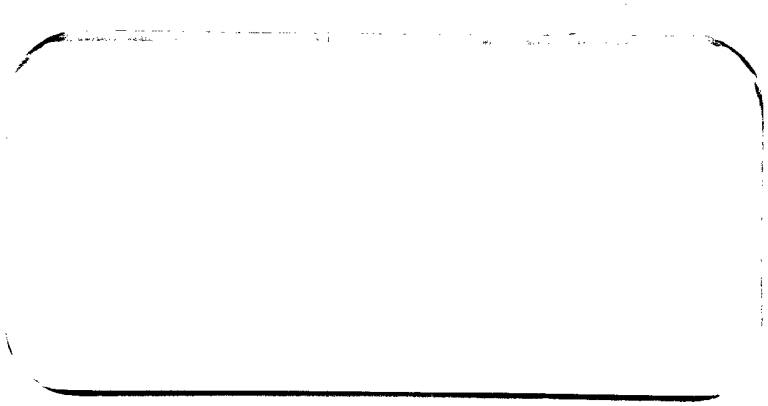

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Proposal No. P-5578-A

ADVANCED PHOTOMETER

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Approved by:

November 1971

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SECTION I
TASK ABSTRACT

This proposal describes an advanced Photometer designed as a portable instrument to measure brightness of an image through optical systems (such as microscopes). It also measures luminance of light tables and projection screens. The Photometer simulates the characteristics of the eye by providing filters simulating the observer's photopic response. The Photometer's entrance pupil and optics are designed to determine the apparent brightness sensed by the observer. The design emphasizes "ruggedness" and "accuracy", consistent with its use in field environment, without requiring "re-calibration". The Photometer supplies digital readout as well as an analogue output for use in chart-recording. The system can be used either with its own rechargeable battery or with standard 115 VAC supply. All components are enclosed within 8 1/2" x 8" x 5 3/4" portable case weighing less than 11 pounds, which includes detecting heads, electronics, display, battery, and battery charger.

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SECTION II
INTRODUCTION

1. BACKGROUND

[redacted] has designed and built several types of STAT photometers for special applications. As an example, the Model 356 Quick Response Photometer has been designed by [redacted] STAT for the U. S. Army Signal Corps, for automatic measurement of sky brightness within the range of 10^{-1} to 10^{-6} foot lamberts, with an accuracy of 5% over this range. This instrument has been in continuous use for 8 years, and was found to be highly reliable. Infrequent calibration (about once per year) has been required. [redacted] STAT has also manufactured other types of light measuring systems which are described in a separate section at the end of this proposal.

In addition to [redacted] experience in Photometers, STAT it also has the unique advantage of being a designer of photo-interpretation and photogrammetric equipment. This includes the design and manufacture of light tables, stereo viewers, and rear projection viewers. This combination of capabilities allows [redacted] to STAT use its understanding of the sponsor's requirements, in the development of a practical (user-oriented) photometer.

2. GENERAL CONFIGURATION

Figures 1,2 & 3 illustrate the configuration of the Advanced Photometer. The photometer includes a small detecting head (1 1/2" diameter by 2 1/2" long), that can be directly attached

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to an eyepiece of a microscope. The flat end of the head is resilient coated to allow its placement directly on the surface of a light table, or on the surface of rear projection screen. The optics within the head can be tilted to allow measurement of brightness from +45° to -45°. The operator has the option of locking the tilt head in the center, so that only central brightness is measured.

The electronic display and control is built into a fiber glass case. All electronic components are inserted into polyurethane foam within this box. The use of these types of shock absorbing materials assure the maximum degree of ruggedness. Figure 5 illustrates the block diagram of the photometer. The detecting head contains a P.I.N. silicon diffused photo diode with a built-in integrated-circuit amplifier. The gain of the amplifier is set through precision resistors located at the control panel to realize the measuring ranges of 10, 100, 1,000, 10,000, and 100,000 foot lamberts. The full scale output is 1 volt per one thousand counts. However, when the output reading is 1999, the voltage is increased to 1.999 volts.

The display uses highly reliable light emitting diodes with 4-digit readout. However, the most significant digit is the over-range bit allowing maximum reading to 1999. This type of readout allows the reading of 1,000 instead of being limited to 999; furthermore, it allows the overlap of scales, maintaining the ease of readability.

The detector-amplifier combination has been selected with extremely low drift, where both short time and long time drift are minimized; calibration will not be necessary for at least 3 months of operation.

STAT

The basis of the design is to use the minimum number of components, increasing maintainability and reliability. Power drain is minimum to decrease heat dissipation, and to allow the use of the smallest battery possible. The power requirement is either 105-130V, 50-60 cps, or built-in battery of 6 volts. The battery supplied with the instrument uses readily available rechargeable silver cadmium sealed cells. A built-in battery charger is provided, which fully charges the battery in less than 10 hours.

The photometer simulates the eye-response by using the combination of filters to realize a spectral response which corresponds to that of the eye within accuracy of better than 10%. In addition, the optical system simulates the eye by providing an area dependent photometer, containing an iris similar to that of the eye. In this manner, if the standard iris is not filled by the photometer, the brightness measurement is reduced in correspondence to the area of the exit illumination.

The photometer enclosed within the case is 8 1/2" long x 8" wide x 5 3/4" high. Weight is estimated at 11 pounds.

STAT

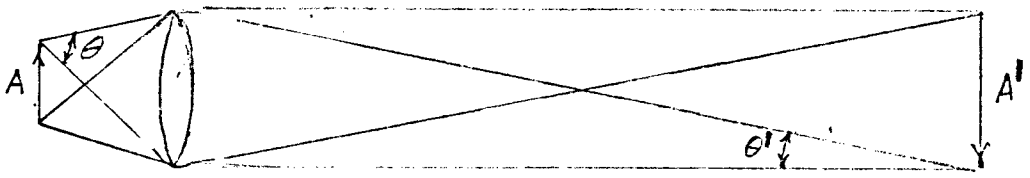
SECTION III
TECHNICAL DISCUSSION

Basic Principles of Brightness Measurement

The definition of brightness is well established and is consistently stated in many handbooks* - It is the luminous flux emitted from a surface per unit solid angle, per unit area (projected normal to the line of sight).

