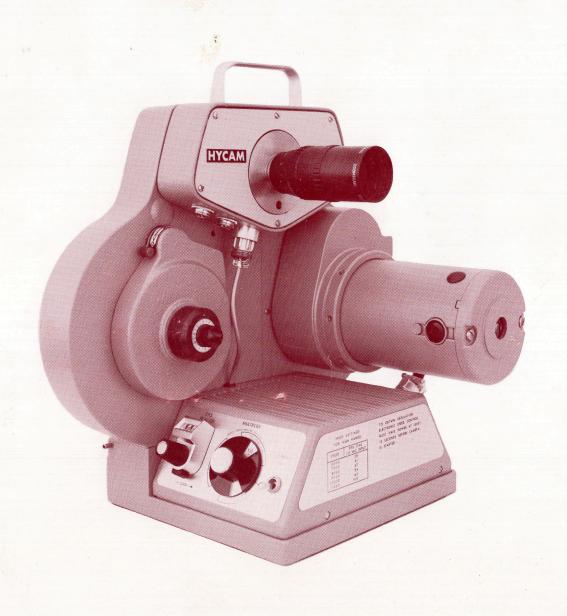
HYCAM INSTRUCTION MANUAL 400 FT. MODEL 16MM HIGH SPEED MOTION PICTURE CAMERA



HYCAM INSTRUCTION MANUAL

MODELS: K20S4E, K20S4AE, K20S4BE, K2004E, K2004AE, K2004BE 16mm High Speed Motion Picture Cameras

DESIGNED AND MANUFACTURED BY

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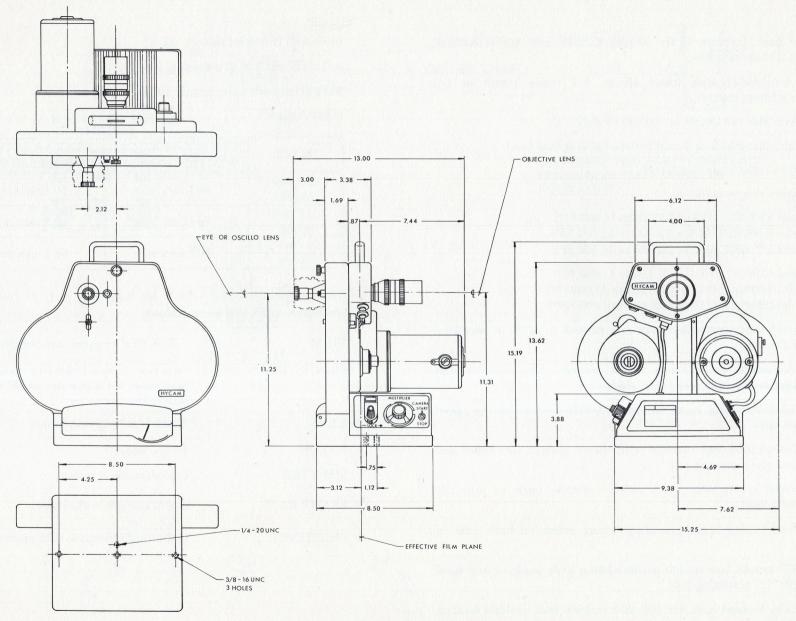


FIG. 1-1 400' HYCAM OUTLINE DRAWING

SPECIFICATIONS

The basic features of the Model K2004E and Model K20S4E HYCAM are as follows:

- a) Available in full frame 16mm, 1/2 frame 16mm or 1/4 frame 16mm formats.
- b) Available in 115 volt or 230 volt models.
- c) Interchangeable and readily detachable optical heads.
- d) Film capacity up to 400 feet.
- e) Speed ranges as follows:

Model K20S4E- (115 or 230) 20 to 11,000 PPS Model K20S4AE-(115 or 230) 40 to 22,000 PPS Model K20S4BE-(115 or 230) 80 to 44,000 PPS

Model K2004E-(115 or 230) 100 to 11,000 PPS Model K2004AE-(115 or 230) 200 to 22,000 PPS Model K2004BE-(115 or 230) 400 to 44,000 PPS

- f) Solid state electronic frame rate control to $\pm 1\%$ in regulated speed ranges.
- g) Automatic servo brake which prevents film over-run and makes possible high speed stop/starts.
- h) Adjustable drag brake on supply spindle for smooth low speed frame rates.
- i) Through-the-lens viewing with direct upright viewfinder and ground glass focusing gate.
- j) Event synchronizer with either normally open or normally closed output.
- k) Dual timing lights providing timing pulses on both sides of film.
- l) "C" mount lens mount accomodating wide angle or any focal length "C" mounting lens.
- m) Film footage scale for 100, 200 and 400 foot daylight loading spools.
- n) End-of-film cutoff switch.

- o) Viscous clutch for smooth starts.
- p) 1/4-20 and 3/8-16 mounting holes.
- q) Ejection buttons for supply and take-up spools.
- r) Resolution:

IMACE	CENTER-VERTICAL	EDGES-VERTICAL		
IMAGE	AND HORIZONTAL	AND HORIZONTAL		
Full Frame 16mm	68 Lines/mm	56 Lines/mm		
1/2 Frame 16mm	80 Lines/mm	68 Lines/mm		
1/4 Frame 16mm	80 Lines/mm	68 Lines/mm		

The conditions under which 68 lines/mm and 80 lines/mm resolution can be met are as follows:

FILM TRI-X REV or equal (not negative film)

PROCESSING One part Kodak Dektol or equal to one

part water for 3 minutes at 68° F with

intermittent agitation.

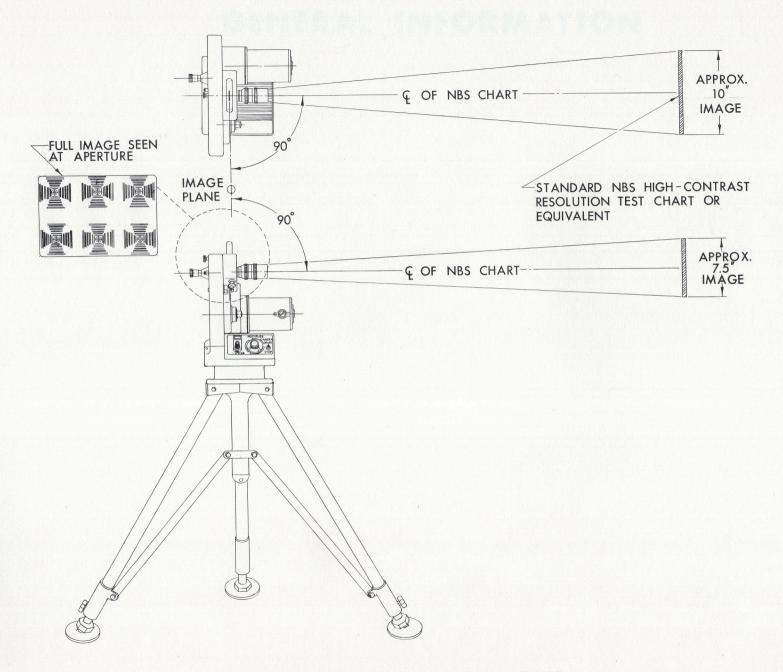
LENS 2 inch focal length or longer

F STOP F/4 or under

SHUTTER 1/5 or smaller opening

FRAME RATE Any frame rate within specs.

LIGHTING Uniform illumination with photoflood lamps



TYPICAL RESOLUTION TEST SETUP

GENERAL INFORMATION

1-1 INTRODUCTION

This technical manual provides general information, installation, operation, and maintenance data for the 400' capacity HYCAM high speed motion picture camera manufactured by Red Lake Laboratories, Inc., Santa Clara, California.

1-2 PURPOSE OF EQUIPMENT

The HYCAM is a high speed 16mm motion picture camera designed for the acquisition of photographic data pertaining to high speed, or short lived phenomenon, and/or recording of cathode ray tube displays operating in conjunction with the photographed event for evaluation, performance, and engineering/research studies.

1-3 DESCRIPTION

The HYCAM is a high speed rotating prism camera. The optical head is a modular constructed unit designed to interchange with all HYCAM film transports, eliminating the need for separate optical systems for every camera. See Section 6 Accessories.

The Film Transport is the central mounting core for the optical head, motor, electronic speed control, and brake.

The Film Transport has a film capacity of 400 feet of standard thickness film on daylight loading spools, and with simple accessories will accept 100, and 200 foot daylight loading spools.

All HYCAM components have been designed to withstand environments of dust, vapor, moisture, and moderate vibration.

1-4 SHIPMENT INSPECTION

The HYCAM is shipped completely assembled. Three cords are furnished as standard equipment; power input cord, remote operation cord, and event synchronization cord. Two timing light connectors are provided, and are mated to the timing light connectors on the underside of the optical head.

Upon receipt of the camera, check the packing list against equipment to insure the order is complete. In the event of shipping damage, the insurance requirements are that you immediately notify the carrier that delivered the shipment, so he can document and file your damage claim. Forward a copy of the damage claim to Red Lake Labs.

1-5 STORAGE

The camera equipment should be stored where adequate safeguards can be taken to protect it. It is suggested that the camera with its associated equipment be contained in its carrying case when not in use, and be stored in an area not subjected to extreme temperatures of heat, cold, or humidity.

1-6 ACCESSORIES

A complete line of accessories are available for the HYCAM making it adaptable for many varied applications. Accessories and their operation may be found in Section 6, Accessories.

THEORY

2-1 OPTICAL HEAD

The HYCAM Optical Head utilizes a unique optical system. The heart of the system is the combining of the film sprocket, rotating prism, and shutter on a single shaft driven by the film; simulating a drive belt from the take up motor. This eliminates the need for gear systems and multiple motors, and enables optimum rotating prism performance. All the internal optics of the HYCAM Optical Head are high efficiency antireflection coated for peak transmission. Customer interchangeable prism, sprocket, and shutter kits, provide the HYCAM Optical head with the versatility of several different film formats. This eliminates the duplicating of Basic Components already existing in the system.

2-2 ELECTRONIC SPEED CONTROL

The HYCAM speed control is a solid state electronic closed loop servo system which can be manually set to control frame rates.

a) GENERAL:

The speed sensor, located in the optical head, generates a frequency proportional to film speed. This low level output is converted by the trigger amplifier into trigger pulses for the tachometer. The tachometer is a frequency to voltage converter; it supplies the differential amplifier with a voltage proportional to motor speed. The differential amplifier compares the tachometer output with the reference voltage derived from the control settings. This differential signal is the error signal which goes to the damping inverter amplifier which amplifies the error signal and controls circuit response sufficiently to prevent system oscillation.

The speed error signal controls the gate and SCR trigger amplifier to produce a variable pulse width drive for SCR motor control.

b) GENERATION OF TIMING PULSES:

Low level timing pulses go to the trigger amplifier which is composed of transistors Q;, Q2, Q3, and tunnel diode D3 (see schematic rear of manual) Q1 is "decoupled" from the power supply by resistor R4 and capacitor C1. Q1 and Q2 amplify the timing pulses causing D3 to rapidly switch Q3 from non-conduct-

ing to full conducting, resulting in a squared pulse which appears across R8.

The squared timing pulses are differentiated and coupled by C4 to the polarizing diode D4 which passes on positive trigger pulses to the tachometer circuit of Q4 and Q5.

The tachometer multivibrator produces a pulse that is constant in width (time), at all frame rates on each of the regulated ranges, X1 X10, and X100. The multi-vibrator duty cycle is nominally 40% "ON" and 60% "OFF" at the top speed of each range. The input stage of Q4 is normally "open", that is "not" conducting. At the same time the other half of the tachometer circuit, Q5 is saturated (Conducting). This is the stable state to which the tachometer circuit always returns after completing one cycle. The evele starts when the input positive trigger causes Q4 to momentarilv conduct and Q5 to stop conducting (through the feed back capacitors connection to the base of Q5). As a result, Q5 base voltage drops and with the common emitter connection of Q4 and Q5 produces a holding action keeping Q4 conducting as long as Q5 is cut off. During this time the Voltage at the base of Q5 is gradually becoming more positive as the feedback capacitor, discharges. When the base of Q5 becomes more positive than its emitter, the resultant feed back through R11 to Q4 returns Q4 and Q5 back to the stable state. The duration of the "ON" cycle is determined by the RC combination of the timing capacitors, R16 and the calibrating resistors in the base circuit of Q5. Three RC time constant circuits are provided for the X1, X10, and X100 ranges so that the duty cycle will be the same for each of the speed ranges. The constant width output pulses feed through R15 to the integrating capacitor C8 and produces a voltage proportional to camera speed.

c) DIFFERENTIAL AMPLIFIER AND DAMPING INVERTER:

The camera speed voltage at C8 couples to the input side (Q6) of the differential amplifier consisting of Q6, Q7 and Q8. The other input (Q7) of the differential amplifier is controlled by the PPS dial. The output of the differential amplifier is the input of the damping inverter amplifier Q9. Q8 is a current generator that supplies Q6 or Q7 or both, depending upon voltage levels at their bases. This circuit provides common-mode rejection, such

that the output voltage developed across R26 is a multiple of the algebraic difference of the inputs at the Q6 and Q7 bases.

The damping inverter delays the error signal so that mechanical and electrical response times are compatible. This circuit technique prevents the error signal from increasing at a rate faster than the mechanical system can reduce it, thereby preventing oscillations of the servo system. Separate compensation is provided for each range through the connections of deck 1D of the multiplier switch to the base of the damping inverter amplifier, Q9.

Also connecting to Q9 base is the stop/start circuit of the remote switch relay and the camera switch. With R27 connecting to ground through the remote switch relay and the camera switch, Q9 is biased to saturation thereby holding the DC output at Q9 collector so that there can be no motor drive. With the ground connection of R27 broken by either the remote switch relay or the camera switch, Q9 responds to (1) the collector output of Q6 in the differential amplifier (regulated range) or (2) the PPS dial output in the "H" position of the multiplier switch (Unregulated range).

The resistive connections of deck 1E of the multiplier switch in the Q9 output circuit provide feedback for reduced gain in the X1 and X10 speed ranges.

