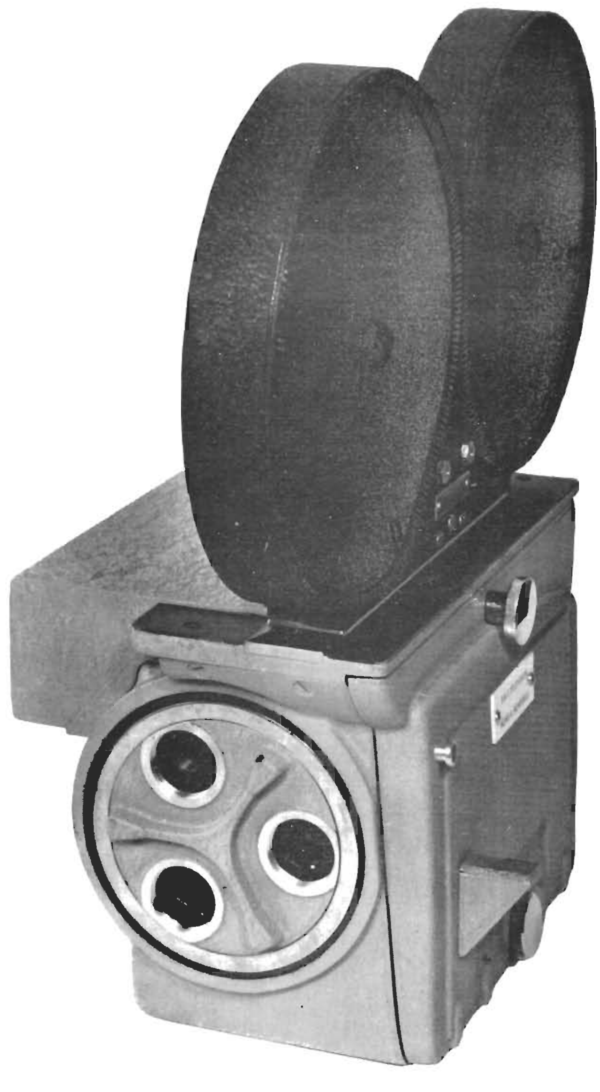


Fig. 1.1. Auricon Cinevoice Camera

bined magnetic stripe, and the corresponding sound amplifiers are RA-31-7A (optical) and NR-25 (optical, with noise reduction) or MA-10 (magnetic). All three types of amplifier are operated from internal dry batteries.

For professional use many of the cameras as originally produced are modified by an independent company. This modification entails removal of the top section of the body, and the fitting of a top plate on which a standard 400-ft Mitchell magazine is mounted. Two variants of this type of camera exist, one with a slipping-belt drive for the take-up spool, and one with an additional 117-volt motor for the same purpose. Modified cameras of this type are used extensively for newsreel work.

For BBC use a further series of modifications is made. The chief of these involve a change to operation with a 12-volt d.c. supply. A 12-volt motor replaces the 117-volt motor, and the drive to the take-up spool is via a slipping clutch, and a belt. The optical sound-head equipment is removed, and in the space left a magnetic sound-recording head is mounted. To minimise wow and flutter a secondary sprocket drive is inserted between the intermittent film pull-down mechanism and the sound-head, and a flywheel-loaded roller and compliance arms are used in the film path. To complete the modification a transistor sound-recording amplifier (AM15/502) is used, operating from internal batteries. This is designed to work with the standard BBC range of microphones.

A further modification may be met, in the addition of a reproducing head to the camera. When such a head is fitted the amplifier used is a Mark II version of the AM15/502. The description of the camera which follows is applicable to the single-head version only, although both versions of the AM15/502 amplifier are described.

Two different basic versions of the camera are used by the BBC. Whilst mechanical construction is similar in the two models, the later one has a larger lens-turret plate. The body castings also differ in that the earlier model is straight-sided, whilst the later version is flared, on one side to accommodate the new lens-turret. The later version of the camera is shown in Fig. 1.1. Apart from these differences the two versions are similar, and the following description applies to both.

SECTION 2

ELECTRO-MECHANICAL ASSEMBLY AND ATTACHMENTS

2.1 General Description of Camera

The body of the camera is a single casting (7, Fig. 2.1), forming the front, bottom, back and one side of the unit. The door on the open side of the body (8, Fig. 2.1) is held in place by captive screws, and gives access to the film-transport mechanism and the film gate. Two versions of the door are available, that shown in Figs. 1.1 and 2.1 being a plain door which is fitted when using lenses having integral viewfinders. The other version has a moulding carrying a turret viewfinder. The top of the body is closed by two plates, one serving as a magazine platform (6, Fig. 2.1), and the other as a cover for the motor compartment (3, Fig. 2.1). The body is lined with sponge rubber to reduce sound radiation from the camera.

Within the body is a main vertical dividing member, the mechanism plate (5, Fig. 2.1), shown in Fig. 2.2. This plate is attached to the main body by three screws, with rubber grommets between the screws and the mechanism plate. Attached to the front of the plate is a sub-assembly comprising the lens turret and film aperture plate, shown detached at 11, Fig. 2.1. This sub-assembly is held in place by two screws, which are accessible through the lens-mounting holes when the turret is rotated to a position intermediate to any of its stop positions. The screws extend through a mounting plate on which the film aperture plate is supported.

The rear face of the turret is undercut to admit a circular raised portion of the mounting plate, and spaced at 120-degree intervals around this raised portion are radial slots. Seated in each slot is a disk to which radially outward thrust is applied by a W-spring located in an edgewise groove. These three disks bear on the rim face of the turret undercut, and act as bearings when the turret is rotated. At stop positions, the disks seat in arc-shaped indentations to lock the turret in place.

In later models the turret and mounting plate are concentric, the radius of the raised portion of the plate being only slightly smaller than that of the turret. Motion of the turret away from the plate is prevented by a flanged phosphor-bronze retainer surrounding its periphery. The outer rim of the retainer is grooved to hold a rubber ring, which forms a light-tight resilient seal between the turret assembly and the camera body, and also reduces appreciably the radiation of noise from the mechanism.

In early models, the raised portion of the mounting plate is off-centre and appreciably smaller than the turret. A flange retainer is not used. The turret is retained in position by a screw passing through the centre of the turret and the centre of the raised portion of the mounting plate, with spring washers between the head of the screw and the turret. The turret is thus off-centre with respect to the mounting plate. The resilient rubber sealing ring fits in a groove around the periphery of the mounting plate.

Fixed to the mechanism plate are a motor plate (4, Fig. 2.1 and 5, Fig. 2.2) and a flywheel plate (8, Fig. 2.2). These lie in the same plane, parallel with the mechanism plate, on the side remote from the film-transport mechanism. The motor plate carries the driving motor (1, Fig. 2.1), a number of shaft bushes, and a mounting for the film-footage counter (2, Fig. 2.1). On the flywheel plate is the magnetic sound-recording head (11, Fig. 2.2) together with the flywheel roller (9, Fig. 2.2), compliance arms (12, 13 Fig. 2.2) and a guide roller (10, Fig. 2.2), all of which protrude through clearance holes in the mechanism plate.

The driving motor is of the permanent-magnet type, fitted with a governor and identical with the motor used in the early L2 tape recorder. Its supply is connected via a three-pin recessed socket and made through a single-pole switch in the positive supply lead. The motor is fitted with a bracket, which is in turn fastened to the motor plate by four screws. Rubber grommets are interposed between the bracket and the fixing screws to provide a resilient mounting (see Fig. 2.3).

The motor governor is of the centrifugally-operated (Creed) type, arranged to control the motor current. For this purpose two resistors connected in series with the armature windings are carried by a plate on the armature. In parallel with these resistors are spring-loaded contacts which remain closed until the motor runs up to speed. The centrifugal force acting on two weights then forces the contacts open, and with the resistors in circuit, the motor speed falls. This causes the contacts to close again, and the motor speed rises. Thus the motor speed hunts between fairly narrow limits, producing a substantially constant-speed drive. The governed speed can be altered by adjusting the tension of the contact springs, and this can be done on removing the plate giving access to the governor mechanism, as shown in Fig. 2.3. When the plate is removed, the motor can be rotated by hand to expose two screws that provide for individual adjustment of the spring tensions. One of the screw heads can be seen at 5, Fig. 2.3.

Drive from the motor shaft is transmitted to a large gear wheel via a cushion drive. This drive can be seen in Fig. 2.3. A collar, clamped to the motor shaft, is coupled to a gear wheel, which is free to rotate on the motor shaft, via two spring arms. Limit stops are provided by a fixed pin in the face of the collar projecting into a cut-away portion of the boss on the gear wheel. If the gear wheel attempts to rotate too far with respect to the

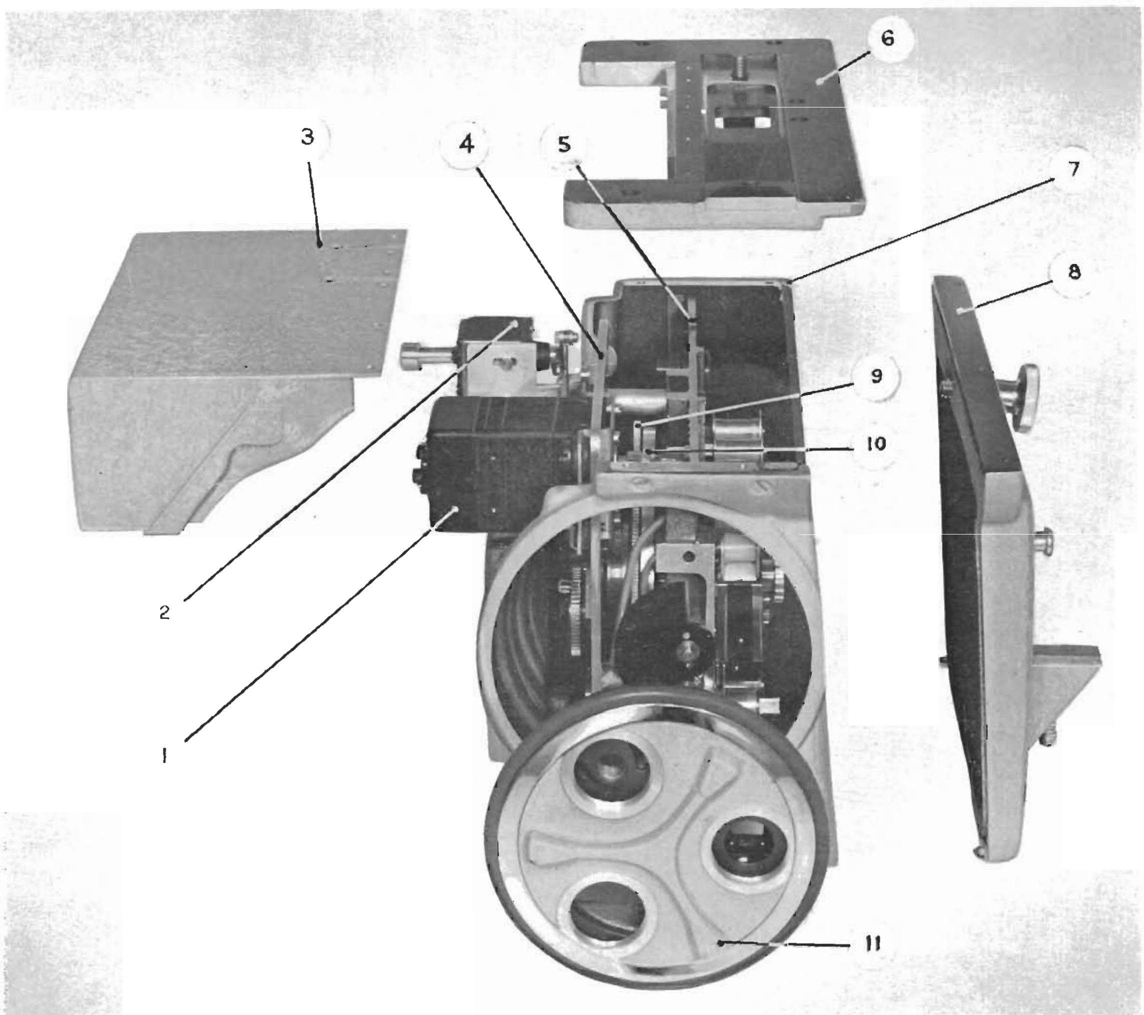


Fig. 2.1. Auricon Cinevoice Camera: Exploded View

1. Motor 2. Film-footage Counter 3. Motor Compartment Cover 4. Motor Plate 5. Mechanism Plate 6. Magazine Platform 7. Main Body Casting 8. Door 9. Large Gear Wheel 10. Flywheel on Main Shaft 11. Lens Turret Sub-assembly collar, this pin strikes the face of the cut-away portion and prevents further relative rotation.