It is also well known that an optical system which magnifies an image does not change brightness (simply due to change of magnification). Thus, a simple magnifier (or a microscope) does not change the brightness of the image. The only attenuation is usually created by the loss of light within the optics, and losses due to reflection, at the air-to-glass surfaces.

This theory that brightness is not effected by changes in magnification is illustrated in an example of a simple lens magnifier:



*Reference: Modern Optical Engineering by Warren J. Smith - Published by McGraw Hill Co - page 199.

In the above example, a lens is shown to magnify the image. The brightness at the object is $\frac{\text{F (flux)}}{\text{A (unit area) } \theta \text{ (solid angle)}}$.

It may be noted that the area has increased due to magnification by (M^2). Also, the subtended angle θ^1 has decreased by the same ratio (M^2). Consequently, the brightness of the image is not changed.

However, any viewer looking into a microscope of high power realizes that apparent brightness is appreciably decreased. This contradiction of theory and practice is caused by the fact that brightness (as normally defined) is not the only criteria to determine the visual sensation. Another important criteria is the area of the pupil of the eye being filled with light. Thus, if the light beam from the microscope is smaller than the exit pupil of the eye, then a visual attenuation of brightness is observed, in proportion of the reduction of the area of the pupil. An example is illustrated in Figure 4.

Typically for 40 power microscope and n (Numerical Aperture of 0.1), the exit pupil = 1.25 millimeters (See Appendix I for calculations).

Thus, in the above example, if the brightness of the illumination is 2,000 ft. lamberts, then the normally defined brightness at 40 power is 2,000 x transmission of optics = 1,000

[redacted] STAT

ft. lamberts, for a typical transmission of 50%. However, the apparent brightness is actual brightness $\times \left(\frac{\text{exit pupil diameter}}{\text{eye pulil diameter}} \right)^2$

$$= 1{,}000 \times \left(\frac{1.25}{3} \right)^2 = 170 \text{ ft. lamberts.}$$

It may be concluded from the above that the actual brightness (as defined) is 1,000 ft. lamberts while the apparent brightness is only 170 ft. lamberts. Consequently, the apparent brightness must be considered, which includes a factor proportional to the exit pupil's area.

[redacted] approach utilizes an optical system whi STAT simulates the eye. It includes an iris which is set the the average diameter of 3 mm of the eye. It also includes a predetermined small angle of 5° of observation. In this manner, the brightness being measured is very closely the same as that brightness being sensed, by the standard human observer.

Considerations of Angle Coverage

The photometer should measure brightness of the field of the image without being effected by other parameters, such as (angular field of view). Let us consider the following example:

STAT

In the above example, the total energy arriving at the detector from a wide angle lens exceeds by far, the total energy arriving at the narrow field lens, even though the brightness may be the same. It is then necessary to always limit the angle of the detector to a value smaller than the minimum output angle of the microscope. It is preferred to limit that angle to that illuminated uniformly: -For this reason, a practical angle of 5°-6° has been selected.

STAT further recognizes that many microscopes may have non-uniformity of illumination, where apparent hot spots are observed in the center of the field. Consequently, the photometer head may be pivoted to measure the brightness at different angles of the field. Since this pivoting is extremely simple, the operator may merely pivot the head and take 3 or more readings, to establish brightness uniformity.

This requirement for measuring brightness at a small field of view is important, when inspecting the brightness of a rear projection screen. With most screens, the brightness is highly directional. If one determines the brightness over 5°, he will obtain a higher reading than averaging over a 30° field of view.

The directionality of brightness on a rear projection screen is certainly an important criteria. In most cases, one average reading is meaningless, since the actual brightness varies by more than 3:1 over that same area. Consequently, STAT has designed the photometer to allow the observer to measure the maximum brightness with 5° subtended angle. He can also tilt the head to observe the apparent brightness at different directions.

Another typical use of the Photometer may be to measure the brightness of a high intensity illuminator. Again, it is not sufficient to only take one average reading, since most high intensity illuminators are highly directional.

Spectral Calibration

A set of filters is provided in front of the photo detector to attenuate the input detector, so that the output of the photo detector corresponds exactly to the sensitivity of the eye. These filters are readily available and have been chosen specifically for the purpose. The filters are sealed within the detector assembly to assure that its characteristics are not changed by humidity, temperature, or contamination of the atmosphere.

Prior to delivery of the unit, the unit will be tested with a Monochrometer test set-up ; - a graph of the output voltage is provided versus known inputs from the ultra-violet to the infrared. This output will be compared to the known visual response of the "Standard Observer". The sensitivity of the photometer is thus checked directly against the pre-established eye data. Correspondence is better than 10% at any point within the spectrum. The test equipment generating the monochromatic spectra through the full range are calibrated and traceable to the National Bureau of Standards.

Both a graph of analogue output, and a recording of the digital outputs will be supplied to assure conformance to the specifications.

STAT

Digital Meter and Display

Reliability and ruggedness is the basis for the procurement of the digital panel meter STAT This is especially designed with integrated circuits, lowest number of parts, and extremely reliable GaAsP light emitting diode display. Power has been minimized to keep heat rise low so that reliability is improved. Quality and maximum usefulness has been assured by using instrument grade components.

The important criteria is this meter is also minimum weight (12 ounces), and low power consumption. This saves weight not only in the meter, but also in the battery and battery charger. The meter does not require an inverter since it uses the battery voltage directly.

The digital system (without polyurethane enclosure) withstands 50 G's of impacts since it does not use any bulky neon tubes. The addition of shock absorbing padding and external energy absorbing case assure further vibration and shock absorption, thus realizing almost indestructible performance.