The output of the damping inverter goes to one input of the gate circuit, Q10, and Q11. The other input of the gate circuit, Q11, is fed by a 120 HZ sawtooth wave developed in the sawtooth generator. In this circuit 60 HZ is full wave rectified and generates a sawtooth wave.

d) SAWTOOTH WAVE GENERATOR

The sawtooth wave generator is composed of R42, C17, R43, R41, R40, C16, Q14 and Q13. R42 couples the 60HZ rectified voltage from the bridge rectifier BR1 to the base of Q14, C17 and R43 filter and bias Q14. Q14 saturates each time the input exceeds one volt causing Q13 to cutoff and allowing C16 to charge through R40. When the bridge voltage drops to zero (at zero crossing of AC line). Q14 stops conducting allowing R41 to saturate Q13; discharging C16. The cycle repeats when BR1 output exceeds one volt.

e) GATE AMPLIFIER AND SCR TRIGGER AMPLIFIER

The gate circuit of Q10 and Q11 produces an output whenever the sawtooth voltage is one volt greater than the error signal from Q9. This gate output pulse is therefore, at the same frequency as the sawtooth generator (120 HZ) and is time synchronized with the zero crossing of the line voltage sine wave. If the error signal is high (low voltage at Q10 base due to inversion of Q9) the time delay of the gate will be small resulting in maximum motor drive. If the error signal is small (high voltage at Q10 base due to inversion of Q9) the delay will be great resulting in little or no motor drive.

The gate output pulses are differentiated by C13 and trigger amplifier Q12 amplifies the trigger pulses that go to the SCR motor control circuit.

f) SCR MOTOR CONTROL CIRCUIT

60 HZ line power connects to the SCR motor control circuit to furnish drive power. SCR conduction occurs in Q19 when a trigger pulse occurs and a positive AC half cycle is present at Q19. Conduction occurs through Q19 and D12. SCR conduction occurs in Q20 when a trigger pulse occurs and a negative AC half cycle is present at D11 and Q20. Conduction occurs through D11 and Q20. In either case, conduction stops when the input AC voltage drops to zero volts thereby cutting off the SCR that is conducting. The gated 60 HZ drive is full wave rectified by the output diode bridge for DC motor operation. In this way the SCR motor control circuit provides variable drive for the camera motor to respond to the speed control circuit demands.

The AC input to the SCR motor control circuit is connected through the cutoff switch, located in the film compartment, to stop the motor at the end of the film run. Capacitor C22 connected across the cutoff switch acts as an arc suppressor.

NOTE

For cameras serial No. 900 and above the bridge rectifier has been eliminated by an SCR diode bridge assembly. The motor power remains DC. Refer to schematic 130017 Rev. G (rear of manual) for details.

g) REGULATED POWER SUPPLY

The regulated power supply consists of transistors Q15, Q16, Q17 and Q18, also Diodes D8 and D9. The functions of these components are as follows:

Q15 and D8 - First amplifier compares the supply voltage derived by the resistive division of R44 and R45 with the reference voltage of Zener Diode D8 and amplifies the error difference.

 $\rm Q16$ - The second amplifier stage amplifies the error signal and impedance matches $\rm Q15$ to $\rm Q17.$

Q17 - The series pass element, Q17, is controlled by the error signal to hold the supply voltage constant.

Q18 and D9 - The current cut off transistor (Q18) compares the voltage developed across R50, which is a function of circuit current, and the reference voltage of Zener Diode D9. As long as circuit current is below the cut off limit, Q18 is biased to saturation by R48. When excessive circuit current develops a voltage across R48 that exceeds the reference voltage of Zener Diode D9, Q18 resistance is increased to hold the current, approximately 250 ma.

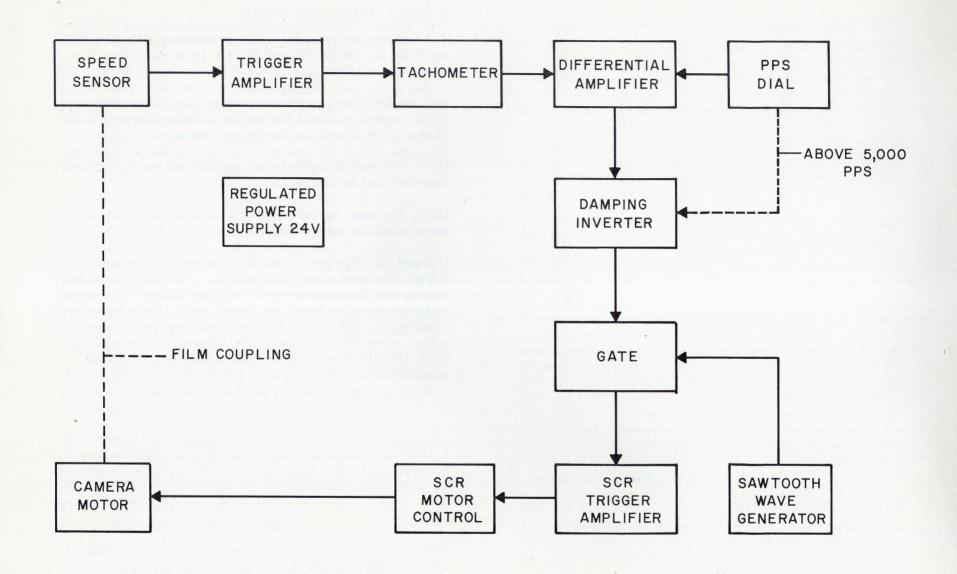


FIG. 2-1 FUNCTIONAL DIAGRAM HYCAM ELECTRONIC SPEED CONTROL

INSTALLATION

3-1 MOUNTING THE CAMERA

Mounting holes are located on the base of the camera. In the center are both 1/4 - 20 and 3/8 - 16 tripod mounting inserts and two 3/8 - 16 inserts at the edge of the camera base. The camera is designed to operate in any orientation, and withstand normal vibration, or shock.

For tower mounting, it is recommended that all three, 3/8 - 16' mounting holes be utilized for maximum stability.

3-2 ELECTRICAL REQUIREMENTS

a) 115 VOLT HYCAM:

Operates on 115 volts AC, 60 Hz, 20 Amp. power source; in the unregulated range a 30 amp. source is required.

b) 230 VOLT HYCAM

Operates on 230 volts AC, 60 Hz, 7.5 Amp. power source; in the unregulated range a 20 amp. source is required.

NOTE

Power fed from an auto-voltage regulator may cause the speed sensor circuitry in the HYCAM to malfunction. Some portable generators have a voltage regulator similar to the auto-voltage regulators, so the cameras and generators should have a preliminary test together before proceeding to a remote site.

CAUTION

THE HYCAM POWER CORD AND OUTLET IS A STANDARD 3 WIRE GROUNDED SYSTEM, AND THE GROUND WIRE SHOULD BE TERMINATED TO A PROPER ELECTRICAL GROUND.

OPERATION

4-1 INTRODUCTION

This section provides information on controls, electrical connections, focusing, exposure, and general operation.

4-2 CAMERA TEST

It is recommended upon receipt of the HYCAM that all components be assembled, and test runs made to become familiar with operational procedures before attempting formal photography.

4-3 CONTROLS (SEE FIGURE 4-1 & 4-2)

a) H-L SPEED REDUCER LEVER: (Models K20S4E, K20S4AE and K20S4BE)

This control is located at the side of the speed reducer housing. The high range is indicated by "H"; in which the take up spindle is coupled to the camera motor with a 1 to 1 ratio for frame rates above 100 PPS. The low range is indicated by "L"; in which the take up spindle is geared down with a coupling ratio of 32 to 1 for frame rates below 100 PPS.

NOTE

When changing gear ratios make sure the speed reducer lever is fully engaged in the indent position.

At the front of the motor is a shaft with a coin slot to enable the operator to rotate the motor to assist in engaging the speed reducer. This shaft must be turned counterclockwise when changing gear ratio to take-up film slack.

b) H-L SERVO BRAKE LEVER:

This control is located on the front of the camera. The "H" setting is used for frame rates over 1,000 PPS, and the "L" setting is used for under 1,000 PPS.

c) DRAG BRAKE CONTROL:

The drag brake setting for frame rates below 1,000 PPS is 30. The setting for frame rates above 1,000 PPS is "0"

NOTE

Before setting the drag brake control, rotate it as many turns as necessary to bring the drag brake dial flush with the drag brake housing. Then rotate the drag brake control to the desired "0" or "30" setting.

d) PPS DIAL

The PPS dial is used to set frame rates in conjunction with the multiplier switch for frame rates in the regulated range.

This dial control has three number wheels; tens of digits, digits, and tenths of a digit. The lock lever at the bottom of the dial provides a means of locking the setting.

e) MULTIPLIER SWITCH

For regulated frame rates, the frame rate is the PPS reading multiplied by the multiplier switch for the appropriate format. As an example, for 4,000 PPS with full frame 16 mm format, the PPS dial should be set at 40.0 and the multiplier switch should be set at X100.

The upper X100 marking indicates a multiplication of 100. The lower "H" marking indicates the speed reducer lever should be set at "H" for the proper gear ratio. The only time the PPS dial will read the actual frame rate is when operating in the regulated range with full frame 16 mm format and the multiplier switch at X1/L. The multiplier switch should not be changed while the camera is running, as arcing will burn out the contacts.

f) CAMERA STOP/START SWITCH

The camera switch connects the motor in the "START" position to AC voltage. This switch should not be thrown to "START" until the unit has been plugged into the line power for at least 10 seconds. This allows the electronic control circuitry to stabilize.

The remote control outlet is in parallel with the camera stop/start switch, and allows remote stop or start actuation.

- 1 TIMING LIGHT CONNECTORS
- 2 DRAG BRAKE CONTROL
- 3 PPS DIAL
- 4 MULTIPLIER SWITCH
- 5 STOP/START SWITCH
- 6 ELECTRONIC CONTROL MODULE
- 7 OPTICAL HEAD
- 8 FRAME RATE SENSING CONNECTOR & PLUG
- 9 SERVO BRAKE CONTROL

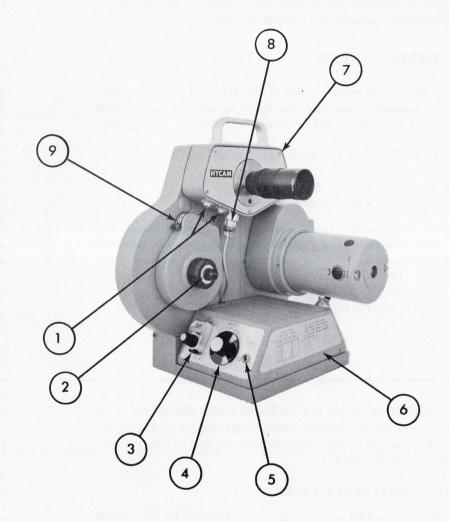


FIG. 4-1 CAMERA NOMENCLATURE

- 1 POWER CONNECTOR
- 2 SHUTTER PULSE CONNECTOR
- 3 MOTOR PLUG
- 4 EVENT CONNECTOR
- 5 REMOTE CONNECTOR
- 6 FUSE HOLDER
- 7 SPEED REDUCER CONTROL
- 8 MOTOR CONNECTOR

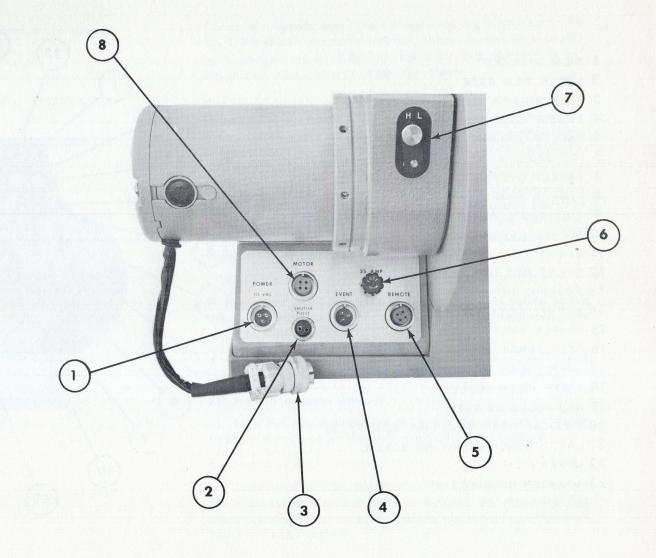


FIG. 4-2 CAMERA NOMENCLATURE

- 1 FILM SPROCKET
- 2 LOWER FILM GATE
- 3 FILM ROLLER
- 4 TAKEUP EJECTOR BUTTON
- 5 TAKEUP DAMPING ROLLER
- 6 100' SPOOL ADAPTER MOUNTING HOLE (3)
- 7 TAKEUP COMPARTMENT ROLLER
- 8 TAKEUP SHAFT
- 9 200' SPOOL ADAPTER MOUNTING HOLE (3)
- 10 SUPPLY DAMPING ROLLER
- 11 EVENT SYNC, SCALE AND SETTING KNOB
- 12 EVENT FOOTAGE FOLLOW ARM ADJUST
- 13 FOOTAGE INDICATOR
- 14 EVENT FOOTAGE FOLLOWER
- 15 SUPPLY SHAFT
- 16 SERVO BRAKE ARM
- 17 SUPPLY EJECTOR BUTTON
- 18 FIRST IDLER ROLLER
- 19 RED FOCUSING GATE
- 20 OPTICAL HEAD MOUNTING SCREWS (3)
- 21 LATCH BLOCK MOUNTING SCREW
- 22 UPPER FILM GATE
- 23 'U' PRISM HOUSING

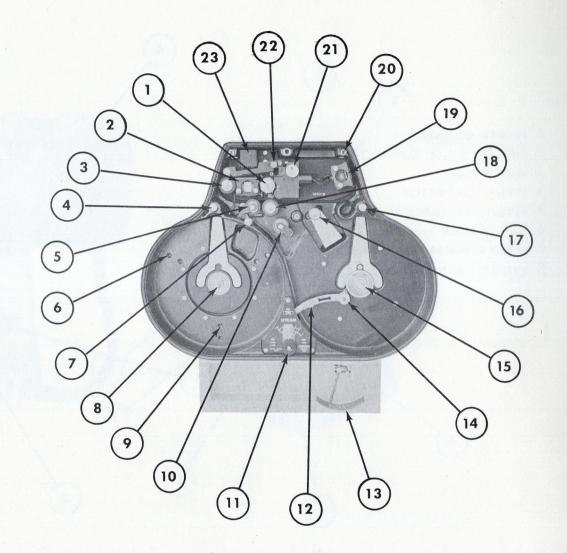


FIG. 4-3 FILM COMPARTMENT

4-4 ELECTRICAL CONNECTIONS

There are five connectors on the connector panel of the camera. (See Figure 4-2)

a) POWER CONNECTOR:

115 volt models - A three pin male connector (MS3102A-14S-7P-639)

230 volt models - A three pin male connector (MS3102A-14S-7PX-639)

b) EVENT CONNECTOR:

A three pin male connector (MS3102A-14S-7PY-639). The upper pins of this connector are marked; "NO" (normally open), and "NC" (normally closed) with the bottom pin common.

c) MOTOR CONNECTOR:

115 volt models - A four pin female connector (MS3102A-14S-2S-639)

230 volt models - A four pin female connector (MS3102A-14S-7S-639)

d) REMOTE CONTROL CONNECTOR:

A four pin connector (MS3102A-14S-2SX-639)

e) SHUTTER PULSE CONNECTOR

A two pin female connector (Amphenol 80-PC-2-F)

There are three connectors on the underside of the optical head. (See figure 4-1)

f) TIMING LIGHT CONNECTORS: (2 Required)

A two pin male connector (Amphenol 80-PC-2-M)

g) FRAME RATE SENSING CONNECTOR:

Connects electronic speed control circuit, mated at factory. (Amphenol 126-216)

4-5 FRAMING AND FOCUSING

Direct, through-the-lens framing and focusing is provided with the 1/2.5 shutter normally supplied. When shutters with smaller openings are used, a full field of view is not seen, so to see the full image area, it is necessary to rotate the shutter.