The large gear wheel (9, Fig. 2.1) has a central boss, and is free to rotate on the main shaft (see Fig. 2.4); the bush also carries the drive pulley for the belt drive to the take-up spool, referred to later. The large gear wheel drives a flywheel (10, Fig. 2.1), secured to the main shaft, via a resilient coupling. The flywheel has four holes through its

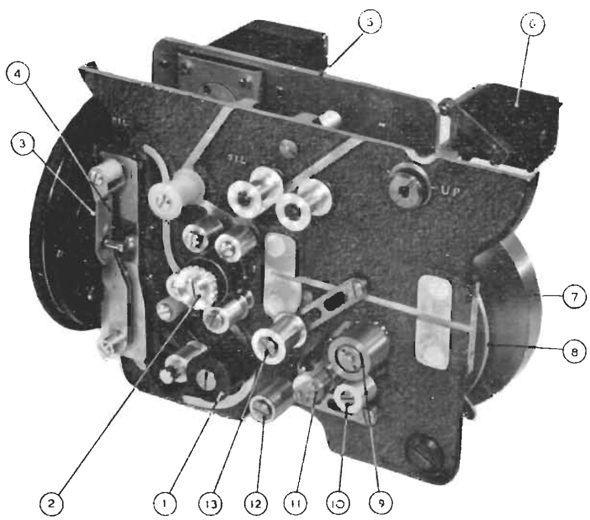


Fig. 2.2. Mechanism Plate

1. Secondary Sprocket 2. Main Sprocket 3. Pressure Plate 4. Spring-pressure Arm 5. Motor Plate 6. Film-footage Counter 7. Flywheel 8. Flywheel Plate 9. Flywheel Roller 10. Guide Roller 11. Magnetic Sound-recording Head 12 and 13. Compliance Arms

face, and two of these are fitted with rubber grommets engaging pins on the face of the large gear wheel. The main sprocket (2, Fig. 2.2), is fixed solidly on the main shaft, and the secondary sprocket (1, Fig. 2.2), is driven via a 1 : 1 gear train as shown in Fig. 2.4.

The large gear wheel also drives the shutter and intermittent film-transport mechanism via a gear wheel on a lay shaft, which can be seen in Figs. 2.5 and at 9, Fig. 2.6. The lay shaft carries a helical gear (8, Fig. 2.6), which provides the drive to the shutter and the intermittent film pull-down mechanism. The shutter is fixed to a second helical gear wheel meshing with the first, and is mounted on a pin (4, Fig. 2.6) in the mechanism plate; the pin also serves to locate the lens turret. With suitable meshing of the helical gears the film-transport action is masked by the shutter intercepting the light path.

In the face of the helical gear (8, Fig. 2.6) on the lay shaft is an off-centre hole to accommodate a peg on a claw mechanism (7, Fig. 2.6) providing the intermittent film drive as the helical gear wheel rotates. After the pin on the helical gear wheel has passed top dead-centre, the claw is progressively advanced through a slot in the film aperture plate into engagement with a film sprocket-hole. During further movement the claw draws the film downwards, until it leaves the sprocket hole as the pin approaches bottom dead-centre. During the return of the pin to top dead-centre the claw is reset for a further traversing motion. The claw is part of an arm with its lower end moving in a slot (6, Fig. 2.6) machined in the mechanism plate. The mechanism-plate slot is bridged by a guide pin passing through an elongated

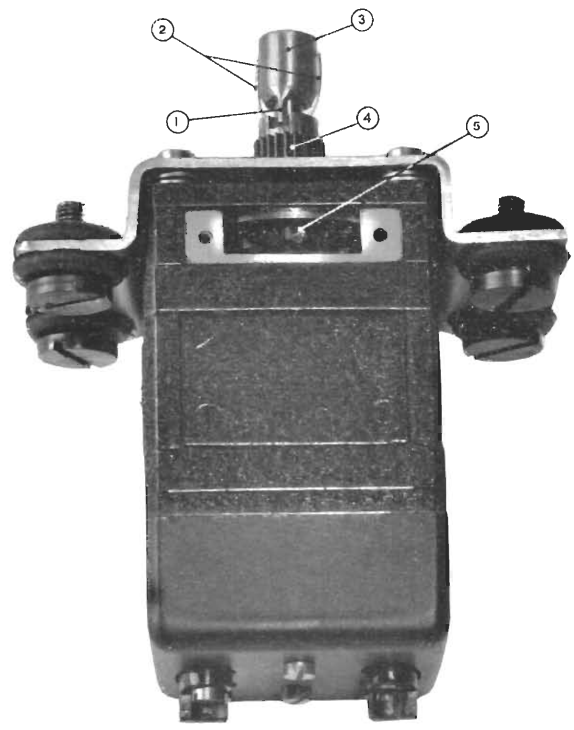


Fig. 2.3. Motor with Governor Control Cover-plate removed

1. Limit Pin 2. Spring Arms 3. Collar (fixed) 4. Gear Wheel (free) 5. Governor Speed-adjusting Screw

slot in the arm and this provides for correct motion of the claw.

Bearing on the back of the film are the edges of two plates (5, Fig. 2.6) with which pressure is

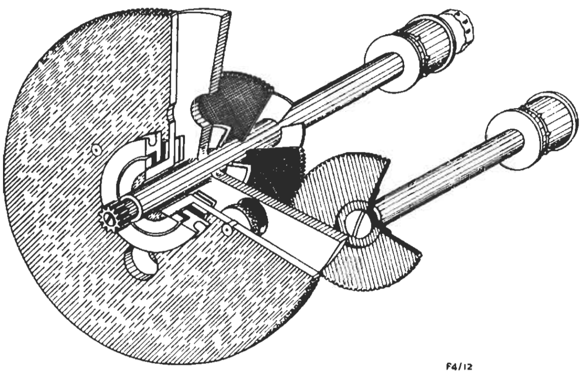


Fig. 2.4. Cut-away View of Main Shaft

applied at both sides of the sprocket-hole track. The plate edges extend over the range of action of the claw and assist in obtaining uniform pull-down.

The film take-up spool is belt-driven from a pulley (3, Fig. 2.6) coupled to the large gear wheel

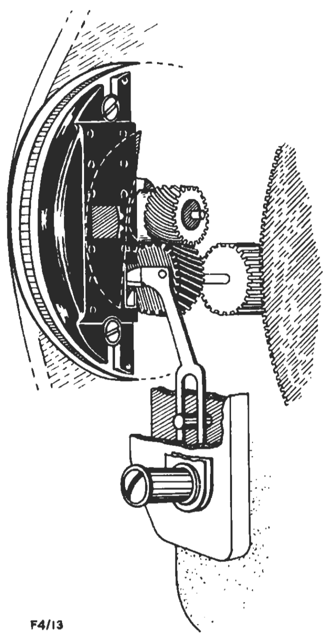


Fig. 2.5. Cut-away View of Shutter and Film-transport Mechanism

via a slipping clutch. The components of this clutch can be seen in Fig. 2.4. The central boss of the large gear wheel is threaded at one end and on it the pulley is free to rotate, although clamped between two felt disks as shown. The clutch tension is adjusted by the threaded disk which bears on the outer felt disk. A channel-section retainer for the belt is fixed to the motor plate, and this ensures that the belt when slack is retained in approximately the correct position. The belt passes through two slots in the motor cover top-plate and over the external drive pulley for the take-up spool of the film magazine.

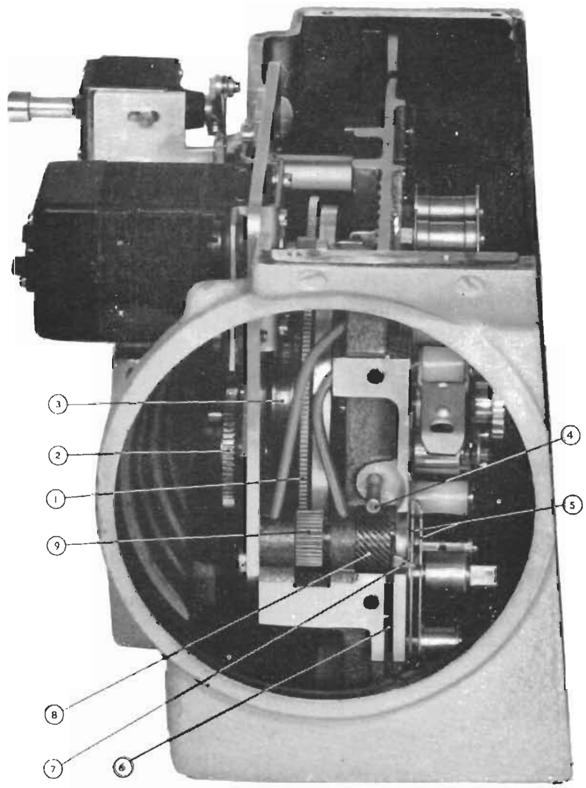


Fig. 2.6. Front View of Camera, with Lens Turret removed

1. Large Gear Wheel 2. Gear Wheel operating Film-footage Counter 3. Drive pulley for Take-up Spool Belt Drive 4. Shutter Mounting Pin 5. Sprocket-hole Track Pressure-plates 6. Slot in Mechanism Plate accommodating Claw Arm 7. Film Claw 8. Helical Gear 9. Shutter-driving Gear on Lay shaft

At the end of the main shaft, remote from the main sprocket, is a small gear wheel driving a larger gear wheel (2, Fig. 2.6); the latter is mounted on the motor plate. This gear wheel carries a pivoted boss to which is attached a spring-loaded link, the whole forming a reciprocating mechanism for operating the film-footage counter.

The path of the film through the camera can be seen from Fig. 2.7. The film is supported off the surface of the aperture plate by two vertical rows of steel balls. These are inserted from the rear of the plate and fixed so that they stand proud of the front to the extent of 4 mils. On the opposite face of the film a spring-loaded plate (3, Fig. 2.2) is used to apply pressure in line with the two rows of steel balls. The plate also carries a single,sunken, steel ball above the gate aperture, to apply pressure at the centre of the film and thus prevent it from bowing.

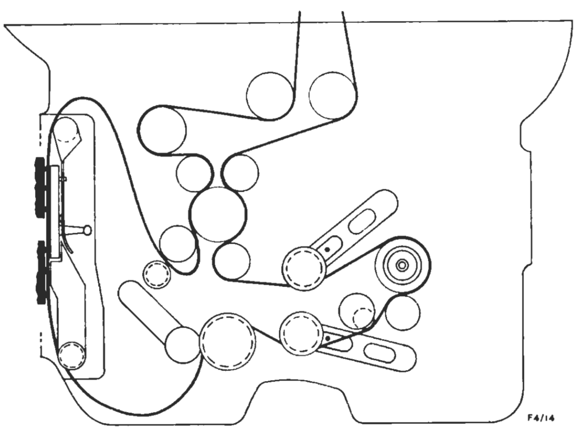


Fig. 2.7. Film Lacing Diagram (Single Sound-head Version)

To minimise wow and flutter on the sound track, the film path past the recording head embraces two compliance arms (12, 13, Fig. 2.2) and a fly-wheel-loaded roller (9, Fig. 2.2). The roller and the flywheel (7, Fig. 2.2) are at opposite ends of a shaft carried in a twin-bearing on the flywheel plate. The flywheel plate also carries the sound recording head and the compliance arms. The latter are slotted, to engage pins in the mechanism plate. In lacing the film care must be taken to ensure that, under equilibrium conditions, the limit pins are as near to the centre line of the slots as possible.

2.2 Motor Control and Supply

The motor is driven by a 12-volt battery. The battery leads terminate in a three-pin Cannon plug which engages with a socket (XL-3-14) at the side of the camera. The motor control-switch, at the rear of the camera, is connected in series with the positive pole of the battery supply.