The selected dot matrix LED display cannot present an erroneous number even if a diode should fail. Whereas a 7 segment display could lose a segment and change a 9 to a 3. The display provides a crisp brillant shaped character which is easy to read.

Display

The digital display is 3 1/2 digits, where readout is available up to 1999. This feature provides an overlap of a factor of 2 between one scale and the next. This display has a decided advantage over only 3 digit display, since the 3 digit display is limited to 999, and cannot read 1,000.

The following table illustrates the maximum range of each scale and the position of the decimal point:

Specified Ranges	Readout Up To	Readout
10	19.99	X1
100	199.9	X1
1,000	1999.	X1
10,000	19.99	X1,000
100,000	199.9	X1,000

Transporting Case

The transporting case has been selected as a standard molded fiber glass case, made by Skydyne Incorporated. This case has been designed specifically for light-weight, hand-portable equipment. These cases are made from molded reinforced shells, using special proprietary formula that make them particularly suitable in hand-portable transit and operational cases. Among these features are:

1. High resistance to impact
2. High resistance to moisture corrosion and weather
3. Extremely high strength to weight ratio
4. Lightweight
5. High thermal shock resistance
6. Inert to most chemicals

These type of cases are designed to be used for military applications including meeting the requirements of MIL-T-21200 as well as MIL-T-945, MIL-C-4150 and MIL-T-4734.

In order to assure further protection, the electronics and optical components are enclosed within polyurethane foam as shown in Figure 2. For example, the digital meter is encased within a molded polyurethane enclosure of at least 1/2" thickness in all directions. A cutout is provided within the control panel to allow easy observation of the display at an angle of 120° in all directions. Access to the digital meter is easily achieved by removing 4 quick-fastening screws holding the control panel.

The batteries and battery charger are also enclosed separately in their own polyurethane cutouts. Quick access is also available through merely removing the control panel. The detecting head has its own separate polyurethane enclosure which closely retains the head. When the cover is closed, the optical head is surrounded by at least 1/2" of polyurethane foam, allowing for very good shock absorbing performance.

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Warm-up

The warm-up time is small due to the use of photo diode detection, LED display and low power consumption, thus minimizing the increase of instrument temperature. Warm-up time is less than 5 minutes. No re-calibration is required after warm-up. Re-calibration is recommended every 3 months.

Temperature

The system is not effected by ambient temperature changes between 50°F and 105°F, and humidities between 20% and 80%. The design allows for a much higher temperature range than that specified.

Construction

The equipment will be designed with the highest commercial standards of construction. [redacted] has a highly effective STAT quality control department that controls and supervises all parts and material through the design, reviewing, in-process inspection and final system test.

Safety

The specified maximum safety precautions are normally followed automatically in [redacted] instruments. There are STAT no high voltages in the system. The maximum voltage is the input 105-135 volts AC. All electronic systems use only 5 volt DC, since no nixie tubes or photomultipliers are used. All metal parts will be electrically connected and ground, and leakage currents will be measured in accordance with ANSI Standard C-101-1971 for two wire non-grounded devices, and shall not exceed 0.5 milliamperes. A circuit breaker will be provided (with automatic reset) to provide added safety.

Battery

The battery selected for this application is a standard rechargeable silver cadmium type having a voltage of 6 volts at 10 ampere hours. This is obtainable for Yardney Electric, or equivalent. The size is 4" x 5" x 1.6", weighing 2.2 pounds. The unit is completely sealed eliminating the possibility of contamination. It is estimated that the total operating time exceeds 12 hours, which exceeds the specifications. The selection of this battery was based on reliability, availability, and performance after extended periods. It is anticipated that the battery will provide years of trouble-free service.

Power Supply and Battery Charger

The power supply provided with this system converts 115 VAC to 6 volts for normal operation from AC voltage; 105V to 135V - @ 50-60 cps. The same power supply is also used to charge the battery by a switch on the control panel, which measures the output voltage by tapping a different point of the transformer. The charging system is supplied with current limiting circuits to limit the charging current so not to overheat the battery. The maximum charging time is 10 hours (from almost fully discharged to fully charged

Weight

The weight of the system is small as possible, but consistent with maximum ruggedness and reliability. The following is the weight estimate:

STAT

Case	-	3.2 pounds
Polyurethane Padding	-	0.8 pounds
Digital Meter	-	0.8 pounds
Batteries	-	2.2 pounds
115VAC supply (and Battery Charger)	-	1.5 pounds
Control Panel & Miscellaneous	-	0.8 pounds
Power Cord and Cables	-	0.6 pounds
Detecting Head	-	0.6 pounds
TOTAL	-	10.5 pounds

Photo Diode and Associated Amplifier

The diode-amplifier is enclosed within a shielded assembly to eliminate electronic noise and to assure electronic stability. The diode utilizes planar diffused guard ring construction with oxide passivation, combining excellent performance characteristics with high reliability. This construction technique eliminates the high noise and functional instability inherent in photo diodes. The diode is completely sealed, whose sensitivity is extremely high (approximately 70% quantum efficiency for certain portions of the input illumination).

The preamplifier consists of a low drift integrating circuit amplifier whose current drift is in the order of 10^{-9} amperes. Gain is varied within each range by the use of feedback resistors. Consequently, the amplifier output is used to develop 1 volt per scale of 1,000 counts; for example, the 10 ft. lambert scale provides 1 volt per 10 ft. lamberts, reading 10.00.

Gain selection is achieved by using wire wound precision resistors having a very low thermal coefficient of expansion, and high stability with time and temperature.

Accuracy

The system design provides an accuracy of better than 2% of full range, over all ranges of photometric measurement. For example, if the range is 10 ft. lamberts, the accuracy is better than 0.2 ft. lamberts (even though the readout can be up to 19.99). To achieve this accuracy, without frequent calibration, the following major design features are supplied:

1. Spectrally compensating filters are supplied which are computer designed, and are guaranteed to have a match to the eye of better than 10%.