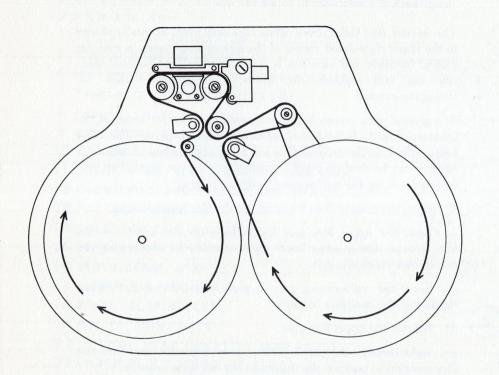
The Model RLFG-1 ground glass focusing gate; normally stored in the upper right hand corner of the film compartment, is used for critical focusing and viewing. It is red anodized for positive identification and replaces the lower, filming gate, while focusing the camera.

The ground glass screen has an engraved cross in the center of the aperture area to focus the eyepiece on the film plane. The cross hairs etched on the ground glass are at 45 degrees from horizontal, so they can be distinguished from the reticle cross hairs. The procedure for using the red focusing gate is as follows:

- a) Open the camera door for access to the film compartment.
- b) Raise the upper film gate by pushing the red button to the left. Remove the existing lower gate assembly by unscrewing the two screws which retain it.
- c) Insert the red focusing gate in place of the lower gate, hand tightening the two thumbscrews.
- d) Relatch the upper film gate.
- e) Sight through the prism of the lower film gate, and turn the film sprocket to position the shutter in the full open position.
- f) Secure the film compartment door.
- g) Rotate the viewing eyepiece to focus the primary objective. For scale focusing of the primary objective, the equivalent film plane is marked by a slot in the handle; which can be used to hook the end of a tape measure.

NOTE

There is an aerial image which can be seen without using the ground glass focusing gate. Never use this image for focusing.



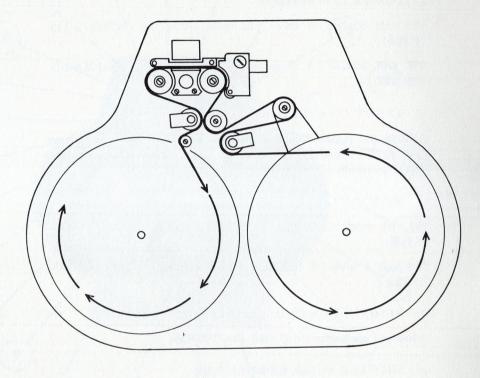


FIG. 4-4 THREADING DIAGRAM NORMAL, EMULSION UP

FIG. 4-5 THREADING DIAGRAM EMULSION DOWN

h) Remove the red focusing gate, and place it in its storage area. Re-insert the regular lower film gate and tighten securely.

i) For focusing on extremely fine lines, or small images, the 30X magnifying viewfinder is available as Model RLFV-30X. It is installed by sliding it in place of the regular viewing eyepiece and securing the thumbscrew. Focusing is done by loosening the thumbscrew on the focusing barrel that rotates on helical threads. It will be helpful to open the lens to the lowest f-stop for critical focusing. (See Section 6, Accessories)

4-6 EXPOSURE

To determine the proper exposure apply the following formula:

SHUTTER EXPOSURE RATIO X
$$\frac{1}{\text{FRAME RATE}}$$
 =

1 OR EXPOSURE TIME SECONDS

With a 1/2.5 shutter and a frame rate of 1,000 PPS the exposure time would be calculated by the formula:

$$\frac{1}{2.5}$$
 X $\frac{1}{1,000}$ = $\frac{1}{2,500}$ (Shutter) (Frame Rate) (Exposure Time)

Shutter exposure ratios are inscribed on the shutter blades for identification. The shutter fraction can be observed by removing the "C" mount lens, or cover, and rotating the shutter by the film sprocket.

a) The Model RLEM-1 exposure meter is available as a guide to selecting correct exposure. See Section 6, Accessories.

b) Rotating prism cameras have a natural aperture that limits the maximum amount of light transmitted through the system. HYCAMS limit is f/3.3; to open the objective lens past f/3.3 the system will not transmit any additional light.

4-7 SHUTTERS

The following shutters are available from Red Lake Labs., Inc.:

FILL I EDAME 16MM VOC 1/25° VOC 1/20

FULL FRAME TOWN	K25-1/2.5	K25-1/20
	K2S-1/5	K2S-1/50
	K2S-1/10	K2S-1/100
1/2 FRAME 16MM & T	RUE 8MM	
	K2S16-1/2.5°	K2S16-1/20

K2S16-1/2.5° K2S16-1/20 K2S16-1/5 K2S16-1/50 K2S16-1/10 K2S16-1/100 (8MM only)

1/4 FRAME 16MM & 1/2 FRAME 8MM K2S32-1/2.5° K2S32-1/10 K2S32-1/5 K2S32-1/20

° STANDARD SHUTTER See section 5-8 for changing or replacing shutters.

4-8 PRE-LOADING INSTRUCTIONS

CAUTION

CHECK TO MAKE SURE THE CAMERA RUN SWITCH IS IN THE OFF POSITION AND DEPRESS THE END-OF-FILM CUTOFF SWITCH ARTIFICIALLY TO INSURE CAMERA IS NOT IN THE RUN MODE.

a) Check the interior of the camera for cleanliness, taking care to remove any emulsion dust or film chips from previous runs. The upper film gate and lower film gate should be checked for emulsion build up. Remove with either an orange stick or soft cloth; never use an abrasive material to clean the film gates.

b) Check the follower arm in the supply chamber and set for use with the proper spool size:

EXTENDED POSITION

100 and 200 foot standard daylight loading spools.

RETRACTED POSITION

When using 3 inch "Z" core with RLL K20F4 split reel.

CENTER POSITION

Standard daylight loading 400 foot spool or split reel with 2 inch "T" core.

In the take up compartment there are two rings of mounting holes spaced 120 degrees apart. The inner ring of holes mounts the 100 foot adapter, and the outer ring mounts the 200 foot adapter to minimize film breakage while using the 100 or 200 foot spools in high speed runs. (See section 6, Accessories)

Located between the supply and take up film compartments is the event adjustment with scales for 100, 200, 400 foot spools, and one for the split reels with 3 inch "Z" core. The 400 foot scale also accommodates split reels with 2 inch "T" core. The footage dial located beneath the camera door has similar scales for footage readings.

c) The latch block assembly (See Figure 4-3) should be checked to determine that the timing light holes are free of any small film chips or dirt. Install the latch block, and lower film gate, fingertight.

d) Connect all required electrical cables.

e) Check for dust or fingerprints on the cover glass, the underside of the "U" prism, and the lens to be installed. If cleaning is required, See Section 5-7, Maintenance.

f) Install the lens in the lens mount at the front of the optical head; making sure it is secure and properly seated in its mount. If a long or heavy lens is used it may be necessary to provide a mounting bracket to adequately support the lens, and assure blur is not induced into the photograph by lens vibration.

g) Check camera mount, or tripod, for basic support and steadiness.

4-9 LOADING INSTRUCTIONS EMULSION UP

The following loading instructions apply to normal objective lens photography. Refer to Section 4-10, for Oscillo Loading Instructions, Streak, or Synchroballistic Photography.

1) The camera should be loaded with the operator, camera, and film under an adequate dark cloth, or other means to shield the film and camera from light fogging the film.

2) Place the film spool on the supply spool shaft with the film coming off in a clockwise direction.

3) Pull out approximately two feet of film from the supply spool, and thread the film onto the take-up spool as shown in Fig. 4-4.

CAUTION

CONTINUAL USE OF PLASTIC FILM CORES ON THE TAKE-UP SPOOL AT HIGH SPEEDS WILL COMPRESS AND EVENTUALLY CRACK FROM FATIGUE. THEREFORE, THE FILM COMPARTMENT DOOR SHOULD ALWAYS BE CLOSED AT HIGH SPEED RUNS, AND PLASTIC FILM CORES PERIODICALLY REPLACED.

4) Turn the take-up spool by hand making sure two or more wraps of film are on the spool, and the end of the film is securely in the film slot. Check that the film is feeding smoothly, and that the film is depressing the cutoff switch actuator arm.

5) Snap the upper film gate into its locked position.

4-10 LOADING INSTRUCTIONS, EMULSION DOWN

The following loading instructions apply to oscillograph, streak, and syncroballistic photography.

- 1) The position of the supply damping roller must be re-adjusted from normal threading. The mounting screw is located on the front of the film transport adjacent to the Optical Head speed sensor connector. Loosen the screw and adjust the roller to the approximate position as shown in Fig. 4-5 and secure the mounting screw.
- 2) The camera should be loaded with the operator, camera, and film under an adequate dark cloth, or other means to shield the film and camera from light fogging the film.
- 3) Place the film spool on the supply spool shaft with the film coming off in a counter clockwise direction.
- 4) Pull out approximately two feet of film from the supply spool, and thread the film onto the take-up spool as shown in Fig. 4-5.

CAUTION

CONTINUAL USE OF PLASTIC FILM CORES ON THE TAKE-UP SPOOL AT HIGH SPEEDS WILL COMPRESS AND EVENTUALLY CRACK FROM FATIGUE. THEREFORE, THE FILM COMPARTMENT DOOR SHOULD ALWAYS BE CLOSED AT HIGH SPEED RUNS, AND PLASTIC FILM CORES PERIODICALLY REPLACED.

- 5) Turn the take up spool by hand; making sure two or more wraps of film are on the spool, and the end of the film is securely in the film slot. Check that the film is feeding smoothly, and that the film is depressing the cutoff switch actuator arm.
- 6) Snap the upper film gate into its locked position.

NOTE

The film will be "emulsion out" on the take-up spool. This should be noted on the exposed film container, and called out to the processing lab's attention.

4-11 TIMING LIGHTS

The two connectors for the timing lights are under the optical head on the front side of the camera. The outer connector is for the outer timing light, and the inner connector is for the inner timing light. A 6.8K ohm resistor is connected in series with each timing light. These resistors are located on the circuit board of the electronic control module and must be removed and replaced to equally balance the line if several cameras are to be run in parallel from one timing light generator.

If a timing light generator is not available, the timing lights can be operated from a 115 volt, 60 Hz source or 230 volt, 60 Hz source (lamp resistance doubled). This will result in 120 pips per second on the film. Due to the relatively long pulse width of AC firing, the light pips will be elongated over a large area of film. These long pips are fairly difficult to read and count, but can be used to determine frame rate.

The following timing light generators are available from Red Lake Labs, Inc.:

1) MODEL RLTLG-4 MILLI-MITE TIMING LIGHT GENERATOR

With 10, 100, and 1000 pulses/second output. Variable output current to lamps. Operates on 115 volts AC, 60 Hz or internal 45 volt battery with automatic switching.

2) MODEL RLMMTLG-2

A compact ruggedized unit with 10, 100, and 1000 pulses/second output designed for 28 VDC operation.

4-12 EVENT SYNCHRONIZER

With the camera door open, the event synchronizer can be seen as shown in Fig. 4-3. The knurled knob provides for any setting between zero and maximum film footage. With the camera door open, the follower arm; which actuates the event switch is retracted. The follower arm has a mechanical compensation adjustment which must be set for the film spool core being used, so that event triggering will correspond to the event adjustment.

When the door is closed, the follower arm rests against the film, and follows the film perimeter as the film is unwound from the spool. When the arm reaches the pre-determined set position for event triggering, the event switch actuates, opening or closing the event circuit as determined by the event cord wiring. With the event cord wired for an event at 100 feet; when 100 feet of film has been run off, the event switch activates to close the event circuit.

CAUTION

WHEN THE EVENT SYNCHRONIZER CIRCUIT OF THE CAMERA IS USED IN CONNECTION WITH AN ORDNANCE OR OTHER HAZARDOUS EVENT, IT BECOMES PART OF THE FIRING CIRCUIT, AND MUST BE TREATED WITH THE SAME PRECAUTION GIVEN TO FIRING PANELS. WHEN USING THE EVENT SYNCHRONIZER IN NORMALLY OPEN MODE, DO NOT CONNECT THE EVENT SYNCHRONIZER PLUG UNTIL THE CAMERA HAS BEEN COMPLETELY ALIGNED, FOCUSED, LOADED, AND IS IN A "READY" CONDITION. THE EVENT SYNCHRONIZER PLUG SHOULD ALWAYS BE DISCONNECTED BEFORE OPENING THE CAMERA DOOR.

When using the event synchronizer in the normally closed mode, it is difficult to insure that a fail-safe condition exists at all times. The event can be triggered if any of the many segments of the circuit are open. Therefore, the normally closed mode is not recommended unless it is impractical. The "NC", and "NO" circuits can be inadvertently triggered while the camera is wired to event by:

a) Closing the camera door with no film, or spool on the supply side.

b) Adjusting the event synchronizer setting knob, while the camera system is in a "Ready" condition.

c) Improper setting of the follower arm.

NOTE

The event synchronizer circuit is activated by a 5 ampere capacity switch, and users should fuse the event circuit line external from the camera.

4-13 SHUTTER PULSE (optional)

The Model K2PP-2 shutter pulse assembly is available with the HYCAM optical head at time of purchase or can be customer installed in the field.

This assembly establishes a light path between a lamp and photocell. Shutter blades interpose the light beam providing output pulses synchronized with the shutter opening.