2.3 Connections to Camera

The camera has two connectors, one for the motor battery-supply and the other for the signal connections to the recording system and the head-phones jack.

The battery plug is type XL-3-14, and connections to the pins are as follow:—

Pin	*Circuit*
1	12V +
2	12V –
3	Frame

If a recording head only is fitted, the signal socket is a four-way type XL-4-13. Connections to the pins are as follow:—

Pin	*Circuit*
1, 2	Headphones
3, 4	Recording head

If recording and reproducing heads are fitted, the signal socket is a six-way type EM-6-13. Connections to the pins are as follow:—

Pin	*Circuit*
1, 2	Reproducing head
3	Recording head
4, 5	Headphones: Pin 5 connected to frame
6	Recording head

2.4 Viewfinder

The viewfinder is a standard Bell and Howell turret having four positions, which hold view-finder lenses appropriate to the range of lenses in use. The viewfinder is housed in an enclosure which forms an integral part of the door of the camera. Parallax correction is provided by adjusting the angle of sight of the viewfinder lens relative to that of the main lenses in use. Adjustment of parallax correction is made by varying the position of the viewing tube which moves horizontally in a slot having a distance scale along the edges.

2.5 Lenses

A range of Taylor, Taylor and Hobson lenses in C-mounts is available for use with the camera, and zoom lenses are also available. The normal complement of lenses depends on local require-ments, and is usually about six. If a zoom lens is available, the complement is usually smaller. The range of focal lengths of fixed-focus lenses in inches is 0·7, 1, 2, 2·8, 4, and 6. The zoom lens is normally the Angenieux 17–68 mm type, and, when used, the lens complement is usually completed by a 1-in. lens (wide angle) and a 6-in. lens (narrow angle).

Both the Angenieux and Berthiot zoom lens have integral viewfinders. The viewing tube extends to the side and rear of the lens, and would foul the normal viewfinder supplied. When a zoom lens of this type is used, the camera door carrying the viewfinder is replaced by a plain door which does not obstruct the lens viewfinder tube. The door has additionally a bracket to support the viewfinder tube, to ensure accurate registration of the viewfinder image with that in the camera gate.

On a number of cameras where a zoom lens is frequently used the lens turret is locked in one fixed position. In earlier models the turret plate and the mounting plate are drilled to take a nut and bolt which prevent rotation. In later models the turret mounting plate has a tapped hole visible through the highest-position lens holder (see Fig. 1.1). A bung with a threaded spigot fits into this unused lens holder, the thread of the spigot engaging the tapped hole. When screwed fully home, the bung prevents rotation of the turret, and so ensures that it does not slip under the weight of the lens or the torque of the operating lever.

2.6 Lens Hood and Filters

A range of lens hoods and filters are available; these are attached to the lens direct. The complement of these items is determined by local requirements.

2.7 Magazines

The magazines are standard 400-ft Mitchell magazines, modified by a change to the external drive pulley of the take-up spool.

The front of the foot of the magazine has a toe portion which engages with a retainer at the front of the locating groove of the camera magazine platform. A single captive screw projecting through the locating groove fastens the magazine in the operating position.

Entrance to the separate feed and take-up compartments of the magazine is gained by releasing the individual covers, which have threaded rims.

SECTION 3

ROUTINE MAINTENANCE NOTES

3.1 General

The regular maintenance required comprises cleaning and oiling. The camera should be cleaned at frequent intervals to remove dust and film emulsion. Particular care should be exercised to see that the sprockets and gate are kept clean. The balls which apply pressure to the film in its passage through the gate should be kept scrupulously clean. Obstinate deposits of dust and emulsion which cannot be removed by brushing with a soft-haired brush or cloth should be attacked with a sharpened soft-wood tool. Under no circumstances should a metal tool or knife be used for this purpose.

Cameras and viewfinder lenses should be cleaned as required with a soft-hair brush or a cloth of well-washed cambric or fine linen. Additionally, the threads of lens mounts should be kept clean and free of dust particles.

Oiling is required at five points only, accessible when the side door of the camera is opened. The oiling ducts are indicated by red spots at the mouths and the correct lubricant is standard machine oil. Care should be taken to ensure that the nylon pinions are at all times free of oil, as otherwise noisy running will occur.

If the motor governor requires adjustment, care must be taken to ensure that the settings of both spring-tension adjusting screws are altered by equal amounts.

3.2 Dismantling and Reassembly Procedure

3.2.1 Dismantling

The procedure for dismantling the camera is:

1. Take off the camera door by releasing the two captive screws. Take off the motor compartment cover. Release the top screw fastening the mechanism plate to the bracket of the top cover. Take off the top cover, by releasing the four Allen screws. Remove the film-gate pressure plate.
2. Rotate the main sprocket by hand and observe the rotation of the shutter blade through the film gate aperture. Set the sprocket so that the shutter blade is not visible and the sprocket is mid-way between the positions it takes up when the shutter is just opening and just closing.
3. Rotate the lens turret until the two mounting-plate retaining screws are visible. These are situated in the vertical line of the mechanism plate.
4. Release and remove the turret mounting screws. Ease the turret assembly forward gently; pressure may be applied to the rear rim of the mounting plate. If the shutter blade has been correctly positioned, the turret assembly will slide clear leaving the shutter on its mounting pin. If, however, the shutter blade has been set incorrectly, it will be fouled by the film gate as the turret assembly is withdrawn. Remove the shutter.
5. Release the two remaining screws fastening the mechanism plate to the camera body, and remove the mechanism plate by lifting it vertically from the body. As the body is lined with sponge rubber, there may be some frictional resistance. As the mechanism plate is lifted, the shutter mounting pin will tend to foul the edge of the body, so that it is necessary to tilt the mechanism plate to complete the withdrawal process.

3.2.2 Reassembly

The procedure for reassembly is as follows:

1. Insert mechanism plate into camera, tilting the plate forward if necessary to allow the shutter mounting pin to clear the body. When the mechanism plate is in position, insert and tighten the two bottom fixing screws.
2. Replace the top cover, and insert and tighten the four Allen screws. Locate and tighten the fixing screw between the mechanism plate and the bracket on the top cover.
3. Place the shutter and spacing washer on the shutter mounting pin, and move the shutter

along the pin until the helical gears are fully meshed. Check the phasing of the shutter by rotating the main sprocket, and observe the shutter blade motion. As the shutter blade rises to the position of the film gate aperture the blade must not foul the film claw mechanism, and should travel upwards so that the aperture is covered before the claw moves into the film path. Correspondingly, at the end of the shutter-closed period the claw should not foul the shutter blade, and should be clear of the film path before the aperture is uncovered. If necessary, readjust shutter gear meshing to achieve this.

4. Set the shutter so that it does not foul the edge of the lens turret on fitting. Replace the lens turret, and insert and tighten the two fixing screws. On later models the rubber ring around the turret may be placed in position after the turret has been replaced, and worked home with the fingers. On earlier models the turret overlaps part of the rubber-ring seating, and the ring must be fitted to the turret before reassembly.

5. Replace the motor compartment cover, re-threading the take-up pulley belt through the slots in the cover.

6. Replace the camera door.

SECTION 4

SOUND APPARATUS

4.1 Introduction

The sound apparatus comprises a magnetic-recording amplifier (AM15/502) and associated equipment, designed to feed a recording head and cameraman's headphones at the camera. The amplifier is fully transistorised, and works from an internal 12-volt battery. The amplifier case has a shoulder strap to enable the sound recordist to carry and operate the unit with the controls at hip level. Provision is made for mixing the outputs of two microphones; the input circuits are designed to operate with microphones of 30 ohms impedance. An input at zero volume can also be accepted, this being fed into the input of the second microphone channel via an attenuator pad. In addition to the outputs to the camera, there is a headphone-monitoring output from the amplifier, and a low-level output for feeding an L2 tape recorder.

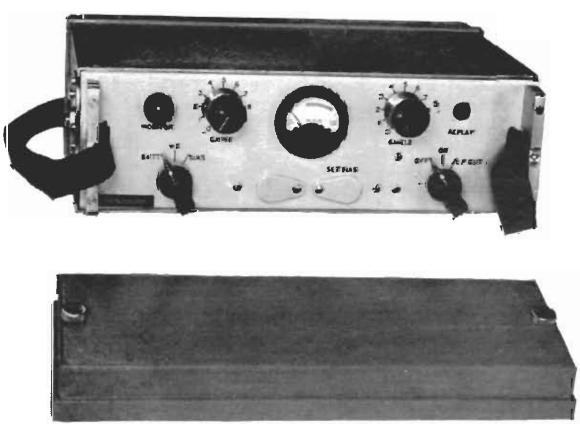


Fig. 4.1. Top View of AM15/502, Mark I, with Cover removed

Two versions of the amplifier AM15/502 exist. Mark II differs from Mark I by the addition of a playback head amplifier which is used when a reproducing head is fitted on the camera.

The controls at the amplifier comprise *Gain* controls for the two input signals, an *On/Off/LF Cut* switch, a *Set Bias* control for the h.f. bias, a pre-set gain control for the headphone output, a selector switch for the panel meter and a pre-set control of meter sensitivity. By means of the

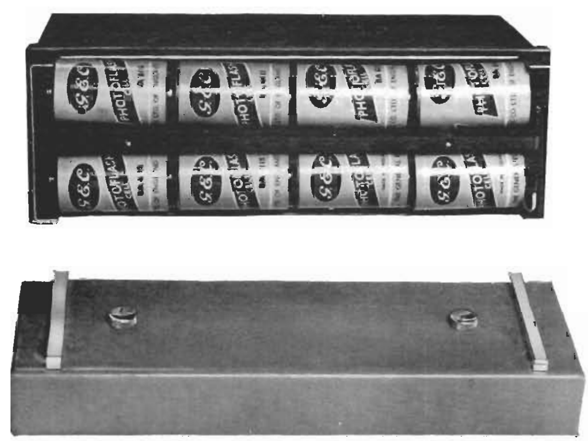


Fig. 4.2. Bottom View of AM15/502, with Cover removed

selector switch the meter can be set to check the bias current and battery voltage or to function as a volume indicator.

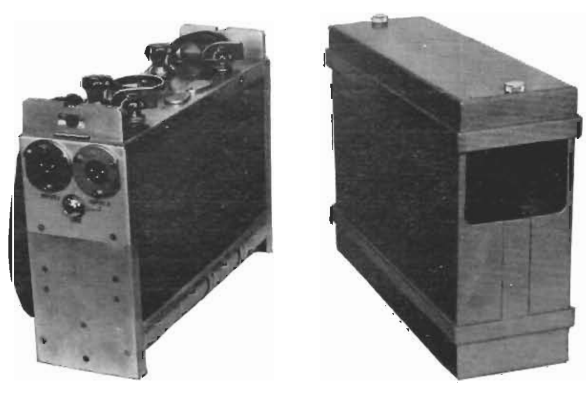


Fig. 4.3. AM15/502, with Covers removed

In addition the Mark II models have a direct/replay switch to feed the monitor amplifier from either the signal to the recording head or the signal from the reproducing head.

The overall dimensions of the amplifier case are $10\frac{1}{2}$ in. by $8\frac{1}{4}$ in. by $3\frac{1}{2}$ in., and its weight with battery fitted is $8\frac{1}{2}$ lbs. Top and bottom views of the amplifier are shown in Figs. 4.1 and 4.2, and a view of the amplifier with the case removed is given in Fig. 4.3.

The following description applies to the Mark I version; details of differences in the Mark II version are given later.