2. The linearity of the amplifier and its accuracy is achieved through high negative feedback, with precision resistors having low thermal coefficients, and high stability. The amplifier response is linear to 0.2%.

STAT

3. The meter used is better than 0.1% accuracy using ultra-stable circuits.

4. The detector is a high stability silicon cell which has a linear range exceeding 7 orders or 10.

5. calibrates the photometer prior to shipment for both spectral and radiation measurement over the full range. The test equipments have their accuracy traceable to the National Bureau of Standards. STAT

Detecting Head

The detecting head (shown in Figure 3) consists of a lens imaging system, iris aperture, detector and preamplifier. The head can be directly inserted over the eyepiece of a microscope. A self containing assembly centers the detectors within the barrel of the eyepiece.

One end of the detecting head can be placed directly on a viewing screen, or a light table. This end is coated with a layer of elastomer to assure that the surface of the glass is not scratched when the photometer is placed on its surface.

The optical assembly can be tilted as shown in Figure 3, and can be locked in position in a detent in the center, so that only measurement of the center of the field of view can be made. A scale is provided every five degrees to allow settability of the optics to within the range from -45° to +45°.

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The design head will follow a study by [redacted] STAT of the sponsor's equipment, to assure that it can be easily utilized. Changes in the detecting head adapter and method of attachment may be necessary to facilitate ease of employment.

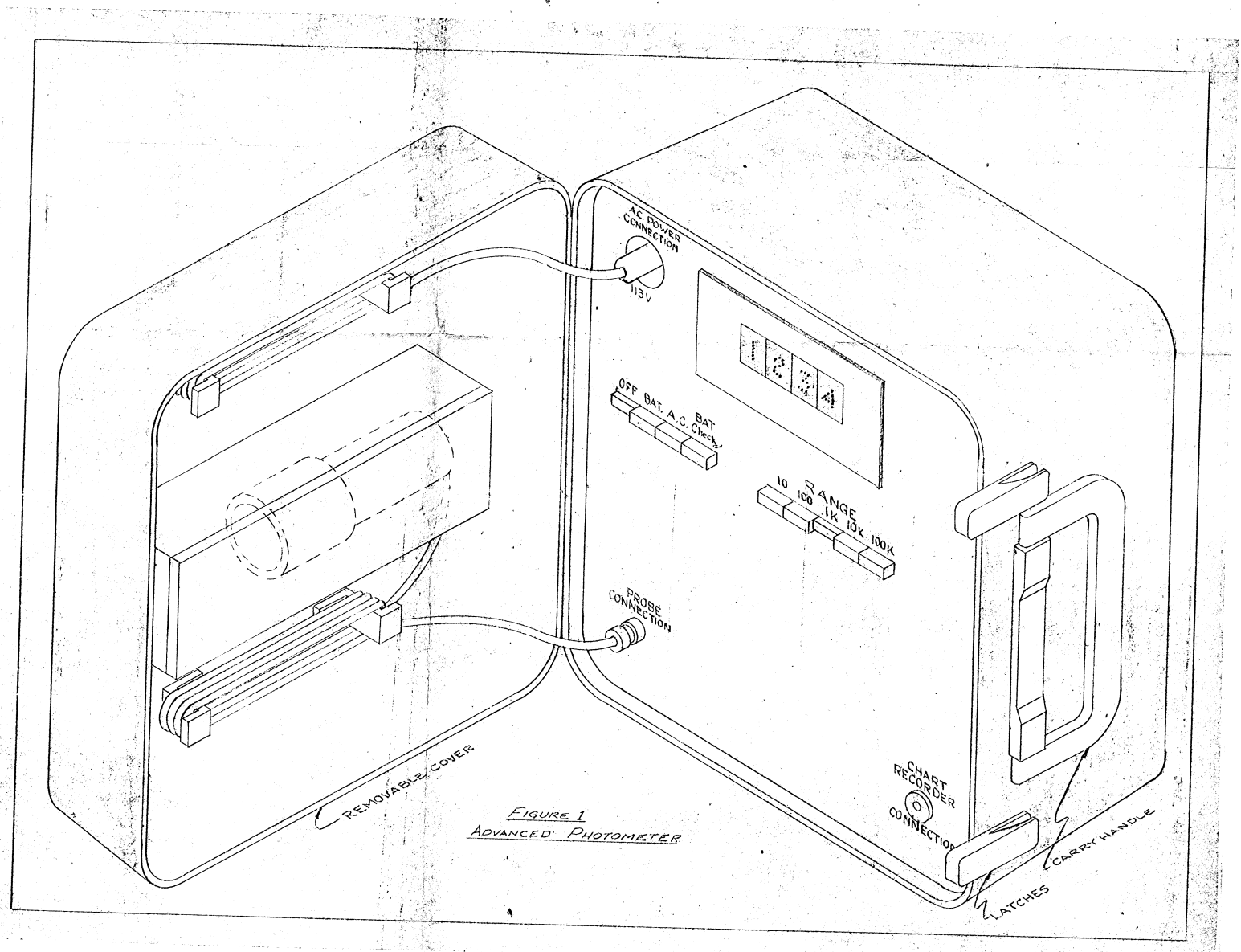
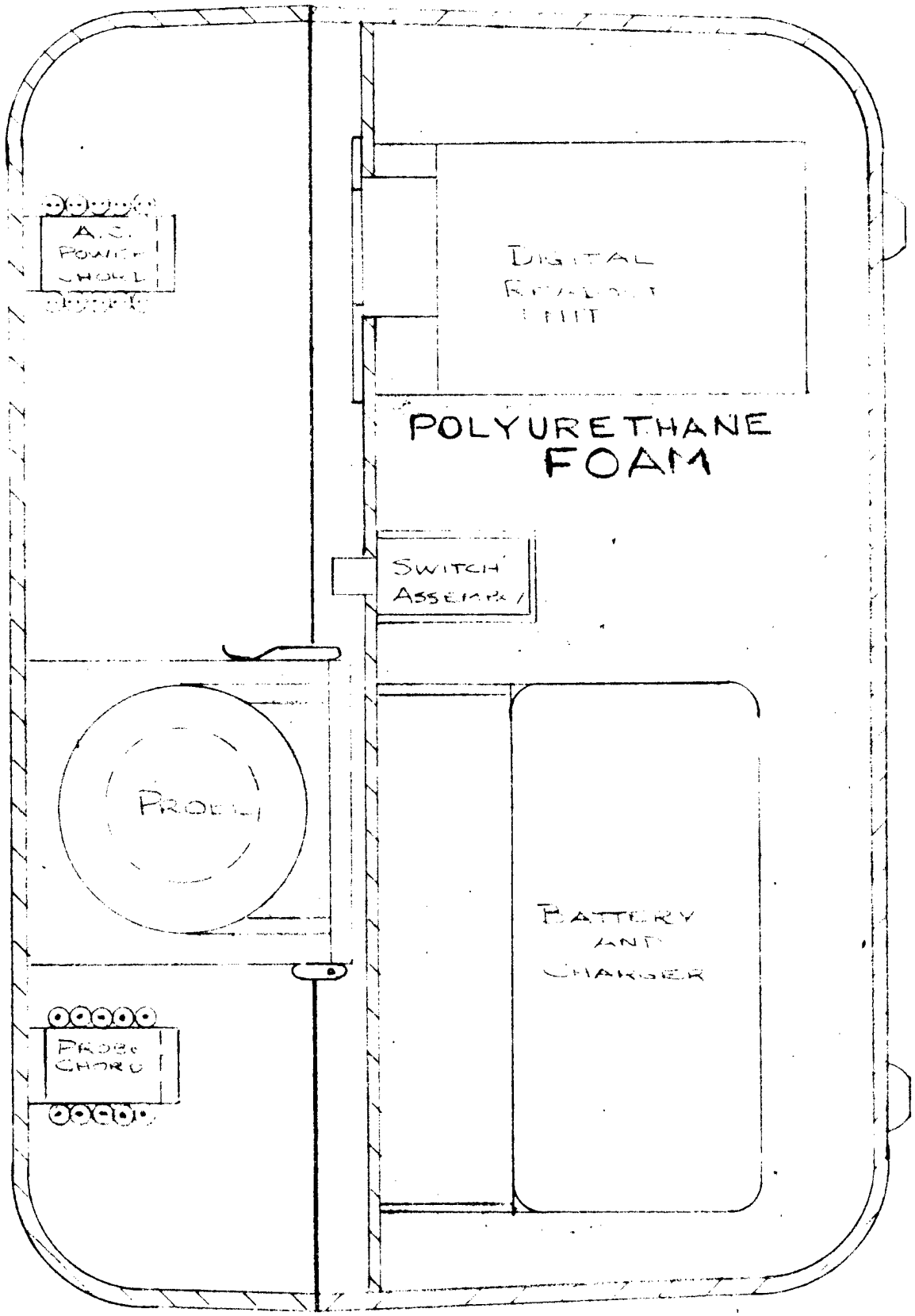
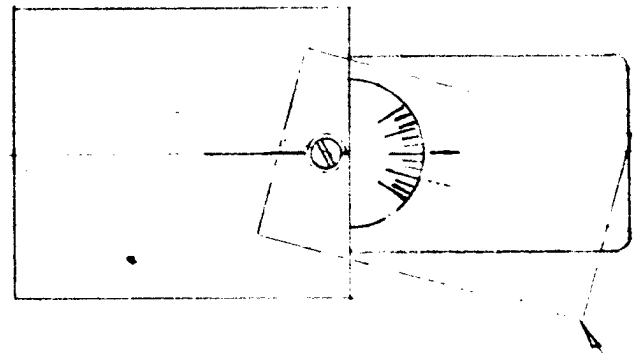