Shutter phasing with a Strobe-Light unit is accomplished by directing the strobe light into the "C" mount aperture opening, and triggering the strobe light with the output signal from the shutter pulse assembly.

The strobe light must be synchronized to the shutter open time; per frame rate selection, because the shutter pulse assembly output signal varies slightly with the length of shutter opening time. If compensation is required in order to synchronize the shutter opening, the shutter pulse assembly can be mechanically adjusted, or a flash delay unit may be used in conjunction with the strobe light.

Output at the shutter pulse connector (Amphenol 80 PC 2F) on the connector panel is approximately 15 volts into a 15K OHM load at speeds to 6,000 PPS. The pulse amplitude falls off gradually above 6,000 PPS to approximately 5 volts peak at 11,000 PPS. A (Amphenol 80-PC-2F) mating cable connector is supplied with the K2PP-2; pin 2 of this plug provides a positive pulse, and pin 1; a negative pulse.

NOTE

The standard 1/2.5 shutter supplied with the HY-CAM optical head is the only shutter that can be used with the shutter pulse assembly and still retain a full 16mm film format.

a) Shutter synchronization procedure with the shutter pulse assembly (See Figure 5-2, Maintenance)

- 1) Load the camera with a dummy spool of film.
- 2) Remove the front panel of the optical head.

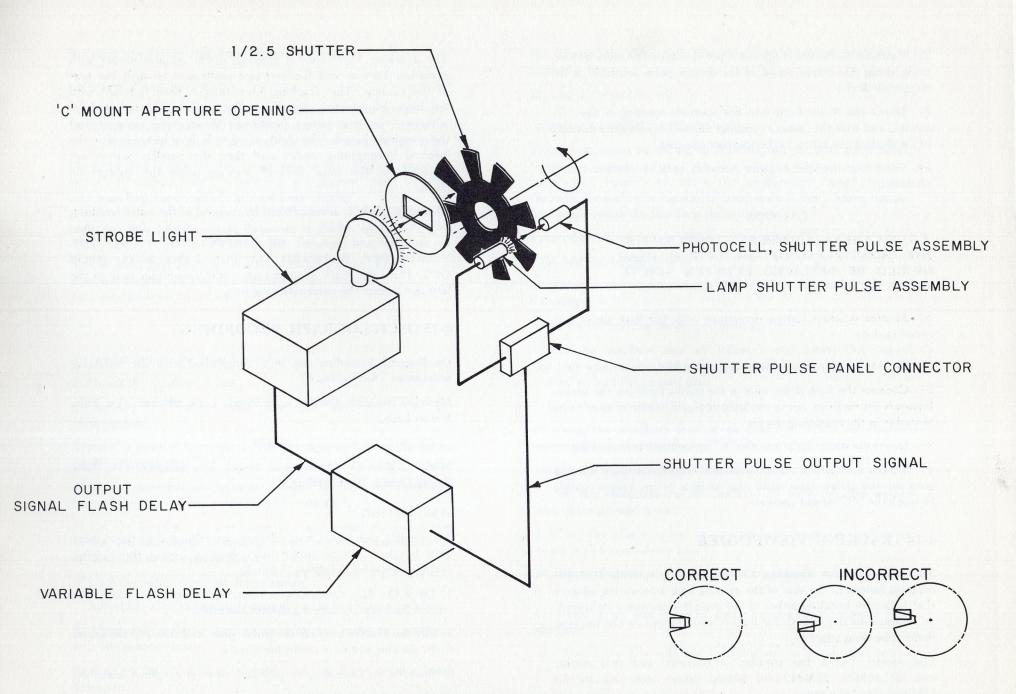


FIG. 4-6 FUNCTIONAL DIAGRAM-SHUTTER SYNCHRONIZATION WITH FLASH DELAY

- 3) Connect the Strobe Light unit per the manufacturers instructions, using the output signal of the shutter pulse assembly as the triggering device.
- 4) Direct the strobe light into the aperture opening of the "C" mount, and with the camera running; visually observe the position of the shutter in relation to the aperture opening.
- 5) Reposition the shutter pulse assembly until synchronization is obtained.

CAUTION

IF THE CAMERA IS TO BE RUN ABOVE 500 PPS, THE FRONT PANEL OF THE OPTICAL HEAD SHOULD BE REPLACED BETWEEN ADJUSTMENTS.

- b) Shutter synchronization procedure with the flash delay unit (See Fig. 4-6)
- 1) Load the camera with a dummy spool of film.
- 2) Connect the flash delay unit to the strobe light per the manufacturers instructions, using the output signal of the shutter pulse assembly as the triggering device.
- 3) Direct the strobe light into the "C" mount aperture opening.
- 4) Set the flash delay unit at zero, and with the camera running increase the delay time until the shutter is no longer visible through the "C" mount aperture.

4-14 TRACKING VIEWFINDER

The Model TVF-1 Tracking Viewfinder for use with HYCAM cameras fastens to the side of the camera with a mounting adapter that is factory installed either at the time the camera is delivered, or returned to the factory for factory installation: of the tracking finder mounting adapter.

The Model TVF-1 has parallax adjustment, and two masks; one for 15MM, 25MM, and 50MM lenses, and one for 75 MM and 150MM lenses.

The Tracking Viewfinder is oriented in the adapter mount with a mating keyway and the eyepiece positioned towards the rear of the camera. The Tracking Viewfinder is then fastened with the large thumbscrew. Parallax adjustment is accomplished by adjusting the two screws positioned 90 degrees apart around the eyepiece barrel. The field of view is first located with the internal boresighting optics and then the parallax screws are adjusted for the same field of viewing using the appropriate mask.

Changing masks is accomplished by removal of the outer retaining ring. The mask which is mounted in an adapter ring can then be removed and replaced. BE CAREFUL NOT TO TIP THE VIEWFINDER FORWARD OR THE LENS WILL DROP OUT. Place the mask adapter ring in the viewfinder next to the lens and replace the outer retaining ring.

4-15 OSCILLOGRAPH RECORDING

Oscillograph recording can be accomplished with the following accessories: (See section 6)

Model K20SA-1P Oscillo and Streak Lens adapter. (To Take Pentax Lens)

OR

Model K20SA-1F Oscillo and Streak lens adapter. (To Take Fastax Lenses, 50mm and up)

a) MOUNTING

The Oscillo and Streak lens adapters are mounted to the camera door by the same mounting holes used to mount the viewing evepiece. Proceed as follows to install:

- 1) Open the film compartment door, and loosen the screw that secures the eyepiece capping shutter assembly.
- 2) Lift the shutter strip off the guide post, and rotate it for access to the viewing eyepiece mounting screws.
- 3) Remove the mounting screws and viewing evepiece assembly.
- 4) Mount the Oscillo/Streak lens adapter with the same screws used to mount the viewing eyepiece mount.

5) Rotate the Shutter Strip back in place, and secure.

b) PULSE RECORDING

For pulse recording of Oscilloscope images, it is necessary to rotate the image 90 degrees by either; laying the Oscilloscope on its side, or reversing the X and Y connections to the cathode ray tube.

Since the film is moving, the sweep rate of the Oscilloscope must be fast enough so that the image is not blurred. Also, the film rate must be great enough to prevent trace overlap.

NOTE

The scope signal must be synced with an internal or external trigger, so that the signal remains stationary on the cathode ray tube face.

Proceed as follows for Pulse Recording:

- 1) Mount the Auxilliary Lens.
- 2) Remove the regular lower film gate, and install the Red focusing gate.
- 3) Insert a piece of focus film in the film gate, and rotate the frame position to open shutter.
- 4) Set the objective lens focus at "infinity" to focus on the crossed lines of the ground glass in the Red focusing gate.
- 5) Set the auxilliary lens at "infinity", and rotate the outer ring of the lens adapter by loosening the locking screw and focus the crossed lines of the ground glass.
- 6) Lock the outer ring of the lens adapter.
- 7) Adjust the oscilloscope trace for maximum brightness, and focus.
- 8) Using the objective lens as an eyepiece, focus the auxilliary lens on the scope trace.
- 9) Remove the Red focusing gate, and install the regular lower film gate.

- 10) Thread the film with the emulsion down as outlined in Section 4-10.
- 11) Cap the objective lens.

c) SIMULTANEOUS RECORDING

For simultaneous recording of framing images, and oscilloscope images, it is required that the film being used have a film base transparent enough to allow the oscilloscope image to pass through. Kodachrome cannot be used since it has a heavy opaque backing between the film base and emulsion.

Proceed as follows for Simultaneous Recording:

- 1) Mount the Auxilliary lens.
- 2) Remove the regular lower film gate, and install the Red focusing gate.
- 3) Rotate the framing position to open shutter.
- 4) Set the auxilliary lens at 'infinity', and rotate the ring of the lens adapter by loosening the locking screw and focus the crossed lines of the ground glass.
- 5) Lock the outer ring of the lens adapter.
- 6) Using the auxilliary lens as an eyepiece, focus the framing image with the objective lens.
- 7) Record the focus setting of the objective lens.
- 8) Set the objective lens at 'infinity' to focus on the crossed lines of the ground glass.
- $9)\ Using the objective lens as an eyepiece, focus the oscilloscope image with the auxilliary lens.$
- 10) Return the objective lens to the focus position recorded in Step 5.
- 11) Remove the Red focusing gate, and install the regular lower film gate.
- 12) Thread the film with the emulsion up; as outlined in Section 4-9.

4-16 STREAK RECORDING

Streak recording can be accomplished with the following accessories: (See Section 6)

Model K20SA-1P Oscillo and Streak lens adapter. (To take Pentax Lens)

OR

Model K20SA-1F Oscillo and Streak lens adapter. (To take Fastax Lenses, 50MM and up)

AND

Model K2SA-1 Streak Attachment-

The Model K2SA-1 streak attachment is a lower gate assembly with a zero to .040 inch adjustable slit. The slit is adjusted by loosening the two set screws at the front side of the gate using an .050 inch Allen wrench, and moving the tabs located just above the screws to set the slit opening.

Proceed as follows for Streak Recording:

1) Mount the auxilliary lens.

2) Remove the regular lower film gate, and install the Red focusing gate.

3) Insert a piece of focus film in the film gate, and rotate the frame position to open shutter.

4) Set the objective lens focus at "infinity" to focus on the crossed lines of the ground glass in the Red focusing gate.

5) Set the auxilliary lens at "infinity", and rotate the outer ring of the lens adapter by loosening the locking screw and focus the crossed lines of the ground glass.

6) Lock the outer ring of the lens adapter.

7) Remove the Red focusing gate, and install the streak attachment.

8) Thread the film with the emulsion down; as outlined in Section 4-10.

9) Cap the objective lens.

4-17 SYNCHRO BALLISTIC STREAK RECORDING

Synchronizing the film movement with a moving object requires: film rate speed synchronized with image motion, and if the film is moving in a left to right direction, the object motion must be moving in a right to left direction.

a) CALCULATING FILM SPEED

To calculate the proper film speed for synchronization, divide the object velocity by the lens multiplier ratio, for example:

To synchronize an object traveling at a velocity of 6,000 feet/second, and the lens slit to subject distance is 100 feet using a 1.968 focal length lens.

Lens Multiplier Ratio
$$\frac{100'}{1.968} = 50.8$$

FILM SPEED REQ.D FOR SYNCHRONIZATION
$$\frac{6000/\text{sec}}{50.8} = 118\text{``/sec}$$

MULTIPLIER SWITCH AT
$$\frac{X10}{H}$$

b) CALCULATING EXPOSURE TIME

To calculate exposure time, divide the slit opening by the film rate of speed, for example:

If you have a slit opening of .040" and the film rate of speed is 118"/second, calculate exposure:

$$\frac{.040}{118"/\text{sec.}}$$
 = 338 x 10⁻⁶ OR 338 Micro-seconds

c) CALCULATING IMAGE SMEAR

In slit streak photography of relatively flat subjects, such as the traveling spot of an oscilloscope, the width of the slit will have little effect on image smear. However, photographic subjects that have extreme depth of field will produce an image smear inversely proportional to slit width, and also, inversely proportional to the lens multiplier ratio. To calculate the image smear for synchronized recording, proceed as follows:

Sample conditions:

Focal Length of lens - 2.000"

Slit aperture opening - .050"

Minimum distance lens - 10'0" slit to subject

Maximum distance lens - 10'2" slit to subject

1) Divide the slit opening by the lens focal length to determine the tangent of the angle formed by the lens, and slit opening.

$$\frac{.050}{2} = .025$$

- $^{\circ}$ Substitute 16 MM frame format height of .300 if not using a slit aperture.
- 2) Divide the minimum distance by the lens focal length to determine the lens multiplier ratio:

$$\frac{10^{\circ}0^{\circ}}{2.000^{\circ}}$$
 = 60 Lens Ratio Multiplier

3) Multiply the tangent of the angle formed by the lens, and slit opening, times the difference of the maximum subject distance, and minimum subject distance:

$$.025(10^{\circ}2^{\circ}-10^{\circ}0^{\circ}) = .050$$

4) Divide the result by the lens multiplier ratio to determine image smear:

$$\frac{.050}{60}$$
 = .000833 IMAGE SMEAR

MAINTENANCE

5-1 INTRODUCTION

The HYCAM has been designed to require a minimum of maintenance, and preventative care. There is no lubrication necessary for the life of the camera provided normal use and handling is observed. Routine cleaning of the exterior, and clean up of the film compartment will assure trouble free operation, and longer equipment life.

5-2 SERVO BRAKE ADJUSTMENT

Using a linear tensioning device, check the tension on the servo brake roller arm in the film compartment for the amount of tension required to free the supply spindle. This should be 28 ounces with the servo brake adjustment at "H", and 18 ounces with the servo brake at "L".

For access to the servo brake adjustment, open the camera door and remove the four 6-32 socket head cap-screws which secure the drag brake, and servo brake housing. Loosen the set screw in the brass block securing the servo brake tension spring and rotate to lengthen, or shorten the tension spring as required.

5-3 DRAG BRAKE CHECK AND ADJUSTMENT

The following is a step-by-step procedure for checking, and adjusting the drag brake mechanism.

- A. Secure the servo brake arm in the released position. (A rubber band may be used for this purpose.)
- B. Rotate the drag brake control knob counterclockwise beyond the '0' (zero) setting.
- C. Rotate the supply spindle back and forth in a circular motion while slowly rotating the control knob in a clockwise direction until a distinct click is heard.
- D. If '0' (zero) is not indicated on the control dial, alignment is made by:
- 1) Loosen the set screw in the control knob and remove.
- 2) Re-install with the setting properly aligned at '0' (zero).