4.2 AM15/502 Mark I. General Description

The circuit components of the AM15/502 are mounted on three printed-circuit cards, designated *Bias Oscillator* card, *Record Amp.* card and *Monitor Amplifier* card. Additionally, controls and switches are mounted on the front panel of the unit. Wiring between the printed cards and other components is by means of flexible connectors made up in cable forms. The layout of the cards and other components can be seen in Fig. 4.4. The battery

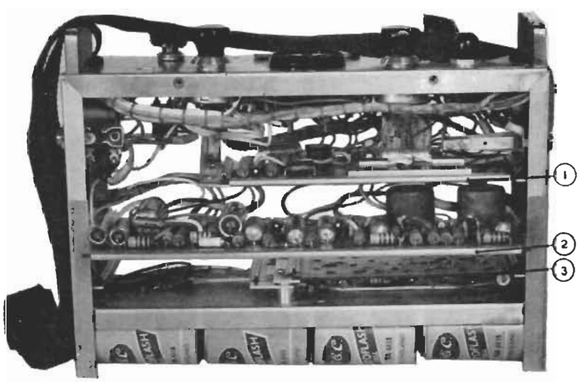


Fig. 4.4. AM15/502, Mark I. Internal View

1. Bias Oscillator Card 2. Record Amplifier Card 3. Monitor Card

comprises eight 1·5-volt (U2-size) cells which are housed in a compartment at the bottom of the case. The unit has top and bottom covers enclosing the front panel and the battery compartment respectively, each cover being held in place by two captive screws.

A block schematic diagram of the sound apparatus is shown in Fig. 4.5. Detailed circuit diagrams, component layouts, and wiring details are shown in Figs. 1 to 3. The two microphone circuits are brought to three-way recessed input plugs, and each feeds an input transformer. The inputs are not earthed, and designed to work from a source impedance of 30 ohms. Across *Input 2* is bridged the output of an attenuator pad, which is fed from the *Line* input jack. The pad attenuates a zero-volume input signal to a level suitable for feeding the microphone amplifier.

The outputs from the microphone transformers are fed to individual single-stage amplifiers, and the outputs of these amplifiers are fed to the sliders of the *Gain 1* and *Gain 2* controls. The outer ends of the gain controls are common and the combined output is fed to a further single-stage amplifier. This amplifier stage has a frequency response rising at high frequencies to provide part of the pre-emphasised recording characteristics. The output from this stage is fed to one pole of the *On/Off/LF Cut* switch. At the *On* and *Off* positions the signal is fed directly to the subsequent stage, and in the *LF Cut* position a low-value coupling capacitor is brought into circuit to attenuate low frequencies.

The subsequent amplifier section is a two-stage amplifier feeding the recording head. Negative feedback is applied over the two stages, and a shunt capacitor is used in the feedback chain to provide a frequency response rising at high frequencies. The overall high-frequency boost provides the required recording characteristic.

The output to the recording head at the camera is fed via two pins of a four-way recessed socket. The bias signal is injected in series with the a.f. signal by means of a coupling winding from the bias oscillator coil; the bias oscillator employs two transistors in a push-pull circuit. A low-impedance path for the bias signal is provided by C16; R33 serves to isolate the a.f. amplifier from the bias supply. The a.f. signal current through the head flows in resistor R10, and the voltage thus developed is fed to the monitoring amplifier. This is a three-stage amplifier providing the headphone-monitoring outputs. The amplifier has a falling high-frequency response to offset the high-frequency boost employed in the recording chain. The level of the output is controlled by the *Monitor* control, from the slider of which the signal is fed to the *Phones* jack, and also to the monitoring jack at the camera, via the four-way connector. The *Phones* jack has an auxiliary contact which breaks the battery supply to the amplifier when the headphone plug is removed from the jack.

The output of the a.f. amplifier is also fed to a single-stage amplifier feeding a bridge rectifier. The output from this bridge is connected to the panel-mounted meter at the *V.I.* position of the meter control switch, and thus gives an indication of the recorded signal volume. The meter is not scaled, but has a green sector. For correct operation the meter pointer should kick up to the middle of the green sector on signal peaks. As the amplifier feeding the bridge rectifier does not have a logarithmic characteristic the meter-pointer movements are different from those which would be obtained on a PPM.

from the input to the final a.f. amplifier in the recording chain, through an attenuator pad feeding a jack designated *L2*. Because of the high-frequency boost applied to the a.f. signal in the preceding stage, the attenuation of the output to the L2 recorder is made to rise with increasing frequency, by means of a shunt capacitor across the output; the overall high-frequency response is thus maintained substantially level. This output is taken from a point subsequent to the *LF Cut* switch, which is thus effective on the feed for an L2 recorder. The output impedance of this signal source is approximately 600 ohms.

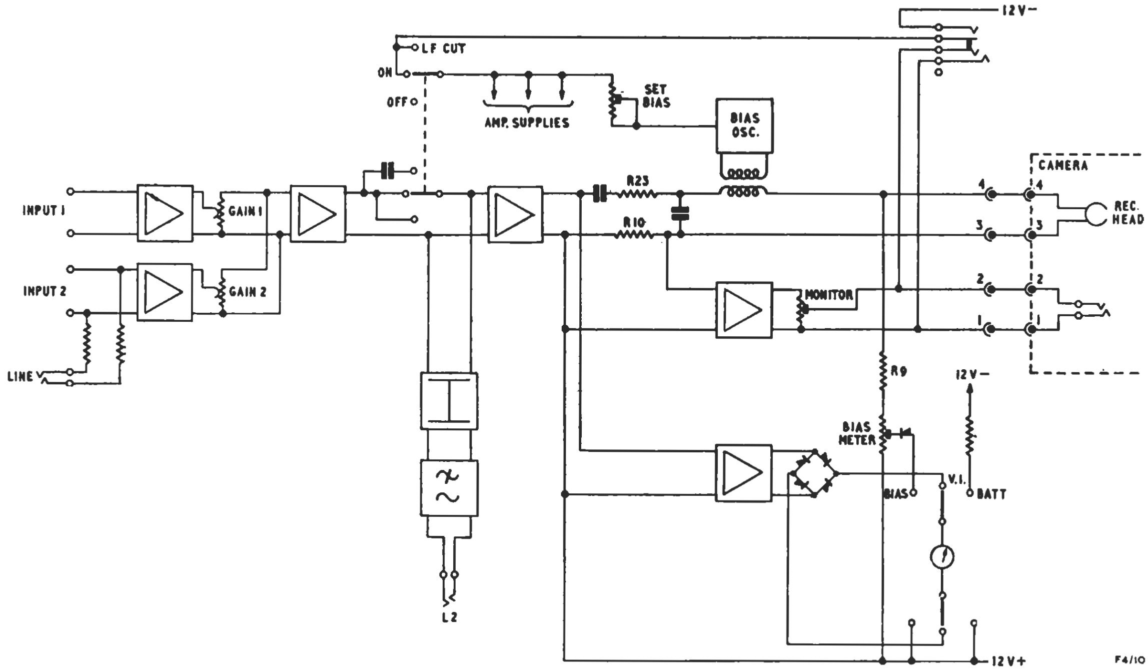


Fig. 4.5. AM15/502, Mark I, Schematic Diagram

The meter may also be used to check battery voltage and the bias-signal magnitude. At the *Batt.* position of the meter control switch the meter is connected in series with a resistor to check the battery voltage. The battery should be changed when the meter reading falls below the edge of the green sector. At the *Bias* position of the control switch the meter indicates the magnitude of bias signal developed across the lower section of the *Bias Meter* voltage divider (Fig. 3), connected in series with R9 (bias oscillator circuit of Fig. 2) across the output to the recording head. In the absence of modulation, the meter pointer should be set to the lower edge of the green sector by adjustment of the *Set Bias* control. The *Bias Meter* control is pre-set so that this meter indication is obtained when the bias voltage is at the optimum value.

An output for an L2 tape recorder is provided

Connections to Amplifier

In normal use a single four-way connector couples the sound amplifier to the camera. The four wires comprise two circuits, one carrying the signal to the recording head and the other the feed for the cameraman's headphones. The output is taken via a four-way Cannon plug type XL-4-14. The circuits at the pins are as follow:

Pin	*Circuit*
1, 2	Headphones
3, 4	Recording head

Microphone input signals are fed via 3-way Cannon plugs type XL-3-14. Pin 1 is earthed, and pins 2 and 3 are used for the signal input. The signal to the L2 recorder is fed via a Bulgin jack type J2, the line-input jack is Bulgin type J16, and the headphone-output jack is Bulgin type J17.

AM15/502 Mark II

The AM15/502 Mark II differs from the Mark I in the following respects:

(*a*) A playback head amplifier for the reproducing head is fitted.

(*b*) A direct/replay switch for the input to the monitoring amplifier is fitted.

(*c*) The four-way plugs, sockets and cable linking the amplifier to the camera are replaced by six-way elements. The two additional leads are utilised to connect the reproducing head to the replay head amplifier.

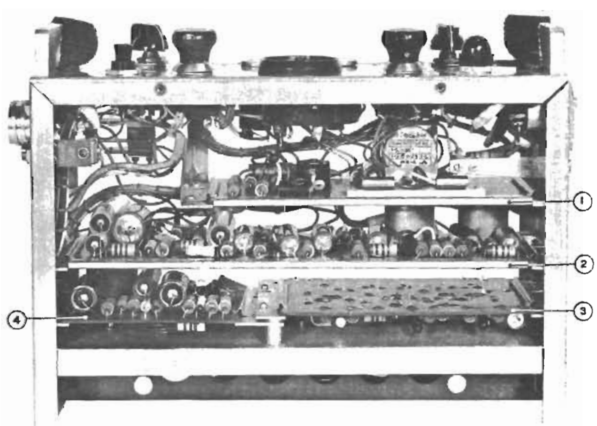


Fig. 4.6. AM15/502, Mark II. Internal View

1. Bias Oscillator Card 2. Record Amplifier Card
3. Monitor Card 4. Playback Head Amplifier Card

A circuit diagram of the playback head amplifier is shown in Fig. 4, and an internal view of the AM15/502, Mark II, in Fig. 4.6. The output from the reproducing head is fed to the input transformer T1, which feeds the transistor VT1. Transistors VT1 and VT2 form a conventional two-stage amplifier, with negative feedback applied from the collector of VT2 to the emitter of VT1. The feedback decreases at high and low frequencies because of the effect of C5 and C6. By their use the overall frequency response rises at high and low frequencies, to equalise the reproducing-head output characteristic. The output signal is taken from the lower arm R14 of the potential divider, R12 plus R14, connected to the collector of VT2. In parallel with R12 is C8, which serves to increase the output-signal amplitude at high frequencies. The value of C8 is chosen on test to provide for variations in the high-frequency response of different reproducing heads.

The output from the playback head amplifier is fed to one pole of the change-over switch designated *Replay*, which feeds the input to the monitoring amplifier. The other input to the switch is taken from resistor R10, connected in series with the recording head; see Fig. 4.5. The switch thus enables the signal fed to the head to be compared with that obtained on reproduction from the film magnetic stripe.

Connections to the six-way output plug, type EM-6-13, and the internal wiring arrangements of the amplifier are shown in Fig. 5. The circuits to the pins of the six-way plug are as follow:

Pin	*Circuit*
1, 2	Reproducing head output
3	Feed to record head
4, 5	Monitor headphone circuit
6	Feed to record head

SECTION 5

AM15/502: TEST SPECIFICATION

The following operations provide a comprehensive test for the individual units of the amplifier. The apparatus required is as follows:

Tone source covering the range 50 c/s to 10 kc/s. Output impedance of 600 ohms.

Valve voltmeter capable of measurement over the range 50 c/s to 10 kc/s, or an amplifier-detector. For measurements at bias frequency (60 kc/s approximately) an accurate valve voltmeter or calibrated oscilloscope must be used.

Oscilloscope.

The apparatus should be connected as shown in Fig. 5.1.

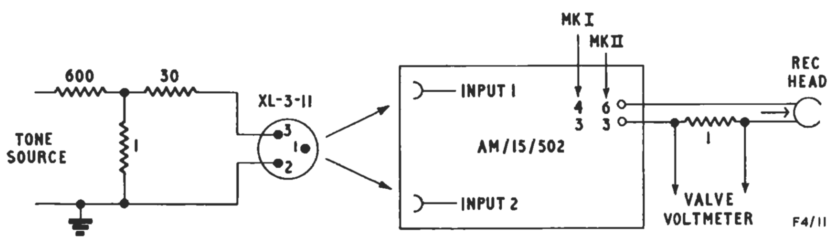


Fig. 5.1. Test Circuit for AM15/502

5.1 Voltage and Current Measurements

Check that the battery voltage, on load, is 12.

Record Amplifier

Emitter Voltage					*Total Current (mA)*
VT1	VT2	VT3	VT4	VT5	
1·8	1·8	1·9	2·4	2·5	29

Bias Oscillator and Modulation-meter Amplifier

Adjust *Set Bias* control to give 30 mV of bias signal across the 1-ohm test resistor.