FIGURE 1
ADVANCED PHOTOMETER



SECTION - ADV. PHOTOMETER

FIGURE 2



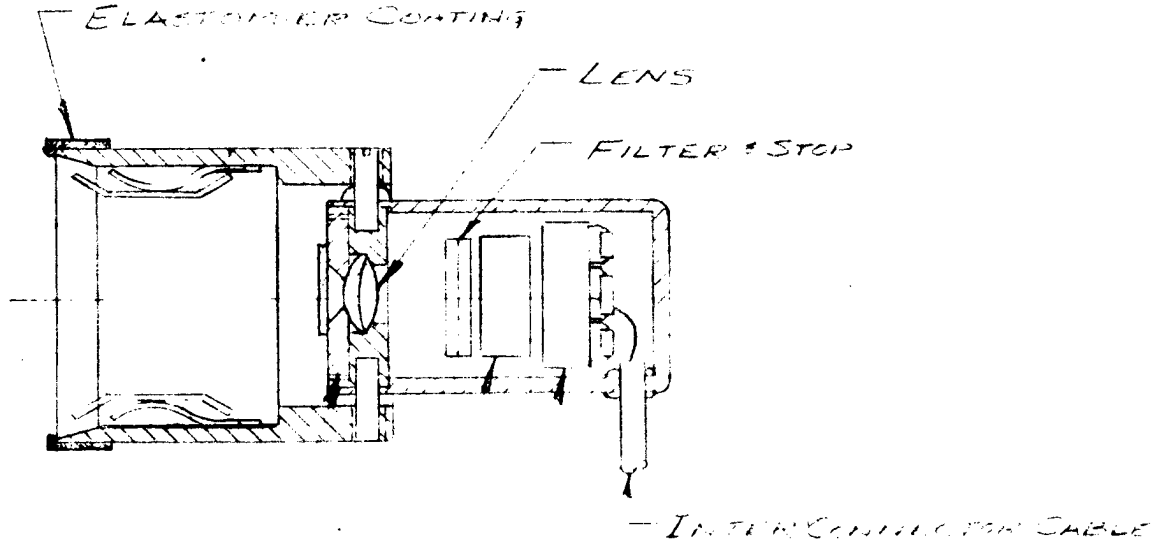
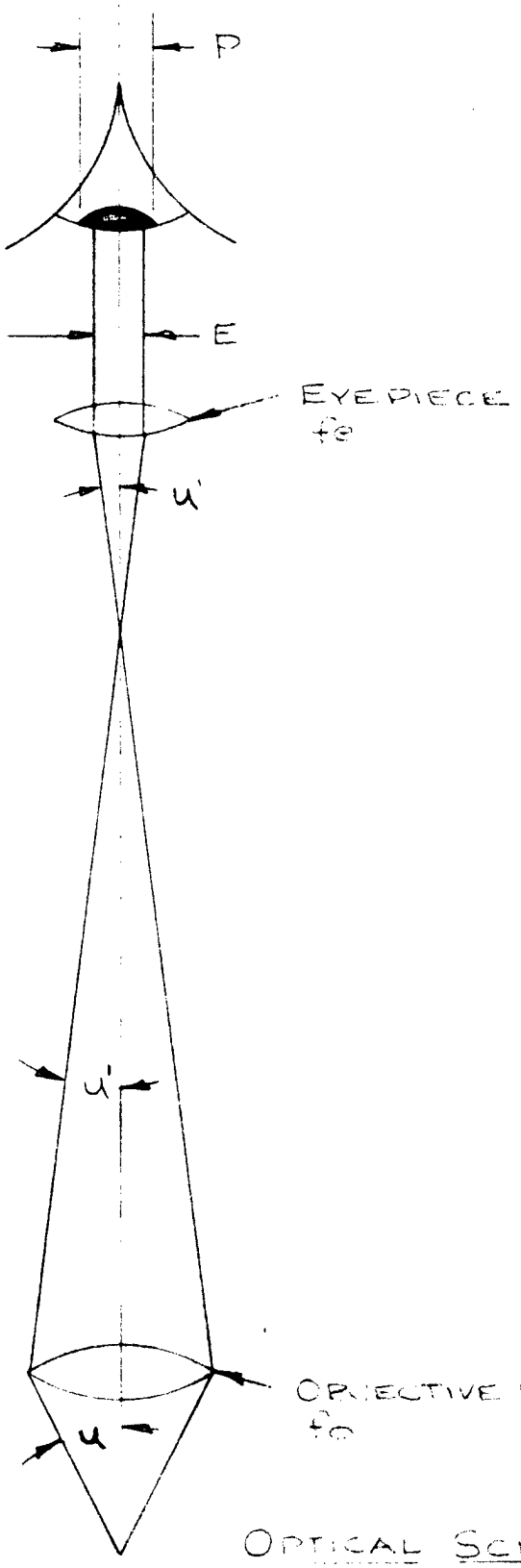


FIGURE 2
CAMERA TUBE



OPTICAL SCHEMATIC
TYPICAL MICRO[illegible]

FIGURE 4

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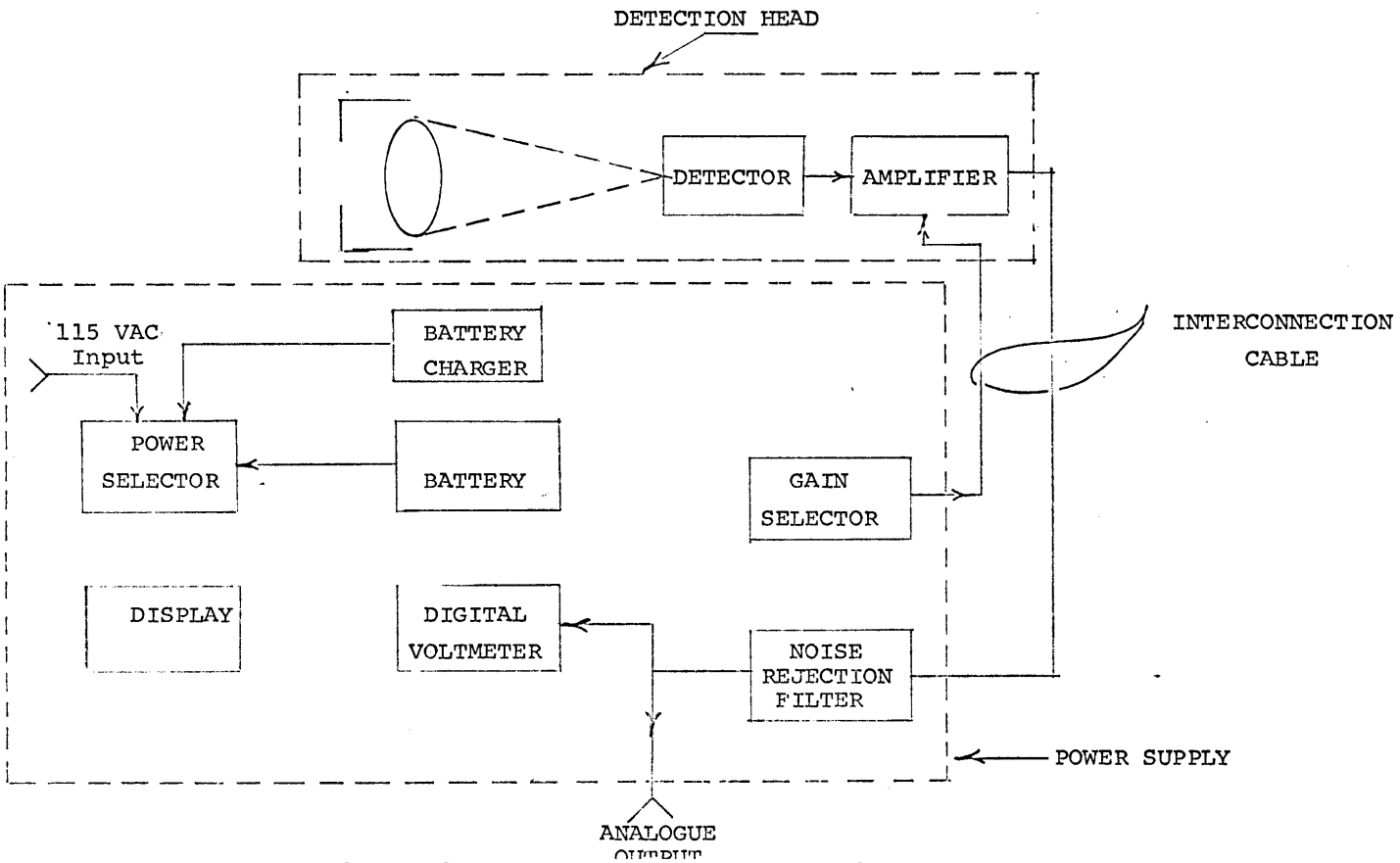
FIGURE 5
PHOTOMETER BLOCK DIAGRAM