3) Push the knob in with the skirt flush to the housing and secure the set screw.

NOTE

With the drag brake control set at "30", the amount of torque required to rotate the supply spindle should be between 8 and 12 oz. in.

- E. Re-Check the system per steps "B" and "C" to assure setting is correct.
- F. Re-set the servo brake arm.

5-4 DRAG BRAKE REPLACEMENT

Remove the drag brake and servo brake housing by the four 6-32 socket head cap-screws. The drag brake pad will fall out of the housing when it is turned over. When the brake pad unit is replaced, the disc tension spring should be in place first, and then the brake pad set in place with its slot in the indexed position.

5-5 FILM ROLLER REPLACEMENT

Periodically the film roller bearings should be checked for wear. If replacement is necessary, the film rollers are removed with a single screw. The shims behind the roller should be retained, and installed with the new roller.

5-6 FILM GATE AND PINCH ROLLER ADJUSTMENTS

Film clearance between the sprocket and the upper film gate, and between the sprocket and the pinch roller assembly in the latch block are adjustable. These adjustments are set to accommodate film thickness up to .0065 inch.

Film clearance adjustments should only be made if they have changed as evidenced by improper operation of the camera. Too tight of an adjustment can result in emulsion build up, and slower frame rates. Too loose a setting can cause "breathing" of the film during exposure, resulting in 'rolling' pictures.

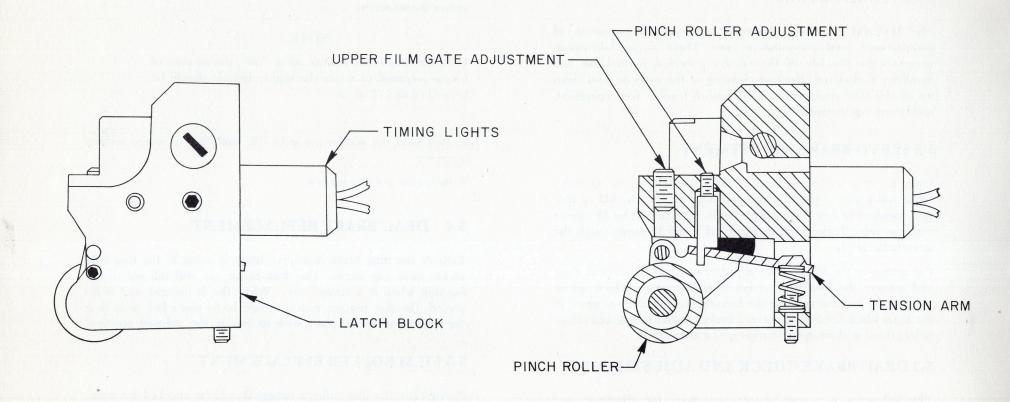


FIG. 5-1 FILM GATE AND PINCH ROLLER ADJUSTMENTS

Film gate and pinch roller adjustments are as follows:

1) Upper Film Gate Adjustments:

With the upper film gate removed, adjust the set screw as shown in Figure 5-1 so when the upper film gate is closed there is .008 clearance between the upper film gate track, and the film sprocket. A modified feeler gauge may be used for this purpose.

2) Pinch Roller Adjustments:

The pinch roller is spring loaded, and its purpose is to keep the film firmly against the sprocket, but without excessive pressure that would cause any emulsion buildup. Remove the upper film gate, and check the clearance by depressing the tension arm at the right of the latch block under the timing lights.

Proper clearance between the pinch roller and the film sprocket with the upper film gate closed should be .0075 to .0085 inches. The pinch roller adjustment is visible with the upper gate removed, as shown in Figure 5-1.

5-7 CLEANING THE OPTICS

The internal optics are located in a gasketed, dust free compartment. Routine checks should be made every few months by looking through the viewing eyepiece with the shutter open and lens cap removed to reveal, if any, foreign matter that has collected on the optics.

CAUTION

NEVER ATTEMPT TO REMOVE, OR ADJUST ANY OF THE FIXED GLASS OPTICAL COMPONENTS OF THE HYCAM OPTICAL HEAD. THE ONLY FIELD REMOVABLE ITEMS ARE THE FRONT COVER GLASS, AND THE ROTATING PRISM ASSEMBLY. ALL OTHER OPTICAL COMPONENTS REQUIRE FACTORY ALIGNMENT.

All the internal optics of the HYCAM optical head can be cleaned with any reputable, commercial grade, lens cleaner.

Wipe off the optical elements with a swab moistened in lens cleaner with soft single strokes.

5-8 ACCESS TO THE INTERNAL OPTICS

(See Figure 5-2)

- 1) Remove the optical head front panel by the six screws around the panel perimeter.
- 2) Remove the lens mounting plate by first loosening the tension screw to the right of the "C" mount. Then remove the four screws mounting the lens mounting plate, and carefully pull free.
- 3) Remove the shims on the prism, sprocket, and shutter assembly.

NOTE

Shutter change or replacement can be accomplished by removing the eight flat head screws securing the shutter. Be extremely careful not to bend the shutterblades.

- 4) With the lens mounting plate removed, clean the internal optics as previously described.
- 5) To clean the glass window of the "C" mount, remove the four flat head screws securing the front aperture mask, and withdraw the "0" ring and glass window.

5-9 OPTICAL HEAD ASSEMBLY

The lens mounting plate mounts the front bearing of the prism, sprocket, and shutter assembly. Care should be exercised when installing this assembly to avoid the possibility of high speed malfunction due to improper installation.

1) Reset the shims on the prism, sprocket, and shutter assembly. These shims furnish the proper preload for the front bearing of the assembly. If there is doubt in having the proper shims, re-shim per Section 5-10a.

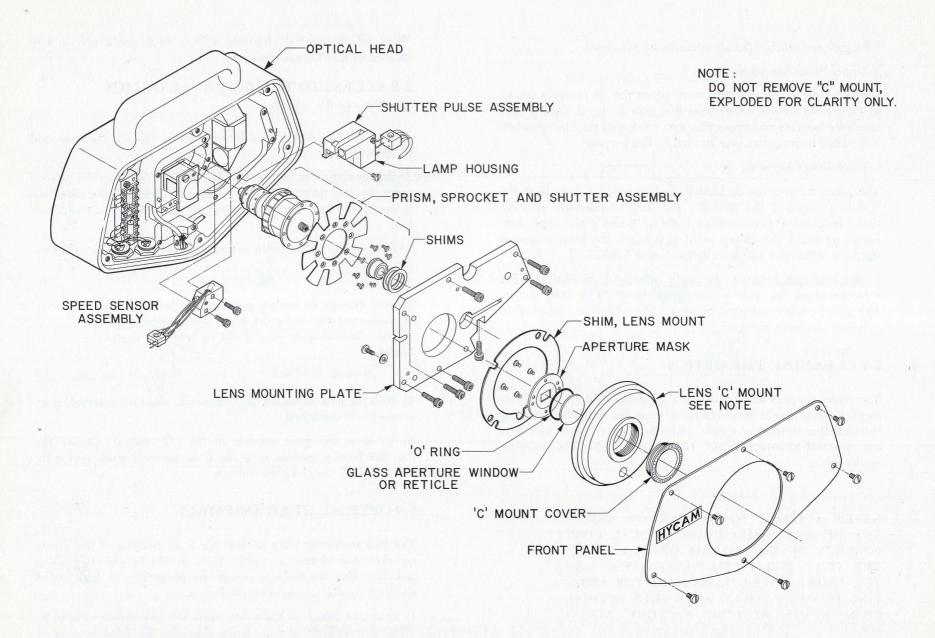


FIG. 5-2 HYCAM OPTICAL HEAD

- 2) Put the lens mounting plate in position making sure the shims are in place on the front bearing. Secure the lens mounting plate tightening the screws evenly.
- 3) The tension screw secures the outer race of the front bearing. Tighten this screw with one hand while turning the sprocket with the other hand, to insure the outer race of the bearing is not deformed.
- 4) Replace the optical head front panel.

5-10 PRISM, SPROCKET AND SHUTTER FORMAT CHANGE

The HYCAM optical head film format can be readily changed with the optional prism, sprocket, and shutter format kits, see Section 6. Accessories.

The kit comes complete with the prism, sprocket, and shutter pre-assembled by the factory. Also, the kit contains the necessary aperture and film gate masks.

If the kit and optical head were ordered simultaneously, the installation can readily be installed in the field. If a different format is desired, and the kit was not ordered at the time of optical head purchase, the optical head should be returned to the factory for initial installation; after which would be readily interchangeable in the field. If the prism, sprocket, and shutter format kit was ordered at the same time as the optical head, the proper amount of shims are included in the kit.

a) INSTALLATION AND SHIMMING PROCEDURE

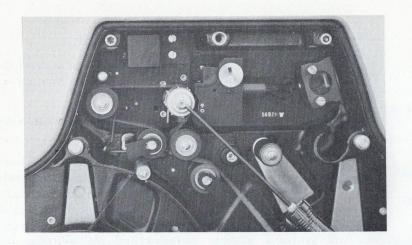
- 1) Remove the optical head front panel by the six screws around the panel perimeter.
- 2) Remove the lens mounting plate by first loosening the tension screw to the right of the "C" mount. Then remove the four mounting screws and carefully pull free.
- 3) Remove the shims on the prism, sprocket, and shutter assembly.
- 4) Remove the prism, sprocket, and shutter, assembly by removing the four socket head cap screws from the film transport side of the optical head.

- 5) Install the aperture mask, and upper film gate mask.
- 6) Install the new prism, sprocket, and shutter assembly from the front side of the optical head securing with the four screws removed in step four.
- 7) Select a trial shimming of .007 inch, and place on the outer race of the front bearing.
- 8) Insert the lens mounting plate aligning the shims, and front bearing. While turning the film sprocket with one hand, slowly install the screws securing the lens mounting plate. If any sudden friction develops, lessen the amount of shimming. If after securing the lens mounting plate the assembly spins freely, this will probably indicate excessive end play. Repeat the shimming procedure as necessary to delete end play, or overloading of the assembly.
- 9) The tension screw secures the outer race of the front bearing. Tighten this screw with one hand while turning the sprocket with the other hand, to insure the outer race of the bearing is not deformed.
- 10) Replace the optical head front panel.

5-11 PHASING THE SPROCKET:

When the frame line is not at the center of the perforations, a phasing adjustment can be made by rotating the sprocket on the prism shaft.

- a) With the camera door open remove the upper film gate, and swing it aside for clearance.
- b) Thread a short piece of focusing leader through the camera.
- c) Remove the objective lens and shine a bright light at the 'C' mount. Rotate the sprocket and note where the light image is positioned with respect to the open shutter position. The edges of the light image should split the perforations. If not, proceed with the remaining steps.
- d) Loosen the sprocket by the socket head capscrew at the end of the prism, and sprocket assembly, See Figure 5-3



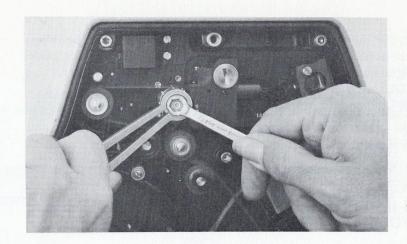


FIG. 5-3 PHASING THE SPROCKET

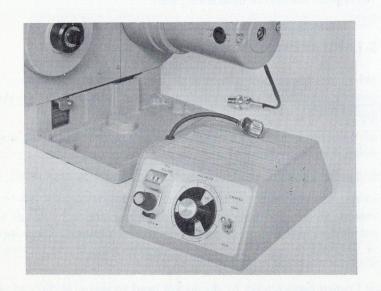


FIG. 5-4 ELECTRONIC CONTROL MODULE REMOVAL

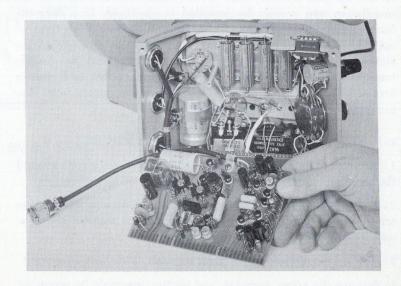


FIG. 5-5 CIRCUIT BOARD REMOVAL

- e) The phasing adjustment is made by rotating the sprocket with a spanner wrench while holding the prism shaft stationary with a box wrench until the light image is properly aligned. (See HYCAM Tool Kit, Section 6, Accessories).
- f) Secure the socket head cap screw.

5-12 RETICLE INSTALLATION (OPTIONAL)

Reticles with either cross, or open center cross hairs, are available for 8mm and 16mm formats. Reticles are installed in place of the glass aperture cover, Section 5-8. The "O" ring should be retained when installing reticles to insure a dust free seal of the internal optics. (See section 6, Accessories).

5-13 SHUTTER PULSE INSTALLATION (OPTIONAL)

- 1) Remove the front panel of the optical head.
- 2) Remove the temporary mounting screw of the shutter pulse connector.
- 3) Install the shutter pulse assembly into place with the shutter blades between the lamp and photocell.
- 4) Secure the assembly with a 4-40 X 1/4 Binder Head screw.

5-14 SHUTTER PULSE LAMP REPLACEMENT

- 1) Remove the front panel of the optical head.
- 2) Unplug the lamp connector.
- 3) Remove the lamp housing.
- 4) Install the new lamp housing, aligning surfaces as shown in Fig. 5-2.
- 5) Plug in the lamp connector and replace the front panel.

5-15 SPEED SENSOR LAMP REPLACEMENT

- 1) Remove the front panel, lens mounting plate, and shutter blade.
- 2) Remove the speed sensor.
- 3) Unplug the diode and lamp connectors, and remove the assembly.
- 4) Loosen the set screw at the side of the lamp housing to remove the lamp.
- 5) Place the new lamp assembly into the lamp housing.
- 6) Install the assembly; replacing the shutter, lens mounting plate, and front panel (See Section 5-9)

5-16 TIMING LIGHT-LAMP REPLACEMENT

- 1) Detach the latch block by the center captive screw.
- 2) Loosen the set screws on each side of the latch block to release the lamp socket adapters.
- 3) Pull each socket out, and unscrew the lamps.
- 4) Remove the threaded lamp retaining rings, and install on the new lamps.
- 5) Re-install the assembly in the reverse order of removal.

5-17 ELECTRONIC CONTROL MODULE REMOVAL

- 1) Disconnect the speed sensor cable and all other control cables from the connector panel.
- 2) Remove the four screws securing the base.
- 3) Remove the control module by lifting the outside edge, and pulling out.

5-18 CUTOFF AND EVENT SWITCH ACCESS

The cutoff and event switches are located in the lower portion of the film transport, for access:

- 1) Remove the electronic control module.
- 2) Remove the film transport base.