Emitter Voltage	*Collector Current (mA)*
VT1	VT2 + VT3
3·0	24·5

Playback Head Amplifier

Total Current: 1 mA (± 50 per cent)

Monitor Amplifier

Emitter Voltage			*Total Current (mA)*
VT1	VT2	VT3	
3·9	2·8	1·1	13·8

Tolerances ± 20 per cent, unless otherwise specified.

5.2 Record Amplifier

5.2.1 Gain

Set tone-source frequency to 1 kc/s. Remove supply to bias oscillator. Set the gain control of the channel in use to maximum, and the other gain control to minimum. If both gain controls are set at maximum the gain will be reduced by 1 dB. Connect a 4·7-kilohm resistor across the *L2 In* jack. The position of the test points *a*, G_M, etc. are shown in Fig. 1.

Input and output signal levels are expressed relative to 0·775 volts r.m.s.

Set the tone-source output to give a signal amplitude of 3 mV r.m.s. (−48·5 dB) across the 1-ohm test resistor. The tone-source output and levels at test points should be as given in the table below.

Tone-source Output (dB)	*Level (dB) at Test Point*						
	a	G_M	*l*	*p*	*q*	*t*	*L2 In*
25·5	−67·5	−47·5	−35	−36	−7	−24	−55

Tolerance for all readings is ± 3 dB.

Connect tone-source output direct to *Line In* jack. Set tone-source frequency to 1 kc/s and set output level to −12·5 dB. Set *Gain 1* to minimum setting and *Gain 2* to maximum setting. Adjust tone-source output to give a signal amplitude of 3 mV r.m.s. (−48·5 dB) across the 1-ohm test resistor. The tone-source output should be −12·5 dB ± 3 dB. N.B. There should be no connection to the *Input 2* socket during this test.

5.2.2 Frequency Response

Set the gain control of the channel in use to maximum, and the other gain control to minimum. Set the *On/LF Cut/Off* switch to *On*. Set the tone-source frequency to 1 kc/s. Set the tone-source output to −35 dB approximately, and adjust the tone-source output until the signal amplitude across the 1-ohm test resistor is −58 dB (reference level). Connect a 4·7-kilohm resistor across *L2 In* jack and note the signal level. Measure the outputs across the 1-ohm resistor and the *L2 In* jack at the frequencies given in the table below, and check that the responses are as shown, within the limits ± 2 dB.

Frequency	*Relative Response (dB) across 1-ohm resistor*		
	On	*LF Cut***	*L2 In*
40 c/s	−2·5	−20	−2·5
60 ,,	−1·5	−15	−1·0
100 ,,	−0·5	−10	0
200 ,,	0	− 4·5	+0·5
500 ,,	−0·3	− 1·3	0
1 kc/s	0	− 0·3	0
2 ,,	1·0	1·3	0
4 ,,	3·3	3·6	0
6 ,,	7·0*	7·0*	0
8 ,,	10·5*	10·5*	0
10 ,,	14*	14*	0

*These responses may vary owing to modifications to the amplifier to offset variations of response of particular recording heads. Where such modifications have been made the response limits are ± 4 dB above 6 kc/s

** *LF Cut* capacitor = 0·02 μF.

Repeat above test for the other input channel, checking in the *On* position only.

5.2.3 Noise

Terminate *Input 1* in 30 ohms.

Set *Gain 1* to maximum setting, and *Gain 2* to minimum. Measure the noise output at the *Out* and the *Mod.* terminals of the record amplifier. These figures should be less than −52 dB and −47 dB respectively.

Terminate *Input 2* in 30 ohms, and repeat above with *Gain 1* set to minimum setting and *Gain 2* to maximum, and check noise outputs.

To obtain the signal-to-noise ratio, subtract the levels measured at these points (*t* and *q*) respectively in the test under 5.2.1. The values of the signal-to-noise ratios at the *Out* and *Mod.* terminals should be not less than 28 dB and 40 dB.

5.2.4 Distortion

Connect a 40-dB amplifier and filter unit FHP/3 in series between the 1-ohm test resistor and the valve voltmeter. Adjust tone-source output so that the signal level across the 1-ohm resistor is −46 dB. Using test frequencies of 100 c/s and 1 kc/s, check that the total harmonic distortion is less than 2 per cent (−34 dB).

5.3 Bias Oscillator

(a) Set *Bias Current* control to give maximum output. Measure bias voltage across the 1-ohm test resistor; this should be greater than 38 mV. Measure also the direct-current feed to the oscillator (in series with the terminal *B* (*ADJ*) of the bias-oscillator card; this should be less than 41 mA. Check the oscillator frequency: this should lie between 40 kc/s and 60 kc/s.

(b) Set *Bias Current* control to give a bias voltage of 30 mV across the 1-ohm test resistor. Check that the direct-current feed to the oscillator is between 21 and 32 mA.

N.B. The record amplifier must be operating during the measurements.

5.4 Monitor Amplifier

Disconnect input lead to the monitor card. Connect a 10-ohm resistor in parallel with the input and apply the output of the tone source to the input through a series 600-ohm resistor.

5.4.1 Output Impedance

Set the tone-source frequency to 1 kc/s and adjust the output of the tone source so that the monitor output is 1 volt r.m.s. on open circuit. Connect a variable resistor to the output, and adjust its value until the output falls to 0·5 volt. The resistance employed is then equal to the monitor-amplifier output impedance, and should be within the limits of 150 and 250 ohms.

5.4.2 Gain

When the output is 1 volt r.m.s. on open circuit, the input signal level should be –37 ± 2 dB. Levels at intermediate points in the amplifier should be as given below.

Input (dB)	*Level at Test Point (dB)*				
	0	*l*	*h*	*g*	*b*
—37	0	–35·5	–36	–27	–47

Tolerances ± 2 dB.

5.4.3 Frequency Response

Set the tone-source frequency to 1 kc/s, and set the tone-source output so that the open-circuit monitor output is 1 volt r.m.s. Measure the output at the frequencies given in the table below, and check that the responses relative to 1 volt r.m.s. are within the limits ± 2 dB.

Frequency	*Output (dB) relative to 1 volt r.m.s.*
40 c/s	–1
60 ,,	–0·5
100 ,,	0
200 ,,	0
500 ,,	0
1 kc/s	0
2 ,,	–0·2
4 ,,	–1·5
6 ,,	–4
8 ,,	–6
10 ,,	–8·5

5.4.4 Noise

With no input signal, measure the noise output, which should be less than –50 dB.

5.4.5 Distortion

Connect filter unit FHP/3 between the monitor output and the valve voltmeter. Set tone-source output so that the output signal level on open circuit is 1 volt r.m.s. Using test frequencies of 100 c/s and 1 kc/s, check that the total harmonic distortion is less than 2 per cent (–34 dB). Remove 10-ohm resistor from input and re-connect monitor-amplifier input lead.

5.5 Playback Head Amplifier

5.5.1 Gain

Connect the test circuit arrangement shown in Fig. 5.2. Set tone-source frequency to 1 kc/s, and set the tone-source output level to –13 dB. Connect the valve voltmeter to the output of the playback head amplifier. Check that the output signal level is –34 ± 2 dB.

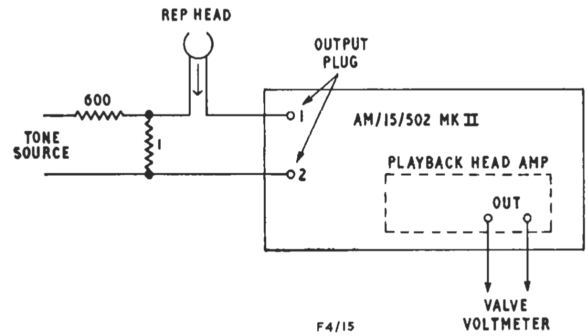


Fig. 5.2. Test Circuit for Playback Head Amplifier of AM15/502, Mark II

5.5.2 Frequency response

With the test circuit arrangement employed in 5.5.1 above, check the response at the frequencies given in the table below. At each frequency, adjust the tone-source output so that the amplifier output-signal level is –34 dB. Check that the tone-source output at each frequency relative to that at 1 kc/s is within ± 2 dB of the value given in the table over the range 60 c/s to 8 kc/s.

Frequency	*Tone Source Output (dB) relative to 1 kc/s*
40 c/s	–17
60 ,,	–20
100 ,,	–18
200 ,,	–12
500 ,,	– 5
1 kc/s	0
2 ,,	+ 2
4 ,,	– 0·5
6 ,,	– 3
8 ,,	– 6
10 ,,	– 8

5.5.3 Noise

With no input signal, measure the noise output. This should be less than –66 dB.

5.6 Metering Facilities

5.6.1 *Modulation-meter Amplifier*

With the apparatus connected as shown in Fig. 5.1, set the tone-source frequency to 1 kc/s.

Set the meter switch to *V.I.* Adjust tone-source output so that meter pointer reads at the leading edge of the green band (signal level across 1-ohm test resistor approximately –56 dB). Check that the signal level at intermediate point *f* is –9·5 dB.

Vary tone-source frequency over the range 100 c/s to 8 kc/s, and check that the input-signal level required for the meter pointer to set at the leading edge of the green band does not vary by more than ± 3 dB.

5.6.2 Bias Indication

Set meter switch to *Bias*. Adjust *Set Bias* control so that the voltage across the 1-ohm resistor is 30 mV. Adjust the Bias Meter resistor (see Fig. 5 for Mark II and Fig. 3 for Mark I) so that the meter pointer is set to the leading edge of the green band.

5.6.3 Battery Indication

Set the meter switch to *Batt*, and check that the meter pointer indicates the leading edge of the green band when the battery voltage is 9.

5.6.4 Bias Break-through Check

Set meter switch to *V.I.* Check that the meter pointer does not move from the back stop when the *Set Bias* control is rotated from minimum to maximum setting.

SECTION 6

ALIGNMENT INFORMATION

6.1 Sound System Lining-up Procedure

The following procedure is that employed when lining up a camera and the associated amplifier. It is assumed that the amplifier conforms with the requirements of the Test Specification in Section 5. Because of differences between individual heads at the camera the individual amplifier characteristics are altered to produce an overall recording characteristic correct to C.C.I.R. specification. For this reason each amplifier should be treated as an integral part of the channel after lining-up, and the lining-up procedure should be repeated if the recording or reproducing heads are changed. For those channels having a single recording head and a Mark I type amplifier the following procedure applies if all references to the reproducing head and the replay head (playback) amplifier are ignored.

6.1.1 Heads

To facilitate alignment, the outputs from the two heads should be fed to a change-over switch preceding the input of a static replay amplifier corrected to the C.C.I.R. characteristic. The film stock used should be of the type normally expected to be used in the camera.

The following sequences of four adjustments ensure that (a) the head gap is in the centre of the length of the film in contact with the head, (b) the head gap is perpendicular to the length of the film stripe, (c) the plane of the film is the same as that of the pole faces of the head, and (d) the head gap is centrally placed with respect to the width of the stripe.

The heads should be inspected initially, and if no major errors of alignment are immediately apparent proceed as in (1) to (6) below. If major errors of alignment are apparent these should be minimised before proceeding.

Lace up a standard azimuth-adjustment film in the camera without passing it through the picture gate, to avoid unnecessary gate wear, and carry out the following alignment procedure for each head in turn.

1. Slacken head lock-nut and rotate head for maximum output. Tighten lock-nut.
2. Insert tommy bar in the hole in the top of the head bracket, and rock the head bracket until maximum output is obtained.
3. Slacken the set-screw retaining the film balancing shoe. Adjust position of balancing shoe for maximum output. Tighten set-screw.
4. Check that the head gap is centrally placed with respect to the width of the stripe; if it is not, insert shims between head and head bracket.
5. Lace up and run a new reel of film (400 ft.). Run through the camera six times, or until the heads are polished.
6. Lace up and run standard azimuth-adjustment film, and repeat (1) to (4) above until no further improvement is obtained.

6.1.2 Amplifier Adjustments

(a) The amplifier should be connected to the recording and reproducing heads at the camera, and the camera should be loaded with new stock. Connect the output of a variable tone source to the *Input 1* of the amplifier via a matching pad of the type shown in Fig. 5.1. Adjust tone-source frequency to 1 kc/s.