APPENDIX I
REFERENCE CALCULATION FOR EXIT PUPIL
TYPICAL MICROSCOPE

Figure 4 illustrates a typical microscope. As shown, (u) is the half angle of the objective. Numerical aperture = n(sinu) where n is the index of refraction.

Objective Magnification $M_o = \frac{u}{u^1}$.

Exit diameter of microscope (E) = $\frac{2u}{M_o}$ where f_e is focal length of the objective. We can substitute $f_e = \frac{254mm}{M_e}$; where, 254mm is the 10" standard focussing distance of the eye, and M_e is the magnification of the eyepiece.

Consequently, $E = \frac{2u}{M_e M_o} \times 254mm$

$E = \frac{508u}{M}$; where, u = numerical aperture, and M is total magnification.

The above formula can be used to determine exit diameter in millimeters of a microscope.

STAT

SECTION IV

WORK STATEMENT

The Work Statement is included in the Technical Discussion which is covered in Section III herein.

[redacted] STAT

SECTION V
DELIVERABLE ITEMS

1. Interim and Final Reports

[redacted] will adhere to the provisions of Specifica STAT tion Number DB-1001, "Contractual Documentation to be Supplied by Contractors". Monthly and Final Reports will be provided in accordance with the modified time schedule proposed herein. Report format and content will be as defined in the referenced specification. Installation data requirement as set forth in paragraph 2.2.3 of DB-1001, in consideration of the proposed 6 month period of performance for development and delivery of the Photometer, will be modified to provide that preliminary data shall be submitted to the Contracting Officer's Technical Representative at 1 1/2 month point and final data at the 4 month point. Since the Photometer is to be an easily carried, man-portable device, the installation data requirements are minimal and therefore, the alternate delivery schedule proposed will be more advantageous to the Government.

2. Equipment

Specified manuals, operator and maintenance, will be delivered within 4 months of date of contract award. An Acceptance Test procedure will be submitted by [redacted] at 4 months with STAT sponsor approval solicited within 2 weeks thereafter. Upon receipt of sponsor approval of the test procedures, preliminary acceptance

STAT

testing will be accomplished and upon completion, the prototype photometer will be delivered (5 months ARO). The Final Report will be provided within 30 days of equipment delivery.

STAT

SECTION VI
PROJECT SCHEDULE

See Figure A for a Milestone/Time Chart of predicted program progress. Due to short period of performance, only overall costs are defined. For costs, please refer to the Summary of Costs in Section I or the detailed cost breakdown given in Section VIII.

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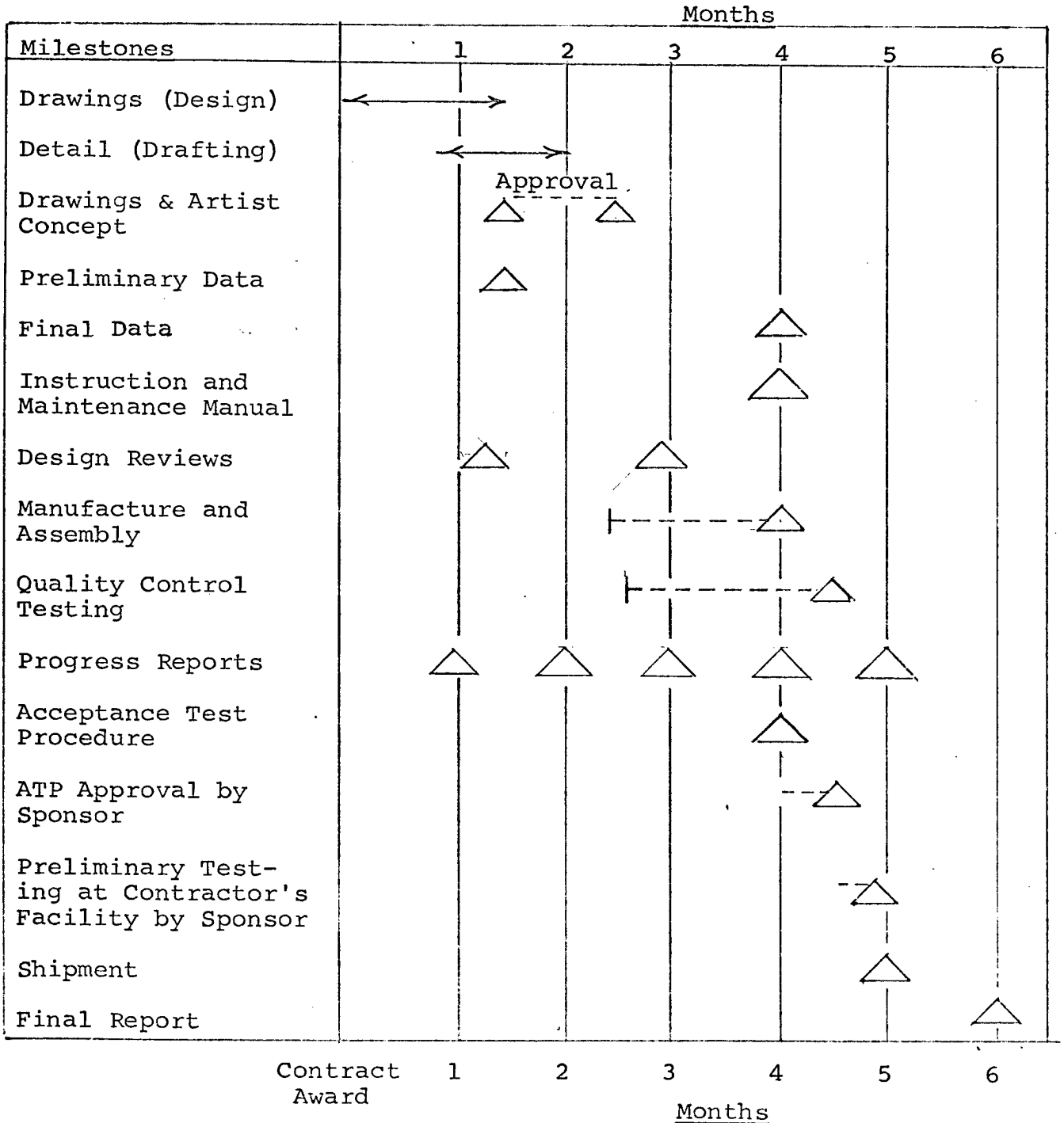
SECTION VII