5-19 CIRCUIT BOARD REMOVAL

- 1) Remove the electronic control module as described in Section 5-17.
- 2) Remove the single screw securing the circuit board to the chassis stand-off.
- 3) Unplug the board from the P.C. Connector.

5-20 TROUBLESHOOTING

To check waveforms and voltages, the control module should be connected to the optical head, and AC power applied to the camera. The Camera stop/start switch only controls the motor, so power is applied to the circuit even in the stop position.

To troubleshoot the control module with the circuit board exposed, pins 1, 5, 2, and 6, of connector P14 should be shorted to simulate the end-of-film cutoff switch. (See Schematic, rear of manual).

6-1 OPTICAL HEADS

HYCAM is so designed that the main optical parts are contained in a removable head. Mechanically, all optical heads are interchangeable with any of the film compartments and transport sections. The earlier non-E series (less speed sensor) are completely interchangeable within their own series only. However, they can be made interchangeable with any series by having a speed sensor installed at the factory.

OPTICAL HEADS K20HE

HYCAM, OPTICAL HEAD, 16mm full frame; with electronic speed sensor installed; with 1/2.5 shutter double timing light assembly; takes "C" mount lenses of any focal length; has 8-sided prism, sprocket, and shutter on one shaft. Fits all HYCAM film compartments and transport sections. Resolution: Center, 68 lines /mm vertical and horizontal. Edges, 56 lines/mm vertical and horizontal.

K20HAE

HYCAM, OPTICAL HEAD, 1/2 frame 16mm or true 8mm; with electronic speed sensor installed; with 1/2.5 shutter; double timing light assembly; takes "C" mount lenses of any focal length; has 16-sided prism, sprocket, and shutter on one shaft; with 3 aperture masks, one for upper gate, one to obtain 1/2 frame 16mm and one to obtain true 8mm. Fits all HYCAM film compartments and transport sections. Resolution: Center, 80 lines/mm vertical and horizontal. Edges, 68 lines/mm vertical and horizontal.

K20HBE

HYCAM, OPTICAL HEAD, 1/4 frame 16mm or 1/2 frame 8mm; with electronic speed sensor installed; with 1/2.5 shutter; double timing light assembly; takes "C" mount lenses of any focal length; has 32-sided prism, sprocket, and shutter on one shaft; with 3 aperture masks, one for upper gate, one to obtain 1/4 frame 16mm and one to obtain 1/2 frame 8mm. Fits all HYCAM film compartments and transport sections. Resolution:

Center, 80 lines/mm vertical and horizontal. Edges, 68 lines/mm vertical and horizontal.

CONVERSIONS

Conversion of Kl or K2 Optical Systems to new K2 higher light transmission and high resolution.

6-2 KITS, PRISM, SHUTTER, SPROCKET

The 8-, 16-, and 32-sided prism, sprocket, and shutter shaft assemblies can be interchanged from head to head.

K2P/S/S/E

8-sided Prism, Sprocket, and Shutter Shaft Assembly, with Electronic Speed Sensor provision, including bearings and full frame 16mm aperture mask. Fits all HYCAM Optical Heads.

K2P/S/S/AE

16-sided Prism, Sprocket, and Shutter Shaft Assembly, with Electronic Speed Sensor provision, including bearings and 3 masks, one for use in upper gate, one for obtaining 1/2 frame 16mm and one for obtaining true 8mm. Fits all HYCAM Optical Heads.

K2P/S/S/BE

32-sided Prism, Sprocket, and Shutter Shaft Assembly, with Electronic Speed Sensor provision, including bearings and 3 masks, one for use in upper gate, one for obtaining 1/4 frame 16mm and one for obtaining 1/2 frame 8mm. Fits all HYCAM Optical Heads.

6-3 SPEED REDUCER ASSEMBLY

S-4 Speed Reducer for 400 Ft. HYCAM retro fit when camera is returned to the factory.

6-4 FILM COMPARTMENT AND TRANSPORT SECTIONS

K20MIR

HYCAM, 100 Ft. Film Compartment and Transport section: complete 100 Ft. HYCAM camera less optical head: includes: direct upright viewfinder 5X: cut off switch; event synchronizer built-in rectifier; with power and event synchronizer cords and connectors. Accepts all HYCAM Optical Heads.

K2SMIR

HYCAM, 100 Ft. Film Compartment and Transport Section: complete 100 Ft. camera less optical head; includes: direct upright viewfinder 5X; cut-off switch; event synchronizer; built-in rectifier; speed reducer; with power and event synchronizer cords and connectors. Accepts all HYCAM Optical Heads.

K20M4E-115

HYCAM, 400 Ft. Film Compartment and Transport Section; complete 400 Ft. camera less optical head; 115V. AC, 50/60 cycle input to motor. Frame rate variable from 100 to 11,000 full frame, 200 to 22,000 half frame, 400 to 44,000 quarter frame pictures per second by use of built-in potentiometer. (No auto-transformer needed) With electronic (SCR) speed control for 1% frame rate regulation \pm 1 frame after acceleration from 100 to 5,000 full frame 200 to 10,000 half frame, 400 to 20,000 quarter frame pictures per second; direct upright viewfinder 5X; event synchronizer; cut-off, switch; film footage counter; with power, remote control, and event synchronizer cords and connectors. Accepts all HYCAM Optical Heads of the "E" series.

K2SM4E-115

HYCAM, 400 Ft. Film Compartment and Transport Section: complete 400 Ft. camera less optical head; 115V, AC, 50/60 cycle input to motor. Frame rate variable from 20 to 11,000 full frame 40 to 22,000 half frame, 80 to 44,000 quarter frame pictures per second by use of built-in potentiometer. (No auto-transformer needed) With electronic (SCR) speed control for 1% frame rate regulation ± 1 frame after acceleration from 20 to 5,000 full frame 40 to 10,000 half frame, or 80 to 20,000 quarter

frame pictures per second; speed reducer; direct upright viewfinder 5X; event synchronizer; cut-off switch; film footage counter; with power, remote control and event synchronizer cords and connectors. Accepts all HYCAM Optical Heads of the "E" series.

K2SM20E-115

HYCAM, 2,000 Ft. Film Compartment and Transport Section: complete 2,000 Ft. camera less optical head; 115V, AC, 50/60 cycle input to motor. Frame rate variable from 100 to 5,000 full frame 200 to 10,000 half frame 400 to 20,000 quarter frame pictures per second by use of built-in potentiometer. (No auto-transformer needed) With electronic (SCR) speed control for 1% frame rate regulation + 1 frame after acceleration; direct upright viewfinder 5X; event synchronizer; cut-off switch; film footage counter; with two Dark Room Loading daylight handling Film Cassettes; power, remote control and eveny synchronizer cords and connectors. Accepts all HYCAM optical heads of the "E" series.

6-5 GLASS RETICLES

K2R-1

Reticle, Engraved Glass, for superimposing Cross Hairs on film in HYCAM heads equipped with full frame, 1/2 frame or 1/4 frame 16mm masks.

K2R-2

Reticle, Engraved Glass, for superimposing Open Center Cross Hairs on film in HYCAM heads equipped with full frame 16mm masks.

K2R-3

Reticle, Engraved Glass, for superimposing Open Center Cross Hairs on film in HYCAM heads equipped with 1/2 or 1/4 frame 16mm masks.

K2R-4

Reticle, Engraved Glass, for superimposing Cross Hairs on Film in HYCAM heads equipped with 8mm or 1/2 frame 8mm masks.

K2R-5

Reticle, Engraved Glass, for superimposing Open Center Cross Hairs on film in HYCAM heads equipped with 8mm or 1/2 frame 8mm masks.

K2R-6

Reticle, Engraved Glass, for superimposing four line grid on film in HYCAM heads equipped with full frame 1/2 frame or 1/4 frame 16mm masks.

6-6 SHUTTERS

Shutters for Full Frame 16mm HYCAM

K2S-2.5	K2S-20
K2S-5	K2S-50
K2S-10	K2S-100

Shutters for 1/2 Frame 16mm

K2S16-2.5	K2S16-20
K2S16-5	K2S16-50
K2S16-10	K2S16-100
	(for use with 8mm Mask only)

Shutters for 1/4 frame or 1/2 Frame 8mm HYCAM

K2S32-2.5	K2S32-10
K2S32-5	K2S32-20

6-7 SPOOLS

K20F4

Film Spool, daylight loading, split reel, 16mm x 400 Ft. to accept Z core and T core laboratory packaged films. Supply and take-up.

ADAPTERS

RLF-41

Adapter, to use 100 Ft. film spools in the 400 Ft. HYCAM. (To prevent film shatter at the end of the run.) Required on take-up only.

RLF-42

Adapter, to use 200 Ft. film spools in the 400 Ft. HYCAM. (To prevent film shatter at end of the run.) Required on take-up only.

6-8 ELECTRICAL AND ELECTRONIC

TIMING LIGHT GENERATORS

RLTLG-4

With 10, 100, 1000 pulses/second output. Variable output current to lamps. Operates on 115 VAC or internal battery with automatic switching.

RLDC-2

DC power supply, used in place of battery for PLTLG-3 generator above, 110V, AC input - 40V. DC output.

RLTLG-3AC

Milli-Mite Timing Light Generator operates from 110V, AC, input, has 10, 100, 1000 cycles per second output from internal power supply. Cords furnished.

RLMMTLG-2A

Micro-Milli-Mite Timing Light Generator, for high G loads, 10, 100, 1000 cycles per second. Operates from 28V, DC input.

TRANSFORMERS, STEP DOWN

RLT-1

Transformer, Step Down, Fixed 230V, AC in 115 V. AC out, 8 watts, for use with timing light generator RLTLG-3DC.

RLT-3

Transformer, Step Down, Fixed 230V, AC in. 115V AC out, 2000 watts for use with 2 RLLI-1 Color Tran Lighting Units.

FOCUSING AIDS

RLDUV-1 Viewfinder, Standard Direct Upright 5X

RLFV-30X Viewfinder, Magnifying 30X

RLFG-1 Gate, Focusing, with ground glass

"C" MOUNT EXTENSION TUBES

RLXTCS-1 Set of 6 .2, .5, 5, 10, 20, 40mm

RLXTC-4 4-inch

RLXTC-6 6-inch

RLXTC-8 8-inch

PENTAX MOUNT EXTENSION TUBE

RLXTCO

Set, 9.5mm, 19mm, 28.5mm, for use with Oscillo Attachment or Pentax to "C" Adapter

TRACKING VIEWFINDER

TVF-1

Tracking Viewfinder, sports type, for use with any model HYCAM, fastens to side of camera. Has parallax adustment for 15mm, 25mm, 50mm and 100mm lenses.

OSCILLO AND STREAK ATTACHMENT

K20SA-1P

Oscillo and Streak, lens adapter to take Pentax lenses 50mm and up for use with 100 and 400 foot HYCAMS.

K20SA-1F

Oscillo and Streak, lens adapter to take Fastax lenses (50mm and up) for use with 100 and 400 foot HYCAMS.

K2SA-1

Lower Gate and Streak Attachment for placing adjustable slit at the film plane. For use with all HYCAMS.

"C" MOUNT BELLOWS UNIT

RLLBXT-1

Pentax Bellows Extension for use with any Model HYCAM

LENS ADAPTERS FOR BELLOWS UNIT

RLKAP-1

Adapter to use Kodak "S" mount lens on Pentax Bellows unit.

RLCAP-1

Adapter to use "C" mount lens on Pentax Bellows Unit.

LENS ADAPTERS

RLFXAC-1

Adapter to use Fastax lens on HYCAM "C" MOUNT

RLKAC-1

Adapter to use Kodak "S" mount lens on HYCAM "C" mount.

RLPAC-1

Adapter to use Pentax lens on HYCAM "C" mount.

RLFAC-1

Adapter to use Fairchild lens on HYCAM "C" mount.

SHUTTER PULSE SYNC UNIT

K2PP-2

Photo Pick Up, for electronic flash synchronizer or HYCAM shutter position indicator Output: 10-15 volt, positive pulse. For use with 400 Ft. and 2,000 Ft. HYCAM models.

SPEED CONTROL CONVERSIONS

Conversion to new high speed motor and new electronic speed control which eliminates need for auto-transformer. Operates at all speed ranges directly off 115V, AC.

Conversion to new high speed motor and new electronic speed control which eliminates need for auto-transformer. Operates at all speed ranges directly off 230V, AC.

6-9 OPTICAL

LENSES, COSMICAR (MADE IN JAPAN) IN FOCUSING "C" MOUNT

RLLC-1/2	Lens, 12.5mm FL, f/1.9
RLLC-1	Lens, 1-inch FL, f/1.4
RLLC-2A	Lens, 2-inch FL, f/1.4
RLLC-3A	Lens, 3-inch FL, f/1.4
RLLC-4	Lens, 4-inch FL, f/2.8
RLLC-5	Lens, 135mm FL, f/2.8
RLLC-7	Lens, 180mm FL, f/3.5
RLLC-8	Lens, 8-inch FL, f/3.5
RLLC-12	Lens, 300mm FL, f/5.6
RLLC-16	Lens, 400mm FL, F/5.6
RLLC-20	Lens, 500mm FL, f/6.3
RLLC-z 1:4	Lens, Zoom 22.5mm to 90mm f/1.5

LENSES, SCHNEIDER (MADE IN W. GERMANY) IN FOCUSING "C" MOUNT

RLLS-10		Lens, 10mm FL, f/1.8
RLLS-16		Lens, 16mm FL, f/2.0
RLLS-25		Lens, 25mm FL, f/1.4
RLLS-50		Lens, 50mm FL, f/2.0

RLLS-75	Lens, 75 mm FL, $f/2.8$
RLLS-100	Lens, 100mm FL, f/2.8
RLLS-150	Lens, 150mm FL, f/4.0
RLLS-300	Lens, 300mm FL, f/5.0

LENSES, WOLLENSAK RAPTAR (MADE IN U.S.A.) IN FOCUSING "C" MOUNT

RLW-13	Lens, 13mm FL, f/1.2
RLW-17	Lens, 17mm FL, f/2.5
RLW-25	Lens, 25mm FL, f/1.5
RLW-40	Lens, 40mm FL, f/1.5
RLW-50	Lens, 50 mm FL, $f/1.5$
RLW-75	Lens, 75mm FL, f/1.9
RLW-100	Lens, 100 mm FL, $f/2.5$
RLW-152	Lens, 152 FL, f/3.8
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LENSES, PENTAX (MADE IN JAPAN) IN FOCUSING PENTAX MOUNT, CONVERSION ADAPTER AVAILABLE

RLLP-50 Lens 50mm FL, f/1.4

Recommended for oscillo or Streak photography with all HYCAM models.