Set:—

On/LF Cut/Off switch to *On*
Direct/replay switch to *Replay*
Meter switch to *V.I.*
Gain 1 to maximum setting

Connect a valve voltmeter to the *Phones* jack. Run film in camera. Adjust the tone-source output level until the meter pointer reads at the leading edge of the green sector, that is the edge corresponding with the smaller deflection.

Adjust the *Set Bias* control until the valve-voltmeter reading is maximum.* Set meter switch to *Bias*, and adjust *Bias Meter* control until meter pointer reads at the leading edge of the green sector.

---

* This determines the optimum setting of the *Set Bias* control. For Mark I versions of the amplifier, this adjustment cannot be made directly. Instead, a recording of 1-kc/s tone should be made using a range of settings of the *Set Bias* control. The recording should then be replayed on a static channel, and the optimum setting of the *Set Bias* control found by noting which setting gives maximum output on replay.

Whilst recording, check the output at the *Phones* jack in each position of the *Direct/Replay* switch, and, if necessary, adjust R14 on the replay head amplifier to obtain equality of outputs.

(b) Use test set-up as in (a) above.

Adjust tone-source output until meter pointer sets at the leading edge of the green sector. Note tone-source output. Run film in camera. Replay the recording on static reproducing channel, corrected to C.C.I.R. characteristic and adjusted to give zero-level output on standard zero-level film. Note deviation of output from zero level.

Adjust tone-source output to compensate for this discrepancy (i.e. if output of channel is –3 dB, reduce tone-source output by 3 dB). Adjust the value of R6 on the bias oscillator card so that the meter pointer now sets at the leading edge of the green sector.

Repeat above, and check that the output from the static channel is now at zero level.

(c) Reduce tone-source output by 10 dB from that determined in the latter part of (b) above.

Record a frequency-response test film using frequencies of 40, 60, 100, 200, 500 c/s and 1, 2, 4, 6, 8 and 10 kc/s. Simultaneously check the output levels at the *L2 In* jack, and at the monitor output in both positions of the *Replay* switch.

Replay the recording on the static reproducing channel, and check that the response relative to that at 1 kc/s is within the limits $\pm$ 2 dB from 100 c/s to 6 kc/s, $\pm$ 4 dB at 60 c/s and 8 kc/s and +0/–8 dB at 40 c/s and 10 kc/s. If the response is outside the limits at high frequencies, adjust the value of C7 in the record amplifier.

The response relative to that at 1 kc/s at the *L2 In* jack and at the monitor output in the direct position of the *Replay* switch should be within the same limits, as given above.

The frequency response in the *Replay* position should be substantially the same as that in the direct position. If it is not, adjust C8 of the replay head amplifier until this condition is met,

6.2 Channel Test

6.2.1 Camera

The following procedure checks the performance of the camera.

1. Insert and lace up film in camera. Fit 1-in. lens and associated viewfinder. Focus on framing test chart using the viewfinder at a number of ranges with the appropriate parallax scale setting. At each range, run camera. Check film after development to ensure that there is no appreciable parallax error. If there is a systematic error, adjust the position of the parallax scale, and repeat above test until the parallax error is minimum.

To reduce the time required to make these adjustments a ground-glass screen fitted in the film gate may be used. The camera should then be set using the viewfinder, and the registration of the chart in the film gate should then be checked. A final check using film should be made.

2. Fit each lens to camera in turn, set up a resolution test chart, and proceed as follows. Set lens to maximum aperture and adjust test chart illumination for correct exposure. Set camera to photograph the test chart at a number of ranges; at each range adjust the lens distance-scale ring setting to the distance measured between lens and chart, and also to settings 10 per cent greater and less than the measured distance.

Check film after development to ensure that the distance scale ring calibrations are substantially correct. If there is a systematic error for all lenses it is probable that the turret assembly is at fault.

Check also that, when the test chart fills the frame area, the resolution is at least 40 lines/mm.

3. Insert and lace up film in camera. Run camera up to speed and check that the film speed is 37·5 $\pm$ 0·5 feet per minute.

4. Measure total picture unsteadiness by the method detailed in report PID/TV/1956/3. This should be less than 0·25 per cent. Maximum figures for the jump and weave components are 0·2 and 0·15 per cent respectively.

6.2.2 Sound Equipment

The following procedure checks the overall performance of the sound channel. For those channels having a single recording head and a Mark I type amplifier the following procedure also applies if all references to the reproducing head and replay head (playback) amplifier are ignored.

1. Repeat lining-up procedure given under 6.1.2.

2. Set *On/LF Cut/Off* switch to *On*, *Replay* switch to the direct position. Adjust *Set Bias* control to its minimum setting.

Connect valve voltmeter to the *Phones* jack. Set *Gain 1* and *Gain 2* to minimum settings. The noise output measured at the *Phones* jack should be less than –40 dB.

Set *Gain 1* to maximum setting. Terminate

Input 1 in 30 ohms. Noise output should be less than –30 dB. Repeat for *Gain 2* at maximum setting with *Input 2* terminated in 30 ohms, and check that noise output is less than –30 dB.

Set *Replay* switch to *Replay*, and check that noise output is less than –30 dB.

Adjust *Set Bias* control to maximum setting, and check that the output in either position of *Replay* switch is less than –20 dB.

Place *Set Bias* control to its normal setting.

3. Connect the output of a tone source to the *Input 1* of the amplifier via a pad of the type shown in Fig. 5.1.

Set:

On/LF Cut/Off switch to *On*
Gain 1 control to maximum
Gain 2 control to minimum
Meter switch to *V.I.*
Tone-source frequency to 1 kc/s

Adjust tone-source output until the meter sets at the leading-edge of the green section. Check that input-signal level is 80 ± 6 dB. Connect valve voltmeter to *Phones* jack, and set *Replay* switch to the direct position. Note valve voltmeter reading (Reading 1).

Set *Gain 1* to minimum and *Gain 2* to maximum. Note valve voltmeter reading (Reading 2). Repeat at frequencies between 100 c/s and 10 kc/s. Check that the level of break-through (Reading 2) is more than 40 dB below the signal (Reading 1).

Repeat the above with *Replay* switch set to *Replay*; check that the level of break-through is more than 30 dB below that of the signal.

4. Apply tone-source output to *Line In* jack, and, with *Gain 2* set to maximum, check that the input signal level for the meter to set at the leading edge of the green sector is –25 ± 6 dB.

5. (a) Lace and run new film in camera. Record the 1-kc/s tone with meter pointer set at leading edge of green sector, and also at a level 8 dB above this. Replay film on static channel and check that the levels of total harmonic distortion are less than 1 per cent (–40 dB) and less than 3 per cent (–30 dB) respectively.

(b) With *Gain 1* and *Gain 2* controls at minimum setting, run film in camera. Replay film on static channel, and check that the noise level is more than 32 dB below zero level.

(c) Record 3-kc/s tone with meter pointer set to leading edge of green sector. Replay on static channel, and measure wow and flutter. These should be within the limits given below.

Wow	0·25% r.m.s.
Flutter	0·25% r.m.s.
Wow (peak to peak)	0·4%

GGJ/960

APPENDIX A

LIST OF ITEMS FORMING CINEVOICE CAMERA CHANNEL

Cinevoice CM-72 Camera
Lenses (see Section 2.5)
Lens hoods, filters; as required
3 Mitchell magazines (400 ft, B-wind) with modified external take-up pulleys
2 Magazine plastic covers
F. and E. tripod with camera head
Leitz range-finder
Exposure meter (Weston Master II or III)
50-ft Chesterman tape-measure
Amplifier AM15/502
Microphone, S.T.C. 4035D
Microphone, S.T.C. 4033 or 4104
Microphone, S.T.C. 4037A or 4032G
Microphone floor stand
Microphone table stand
2 prs headphones (S.G. Brown, type F)
Set of connecting cables:
- 2 battery leads, 2-core (6 ft and 15 ft approx). Terminated in F. and E. EP-GC-2-12 and Cannon XL-3-15
- 2 amplifier-camera cables
  - Mk. I. 4-core (10 ft and 30 ft approx). Terminated in Cannon XL-4-15 and XL-4-12

Set of connecting cables (*continued*)
  - Mk II. 6-core (10 ft and 30 ft approx.) Terminated in F. and E. EM-6-15 and EM-6-12
- 2 microphone cables, 2-core and screen (6 ft approx). Terminated in S.T.C. 4069 plug and Cannon XL-3-11
- 2 microphone extension cables, 2-core and screen (50 ft approx). Terminated in Cannon XL-3-11 and XL-3-12
- Microphone extension cable, 2-core and screen (300 ft approx) on drum. Terminated in Cannon XL-3-11 and XL-3-12
- Single ender (screened)
- 2 cables for feeding L2 tape recorder. Terminated in Igranic jack plug and Cannon XL-3-11

2 carrying cases for camera, magazines, cables, etc.
Carrying case for amplifier
Film changing bag
2 ground sheets
Set of tools
Avominor, soldering iron, pliers, screwdrivers, spanners

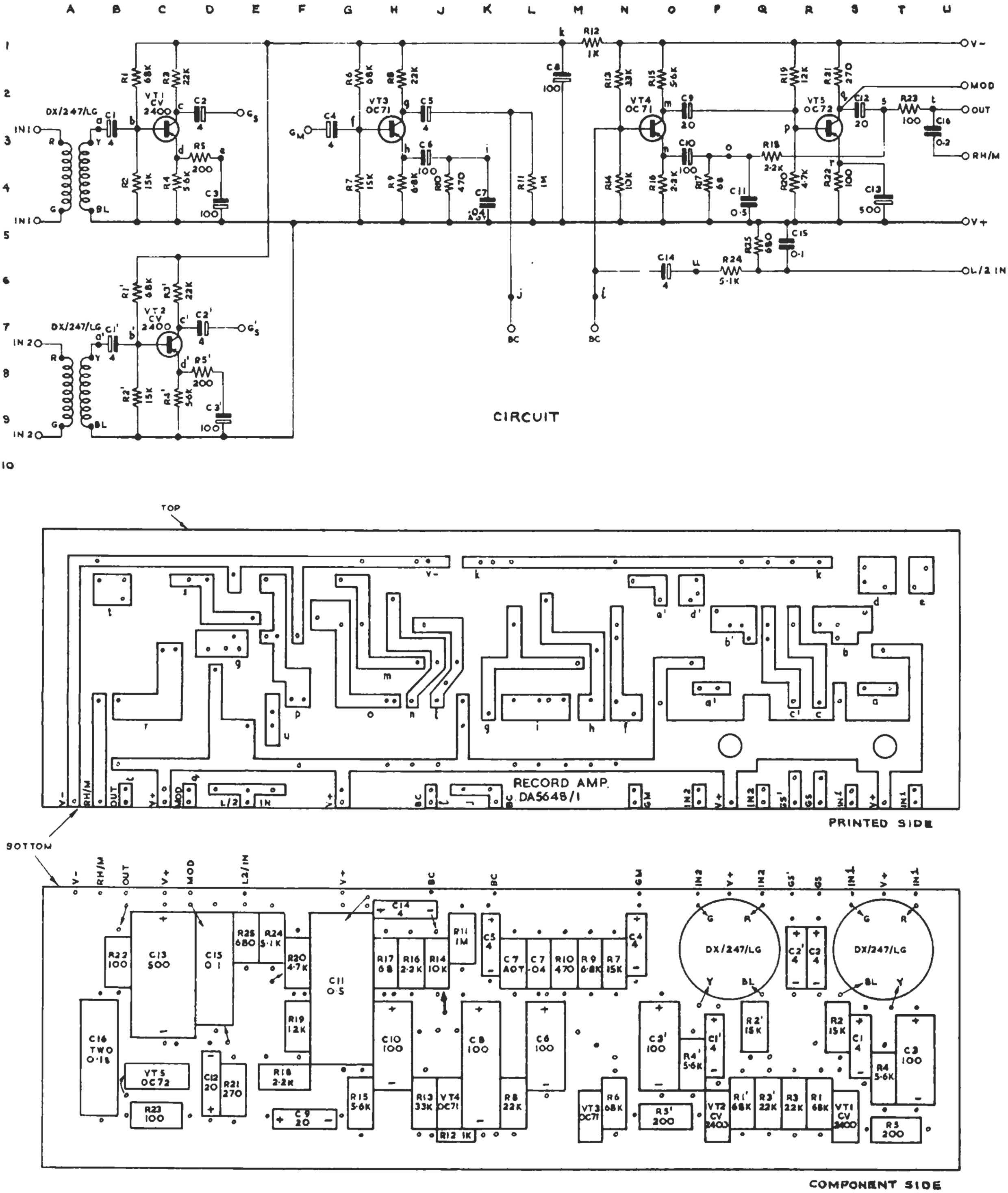
Total weight: $1\frac{1}{2}$ cwt approximately