RLLP-55	Lens 55mm FL, f/1.8
RLLP-85	Lens 85mm FL, f/1.9
RLLP-105	Lens 105mm FL, f/2.8
RLLP-135	Lens 135mm FL, f/3.5
RLLP-8	Lens 8-inch FL, f/3.5
RLLP-12	Lens 12-inch FL, f/4
RLLP-20	Lens 20-inch FL, f/4.5
RLLP-40	Lens 40-inch FL, F/8
	(Supplied with Lens Tripod)

LENSES, ANGENIEUX (MADE IN FRANCE) IN FOCUSING "C" MOUNT

RLLAZ-1:10

Lens, Angenieux Zoom 12mm to 120mm f/2.2 AZO model supplied with 10-inch reflex viewfinder

EXPOSURE METER

RLEM-1

Exposure Meter, 1/21 Degree, reflective, with neutral density filter; includes dials for converting shutter speed to HYCAM frame rate.

6-10 LIGHTING

RLLI-1

Lighting Unit, 1000 watt quartz iodine lamp with housing, stand and heat absorbing glass and bracket, with Fresnel Lens. Operates from 115V line.

RLLI-1L

Lamp 100 watt quartz iodine, replacement for above lighting unit.

RLLI-2

Lighting Unit, alligator clamp, 750R lamp, porcelain socket, switch in line.

RLLI-2L

Lamp, 750R, R-40, 750 Watt.

RLLI-4

Lighting Unit, complete with 2 heads, heat absorbing glasses, adjustable mounting brackets, stand, hi-lo switch and 2 cross bars.

RLLI-4L

Lamp, Quartz Bromine 650W. Replacement.

RLLI-4G

Glass, heat absorbing. Replacement

6-11 TRIPODS

RLTRI-3

Tripod Stand, Elevator and Head, medium weight, adjustable 40" to 80" for use with 400 Ft. HYCAM

RLTRI-3H

Head, Geared, Part of RLTRI-3

RLTRI-3LH

Lo-Hi Unit for use with RLTRI-3

RLHH-3

Hi-Hat for RLTRI-3 Tripod Head

6-12 MISCELLANEOUS

RLCC-2

Carrying Case, for 400 Ft. HYCAM, wooden with polyurethane insert, with compartments for lenses and other accessories

RLCC-4

Carrying Case, for HYCAM Head, wooden with polyurethane insert, with compartments for lenses

RLTK-1

Tool Kit, HYCAM, with case

RLLW-900

Stop Action projector, flicker-free, forward-reverse 1 through 8, 16 and 24 FPS, remote control frame counter, built-in screen.

RLLW-900 1/2

Stop Action projector, 1/2 frame pull down for use with 16mm film having 8mm perforations. (This is a Red Lake Exclusive item) Available only through Red Lake Labs.

RLLW-M224

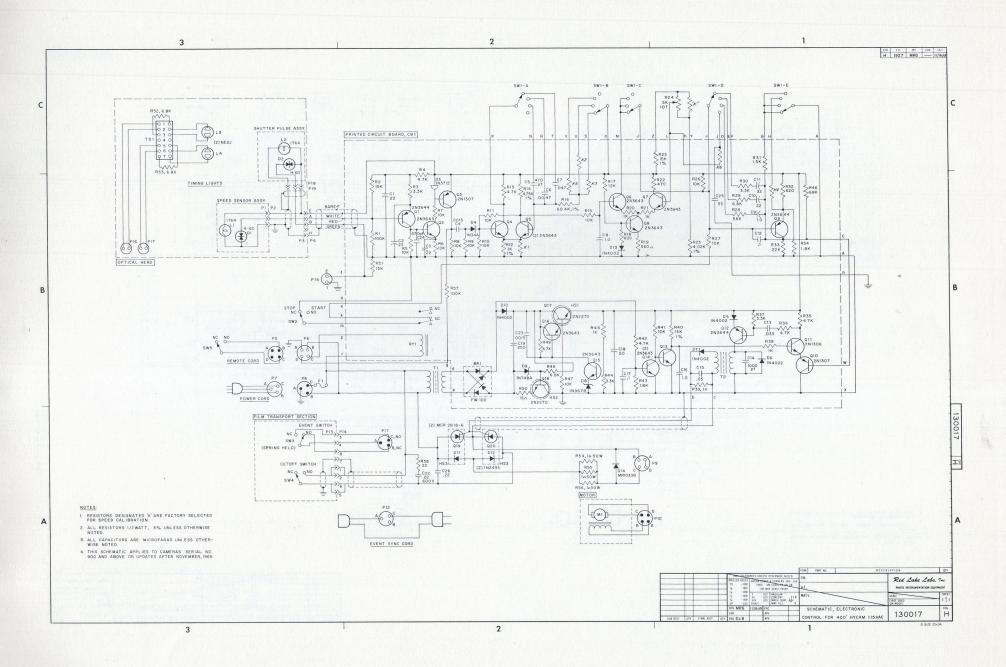
Photo Optical Data Analyzer, flicker-free forward-reverse, 1-2-4-6-12-16-24 FPS 16mm X 400 Ft. capacity, frame counter remote control.

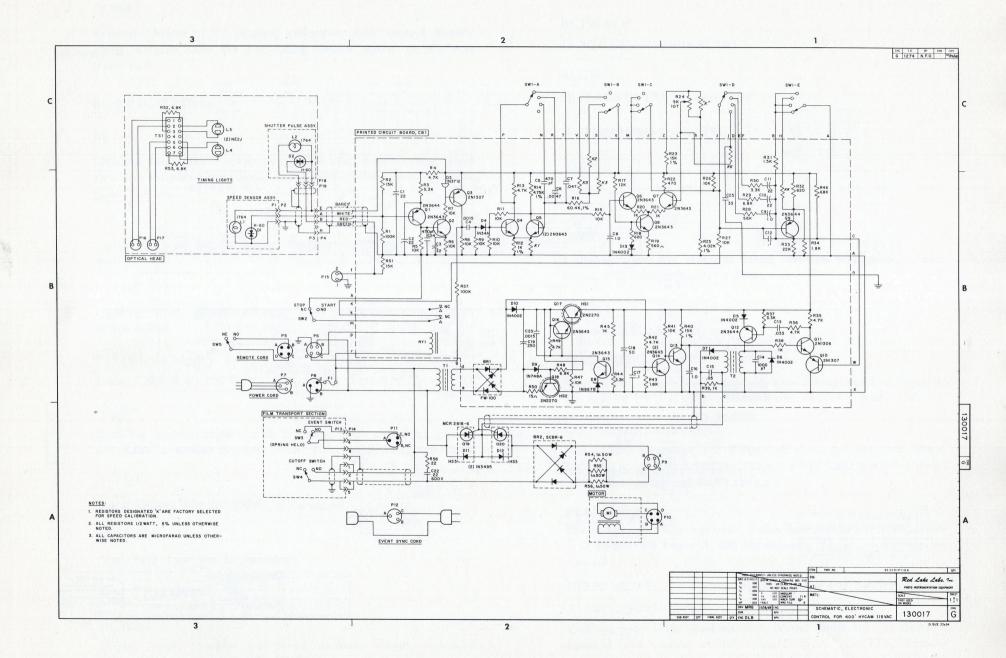
RLLW-M224 1/2

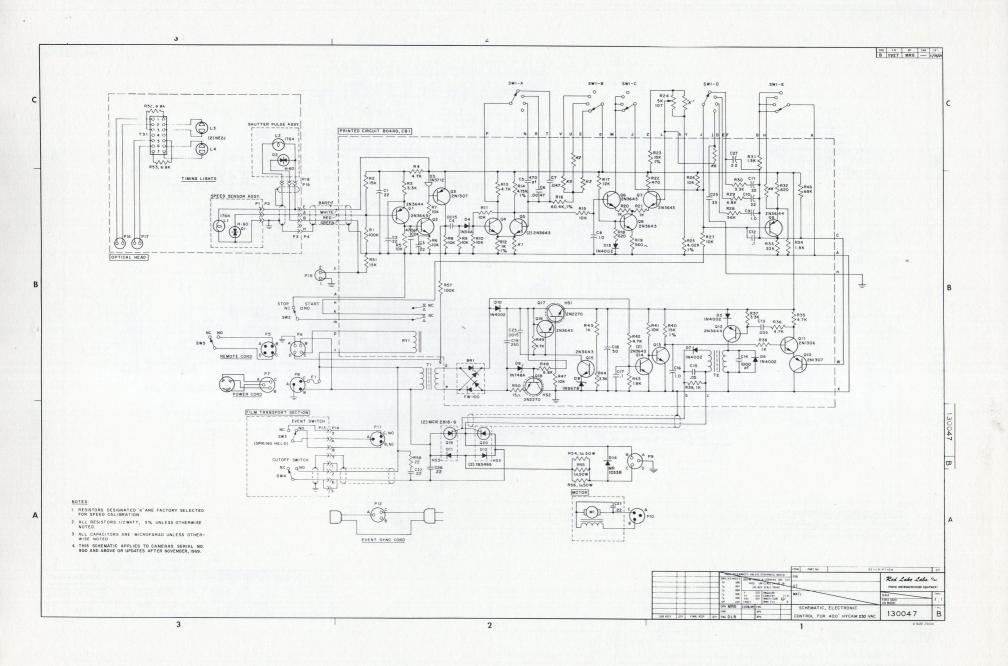
Same as above with half frame 16mm

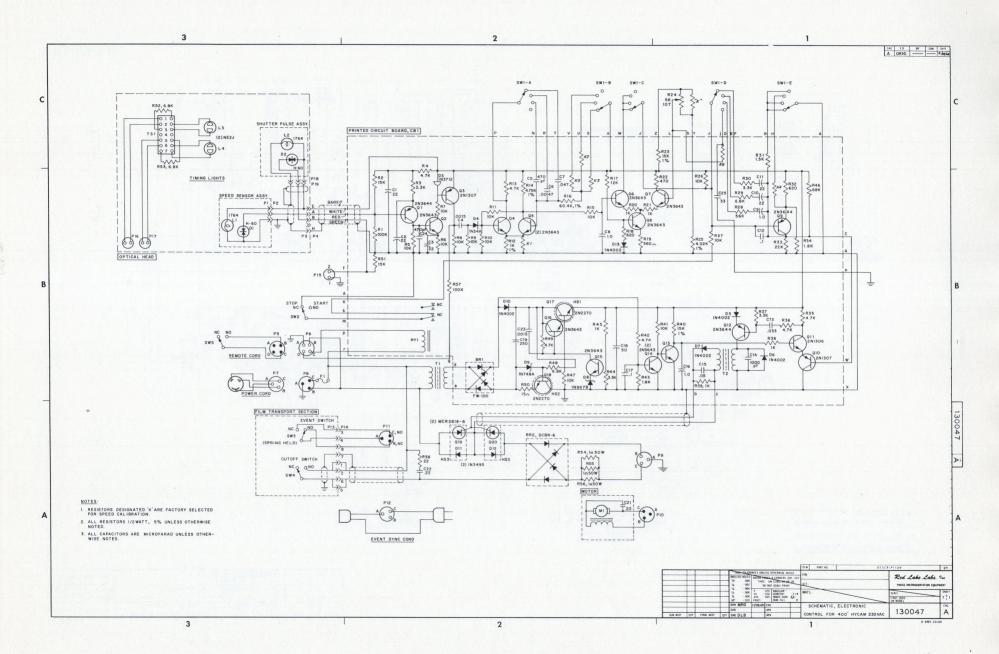
RLLWM224-AV-126TR

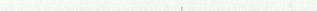
Dual-purpose Data Analysis and Sound Projector. Flicker-free forward and reverse at 1-2-4-6-8-12-16 and 24 FPS. Remote control for single frame and all operating speeds. Illuminated frame counter. Transistorized amplifier for high quality sound projection, 200 Ft. reel capacity.

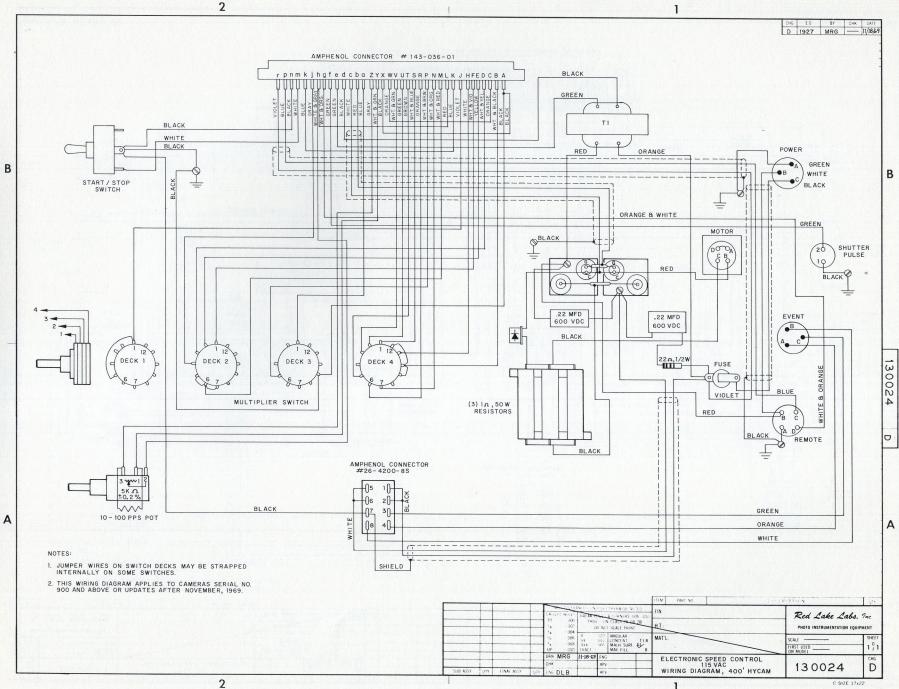


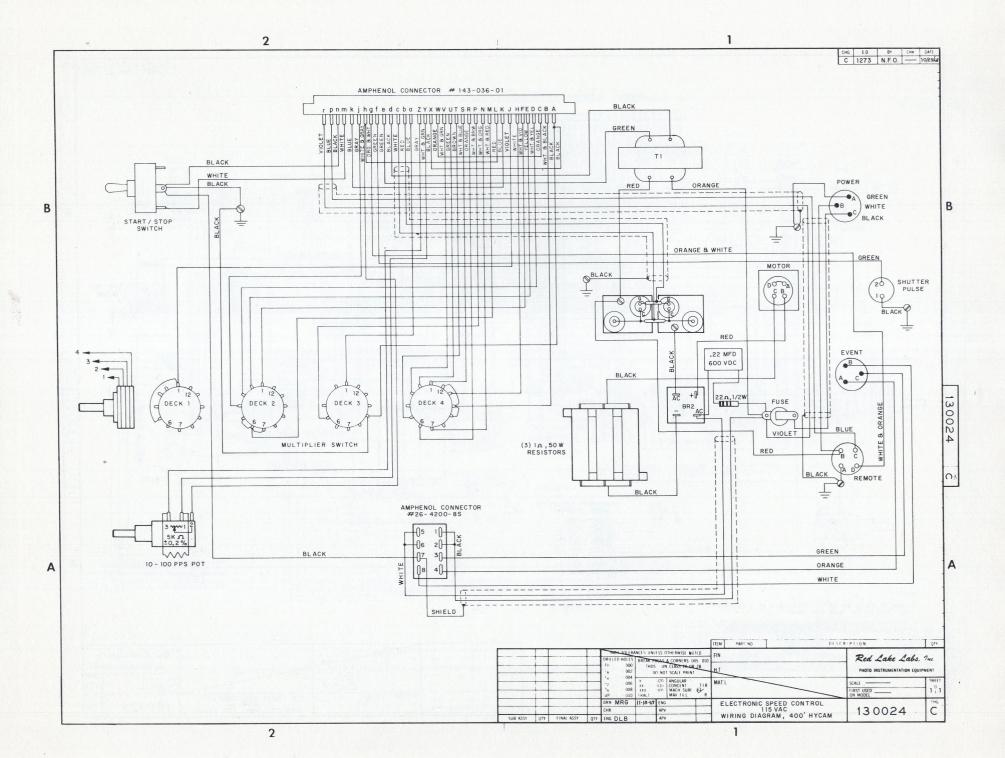


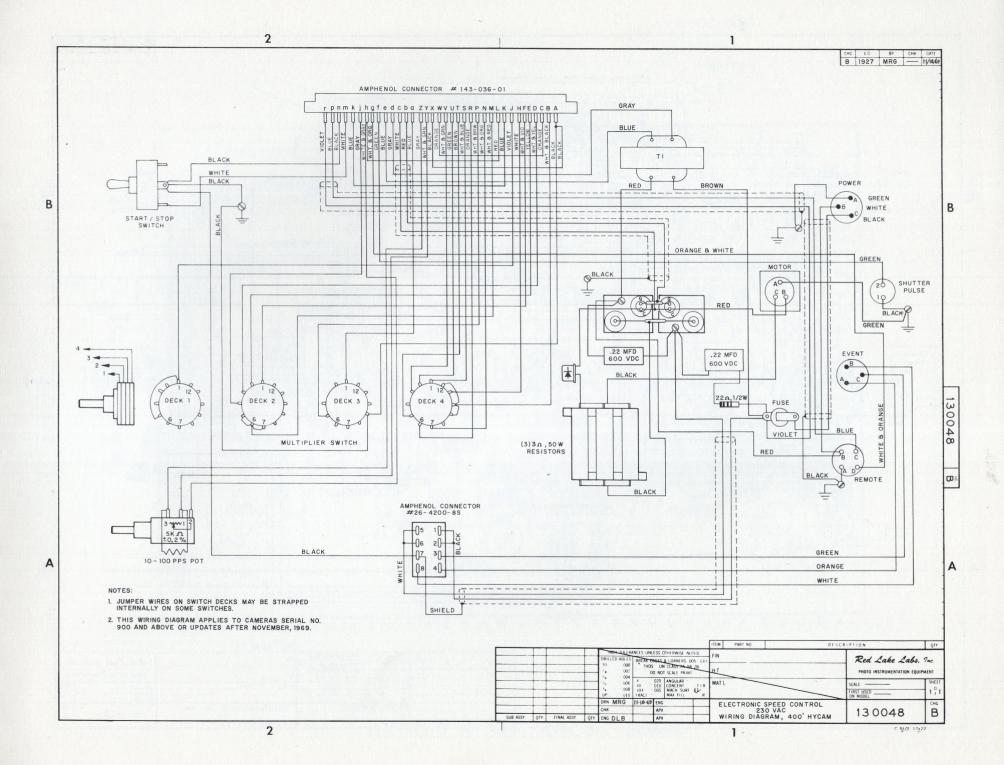


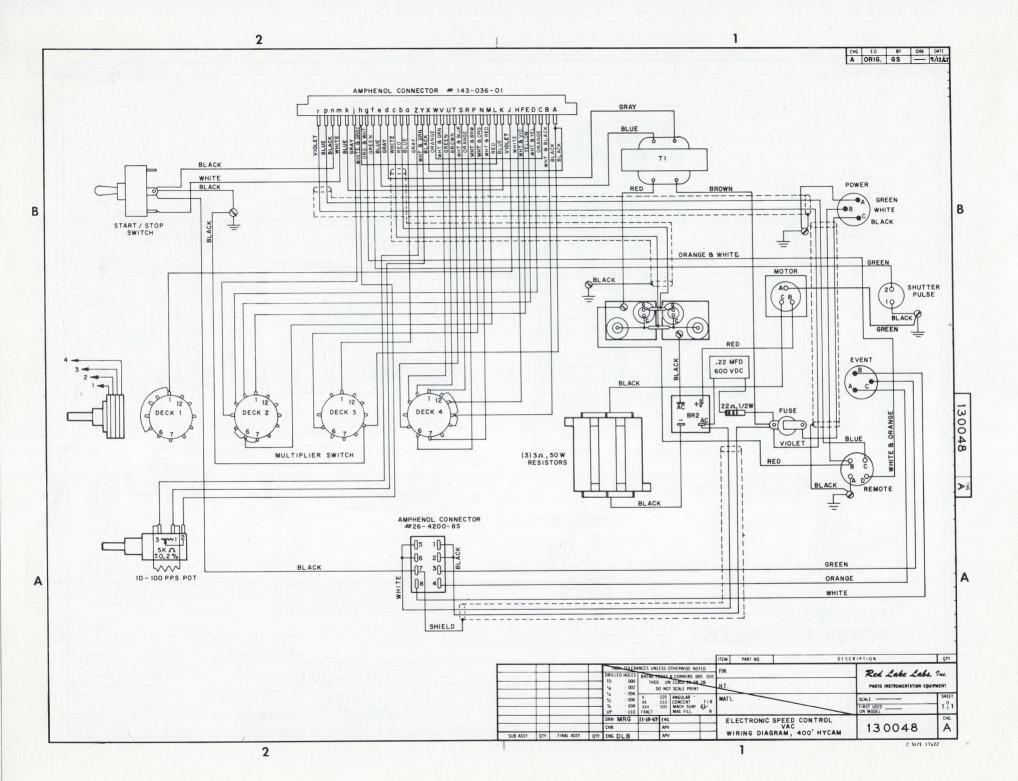


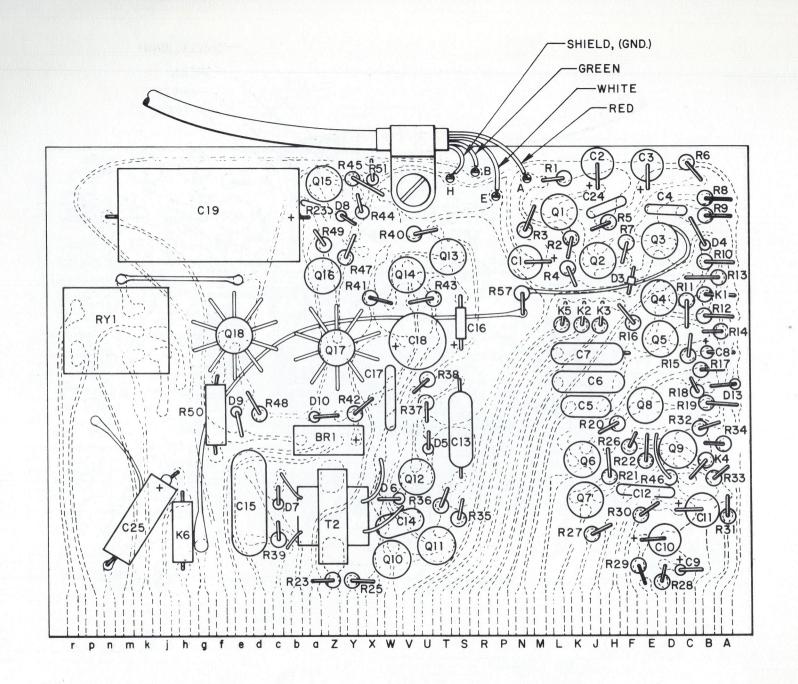


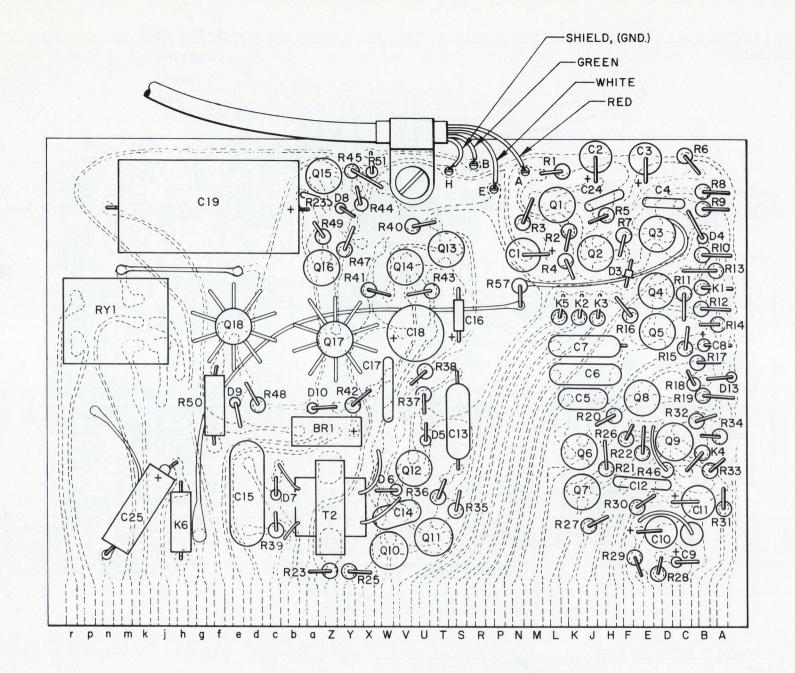


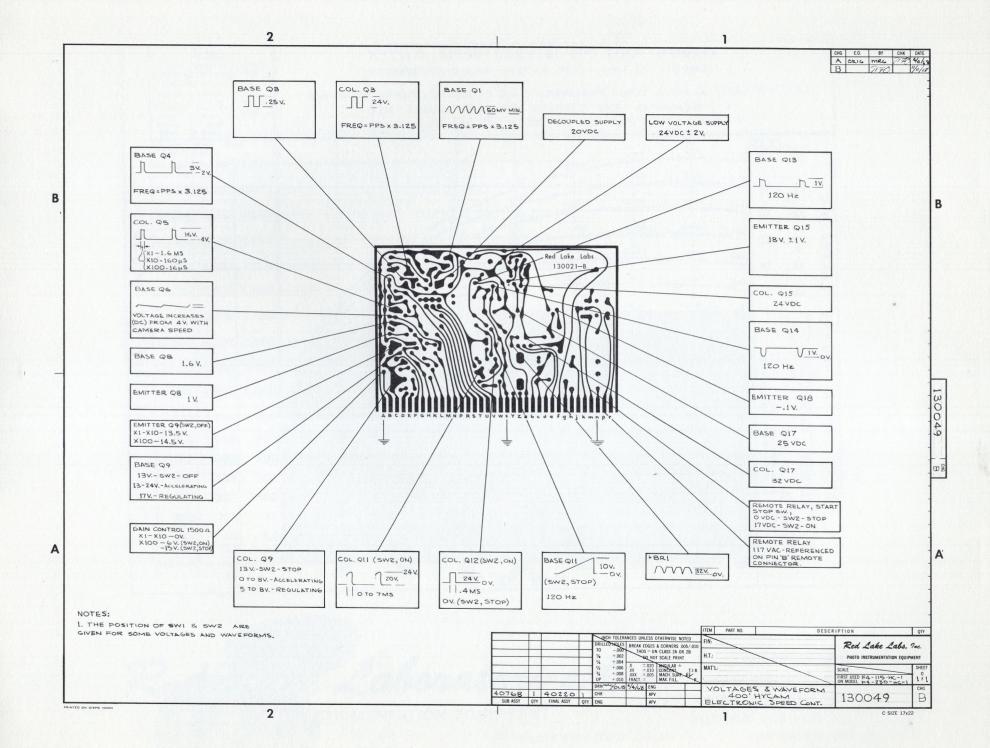


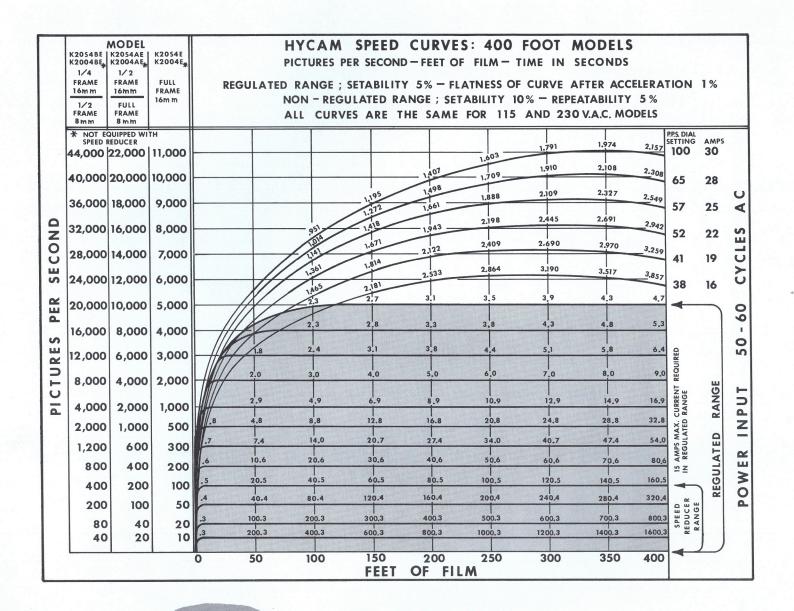












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