COMPONENT TABLE: FIG. 1

Comp.	Loc.	Type	Tolerance per cent	Comp.	Loc.	Type	Tolerance per cent
C1	B3	Plessey CE 20/1 12V		R4	C4	Erie 109 0·25W	2
C1	B7	Plessey CE 20/1 12V		R4	C8	Erie 109 0·25W	2
C2	D2	Plessey CE 20/1 12V		R5	D3	Erie 109 0·25W	2
C2	D7	Plessey CE 20/1 12V		R5	D8	Erie 109 0·25W	2
C3	D4	Plessey CE 1207/1 6V		R6	G2	Erie 109 0·25W	2
C3	D9	Plessey CE 1207/1 6V		R7	G4	Erie 109 0·25W	2
C4	G3	Plessey CE 20/1 12V		R8	H2	Erie 109 0·25W	2
C5	J2	Plessey CE 20/1 12V		R9	H4	Erie 109 0·25W	2
C6	J4	Plessey CE 1207/1 6V		R10	J4	Erie 109 0·25W	2
C7	K4	Hunt B 858		R11	L4	Erie 16 0·25W	10
C8	M2	Plessey CE 1222/1 12V		R12	M1	Erie 16 0·25W	10
C9	O2	Plessey CE 19/1 12V		R13	N2	Erie 109 0·25W	2
C10	O3	Plessey CE 1207/1 6V		R14	N4	Erie 109 0·25W	2
C11	Q4	Hunt W49 B 502K 150V	20	R15	O2	Erie 109 0·25W	2
C12	S2	Plessey CE 19/1 12V		R16	O4	Erie 109 0·25W	2
C13	T4	Plessey CE 1279/1 6V		R17	P4	Erie 109 0·25W	2
C14	O6	Plessey CE 20/1 12V		R18	Q3	Erie 109 0·25W	2
C15	R5	Hunt W 49 B500K 150V	20	R19	R2	Erie 109 0·25W	2
C16	U3	2 x Hunt W 49 B500K		R20	R4	Erie 109 0·25W	2
		150V	20	R21	S2	Erie 109 0·25W	2
				R22	S4	Erie 109 0·25W	2
R1	B2	Erie 109 0·25W	2	R23	T2	Erie 109 0·25W	2
R1	B6	Erie 109 0·25W	2	R24	P6	Erie 109 0·25W	2
R2	B4	Erie 109 0·25W	2	R25	Q5	Erie 109 0·25W	2
R2	B8	Erie 109 0·25W	2				
R3	C2	Erie 109 0·25W	2	Transformer	A3	BBC DX/247/LG	
R3	C6	Erie 109 0·25W	2	Transformer	A8	BBC DX/247/LG	

F4

FIG. 1



AM15/502 RECORDING AMPLIFIER

COMPONENT TABLE: FIG. 2

BIAS OSCILLATOR CIRCUIT

Comp.	Loc.	Type	Tolerance per cent	Comp.	Loc.	Type	Tolerance per cent
C1	A3	Plessey CE 20/1 12V		R1	B3	Erie 109 0·25W	2
C2	B5	Hunt B 810 400V	20	R2	C2	Erie 109 0·25W	2
C3	D3	2 x Hunt B 858	20	R3	C4	Erie 109 0·25W	2
C3	D3	2 x Hunt B 858	20	R4	D2	Erie 109 0·25W	2
C4	D5	Plessey CE 1222/1 6V		R5	D5	Erie 109 0·25W	2
C5	K5	Hunt 500 K 400V	20	R6	D4	Erie 109 0·25W	2
C6	H2	Plessey CE 1222/1 12V		R7	J2	Erie 109 0·25W	2
				R8	J4	Erie 109 0·25W	2
MR1 }				R9	N3	Erie 109 0·25W	2
MR2 }	F4			R10	N5	Erie 109 0·25W	2
MR3 }							
MR4 }							
MR5	M4	CV 425		Transformer	L2	BBC F91 (FX 179)	

COMPONENT TABLE: FIG. 2

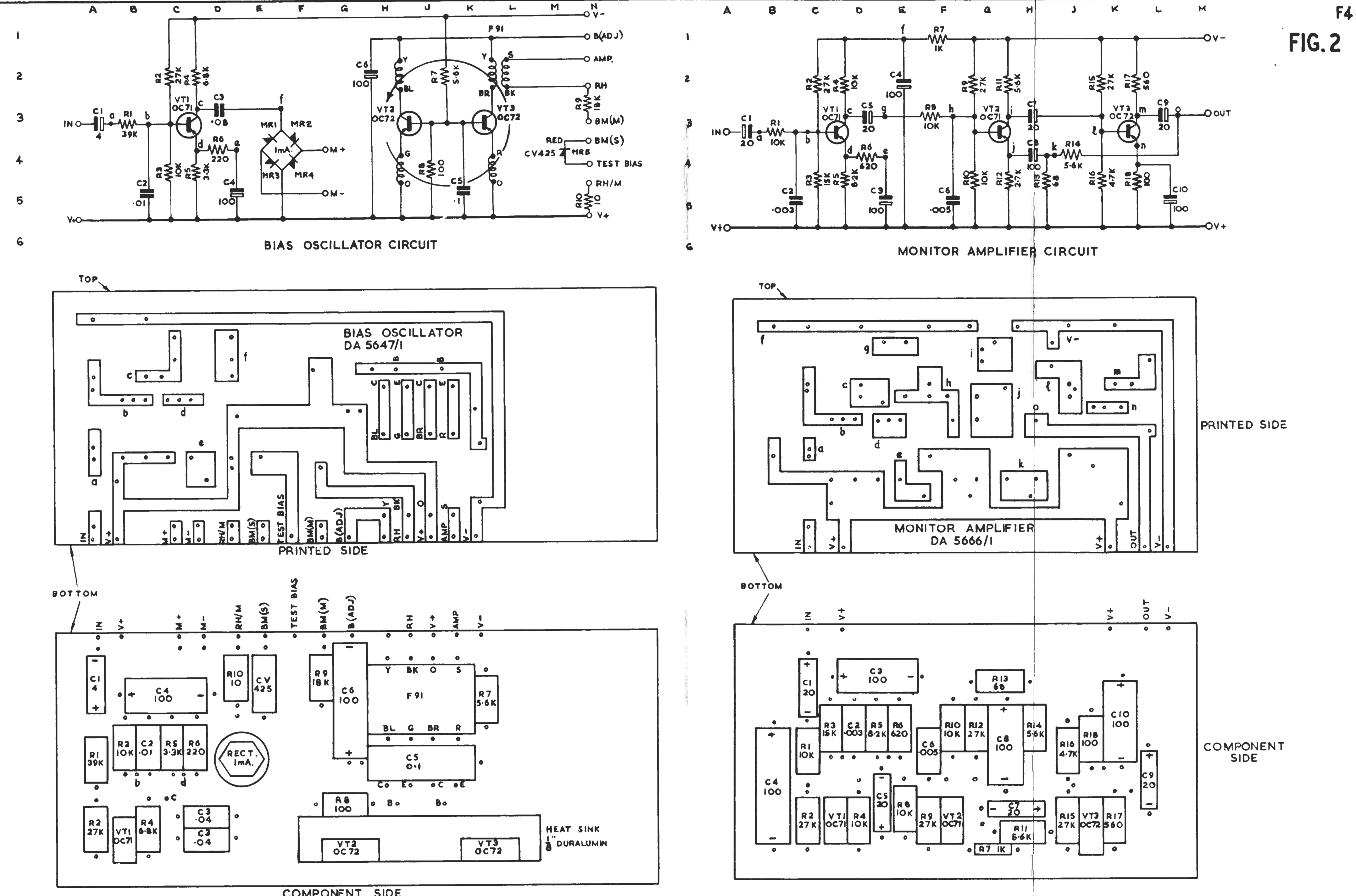
MONITORING AMPLIFIER CIRCUIT

Comp.	Loc.	Type	Tolerance per cent	Comp.	Loc.	Type	Tolerance per cent
C1	A3	Plessey CE 19/1 12V		R4	D2	Erie 109 0·25W	2
C2	B5	Hunt B 815 400V	20	R5	D4	Erie 109 0·25W	2
C3	E5	Plessey CE 1207/1 6V		R6	D4	Erie 109 0·25W	2
C4	E2	Plessey CE 1222/1 12V		R7	F1	Erie 16 0·25W	10
C5	D3	Plessey CE 19/1 12V		R8	F3	Erie 109 0·25W	2
C6	F5	Hunt B 815 400V	20	R9	G2	Erie 109 0·25W	2
C7	H3	Plessey CE 19/1 12V		R10	G4	Erie 109 0·25W	2
C8	H4	Plessey CE 1207/1 6V		R11	H2	Erie 109 0·25W	2
C9	L3	Plessey CE 19/1 12V		R12	G4	Erie 109 0·25W	2
C10	L5	Plessey CE 1207/1 6V		R13	H4	Erie 109 0·25W	2
				R14	J4	Erie 109 0·25W	2
				R15	K2	Erie 109 0·25W	2
R1	B3	Erie 109 0·25W	2	R16	K4	Erie 109 0·25W	2
R2	C2	Erie 109 0·25W	2	R17	L2	Erie 109 0·25W	2
R3	C4	Erie 109 0·25W	2	R18	L4	Erie 109 0·25W	2

59/GGJ/005
PID6172.2.4A
PID6172.2.5A
ISS. 1

F4

FIG. 2

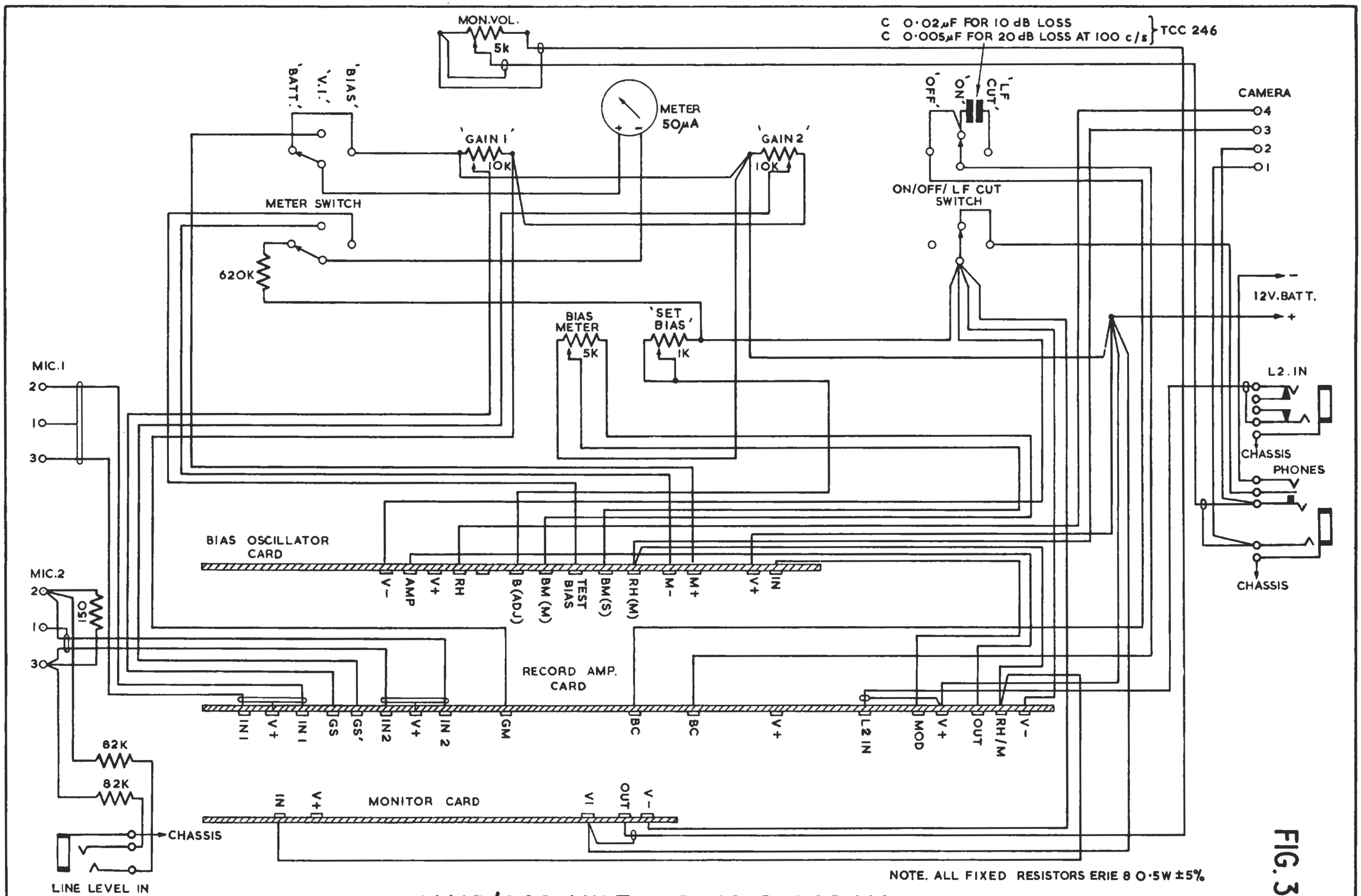


AM15/502 BIAS OSCILLATOR AND MONITOR AMPLIFIER

COMPONENT TABLE: FIG. 3

Comp.	Loc.	Type	Tolerance per cent
Mon. Vol.		Morganite LH/WN 0·25W	20
Gain 1		Morganite E	
Gain 2		Morganite E	
Bias Meter Control		Morganite LH/WN 0·25W	20
Set Bias		Morganite LH/WN 0·25W	20

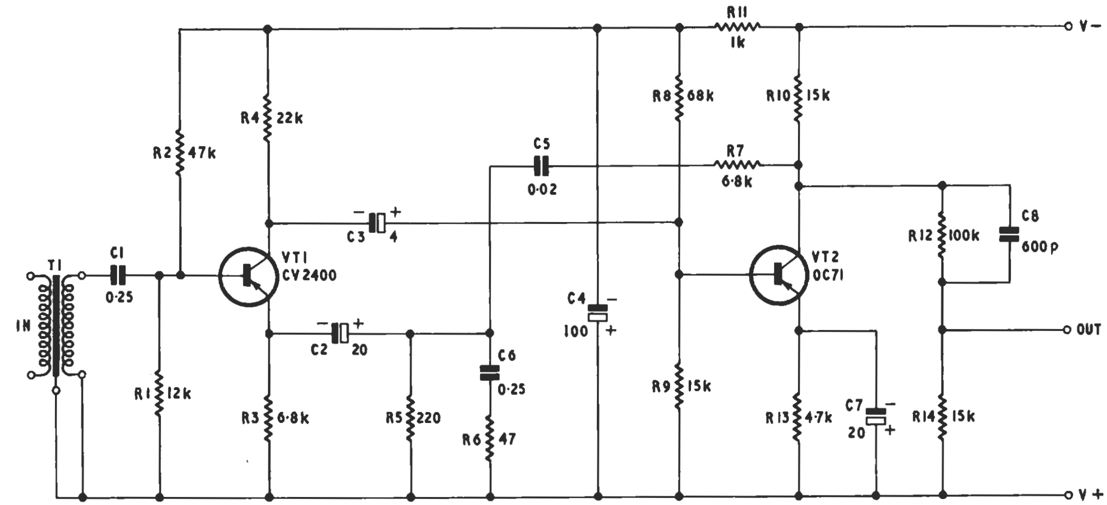
59/GGJ/006
PID.6172.5.1B
ISS.1



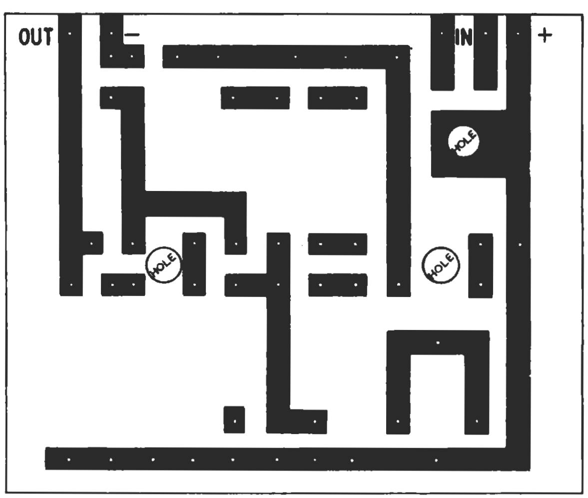
AM15/502 MK I: WIRING DIAGRAM

COMPONENT TABLE: FIG. 4

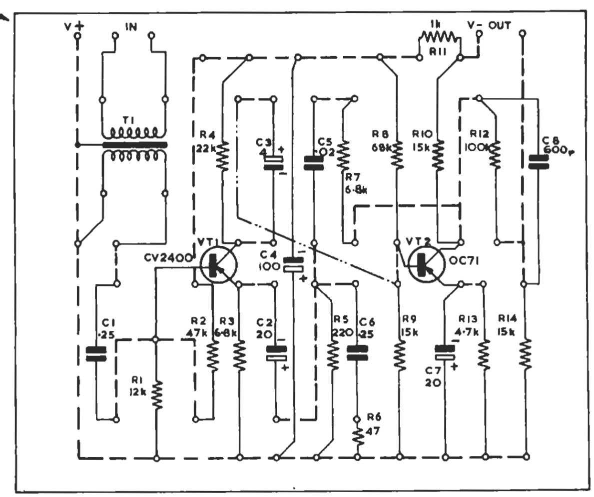
Comp.	Loc.	Type	Tolerance per cent
C1	C4	T.M.C. MN 5910/ Z115563	
C2	F5	Plessey CE 19/1 12V	
C3	F3	Plessey CE 20/1 12V	
C4	J4	Plessey CE 1222/1 12V	
C5	H3	Hunt B 807	
C6	H5	T.M.C. MN 5910/ Z115563	
C7	M6	Plessey CE 19/1 12V	
C8	O3	Hunt L 110	5
R1	D5	Erie 109 0·25W	5
R2	D3	Erie 109 0·25W	5
R3	E5	Erie 109 0·25W	5
R4	E2	Erie 109 0·25W	5
R5	E6	Erie 109 0·25W	5
R6	G6	Erie 109 0·25W	5
R7	K3	Erie 109 0·25W	5
R8	K2	Erie 109 0·25W	5
R9	K5	Erie 109 0·25W	5
R10	L2	Erie 109 0·25W	5
R11	K1	Erie 109 0·25W	5
R12	N4	Erie 109 0·25W	5
R13	L6	Erie 109 0·25W	5
R14	N6	Erie 109 0·25W	5
T1	B4	Fortiphone 1086	



TOP



REAR VIEW (PRINTED SIDE)



VIEW OF COMPONENT SIDE

WIRING LEGEND
- - - - PRINTED CIRCUIT
——— COMPONENT WIRES
—·—·— INSULATED WIRE STRAP ON PRINTED SIDE

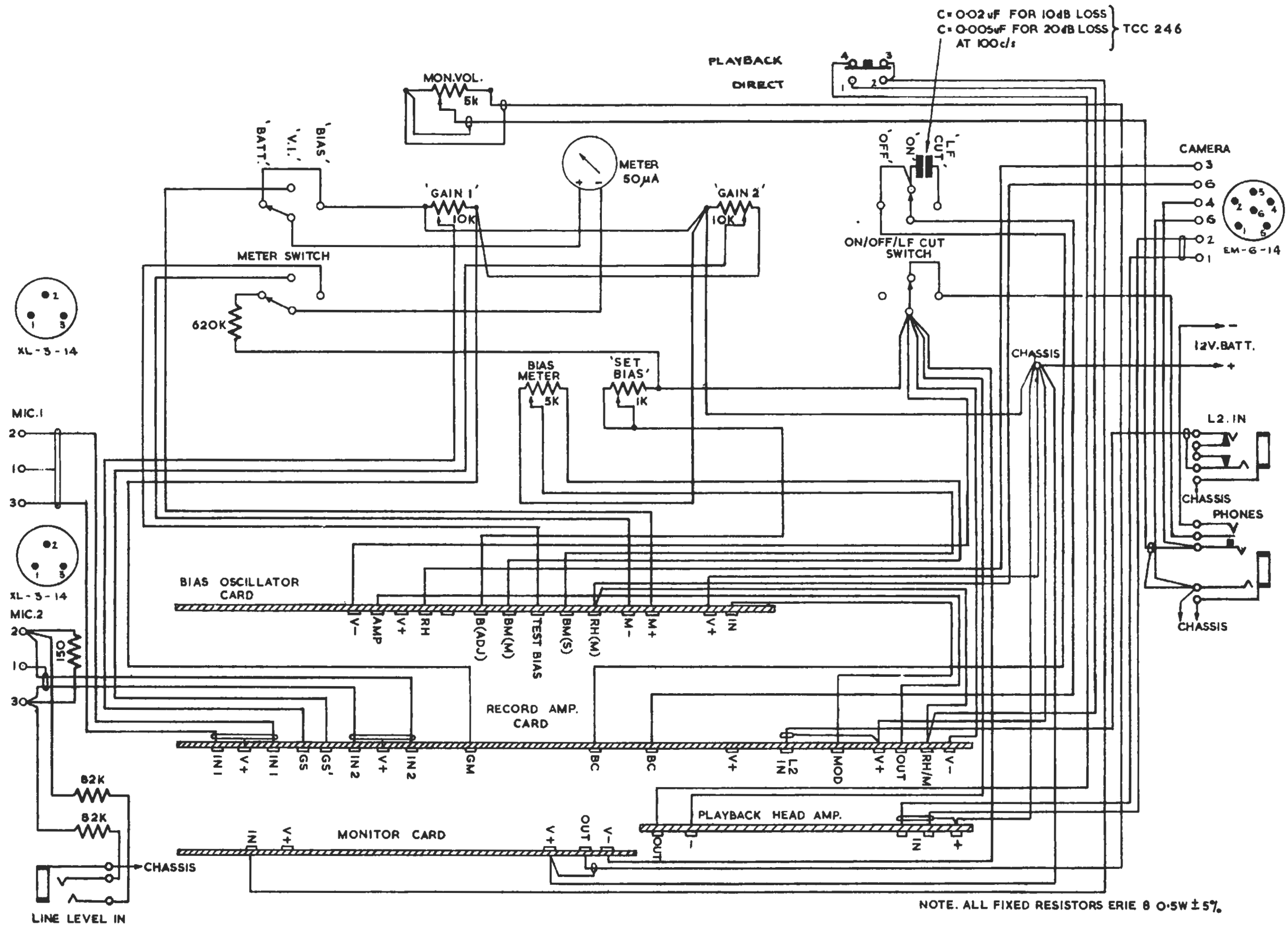
FIG.4

AM15/502: PLAYBACK HEAD AMPLIFIER

COMPONENT TABLE: FIG. 5

Comp.	Loc.	Type	Tolerance per cent
Mon. Vol.		Morganite LH/WN 0·25W	0
Gain 1		Morganite E	
Gain 2		Morganite E	
Bias Meter Control		Morganite E 0·25W	20
Set Bias		Morganite E 0·25W	20

60/GGJ/001/AP
PID.6172.5.28
ISS.1



NOTE. ALL FIXED RESISTORS ERIE 8 0·5W ± 5%.

AM15/502 MK II: WIRING DIAGRAM

FIG.5

F4

ERRATA

To Editor,

Technical Instructions,

305, *St. Hilda's, Maida Vale.*

The following errors have been noted in **Instruction**

Station................................ *Date*............................ *Signature*..........................

ERRATA

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Technical Instructions,

305, *St. Hilda's, Maida Vale.*

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