PROGRAM SCHEDULE

Figure A



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SECTION VIII
FINANCIAL CONSIDERATIONS

Attached hereto are detail cost proposals covering:

a. Design and Production of Prototype Advanced Photometer

b. Production of 5 Advanced Photometers

c. Production of 10 Advanced Photometers

Summary of these costs is as follows:

STAT

(a) Design & Prototype Advanced Photometer - [redacted]
(b) Production - Five Advanced Photometers - [redacted]
(c) Production - Ten Advanced Photometers - [redacted]

Per Unit Costs:

5 Unit Buy
10 Unit Buy

[redacted]

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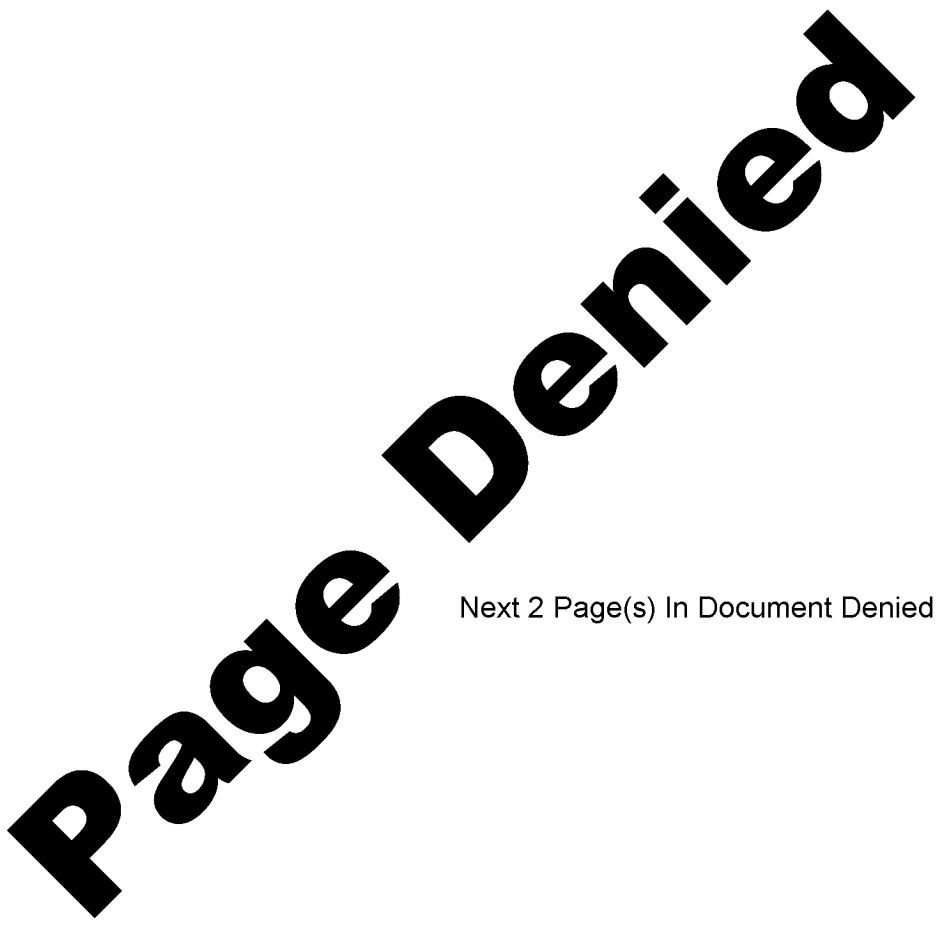

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SECTION IX
MANAGEMENT PLAN

ORGANIZATION STRUCTURE

STAT functionally undertakes contractual performance by assignment of a Program Manager directly designated as responsible for the performance of the contractual commitment. In order to promote necessary personnel resources, the engineering, technical and other skills required are assigned directly to the Program Manager. This concept provides for a responsive and totally coordinated team effort.

PERSONNEL QUALIFICATION

The resumes' of the key individuals to be assigned to the Advanced Photometer are included herein. All personnel are presently available for the program. The program will be managed by STAT

STAT

ASSIGNMENT OF PERSONNEL

The following personnel will be assigned for the design and manufacture of the system; their time will be made available for the fulfillment of the various tasks of the program, as required.

STAT

STAT

- Project Manager
- Mechanical & Optical Engineering
- Electrical Engineering
- Supervisor of Design & Drafting
- Manufacturing
- Quality Control

In addition to the above personnel, STAT Supervisory Personnel and staff consultants will be utilized for the performance of the design effort.

The techniques and project teams developed in programs, such as those mentioned above, will be brought to bear on the presently proposed equipment.

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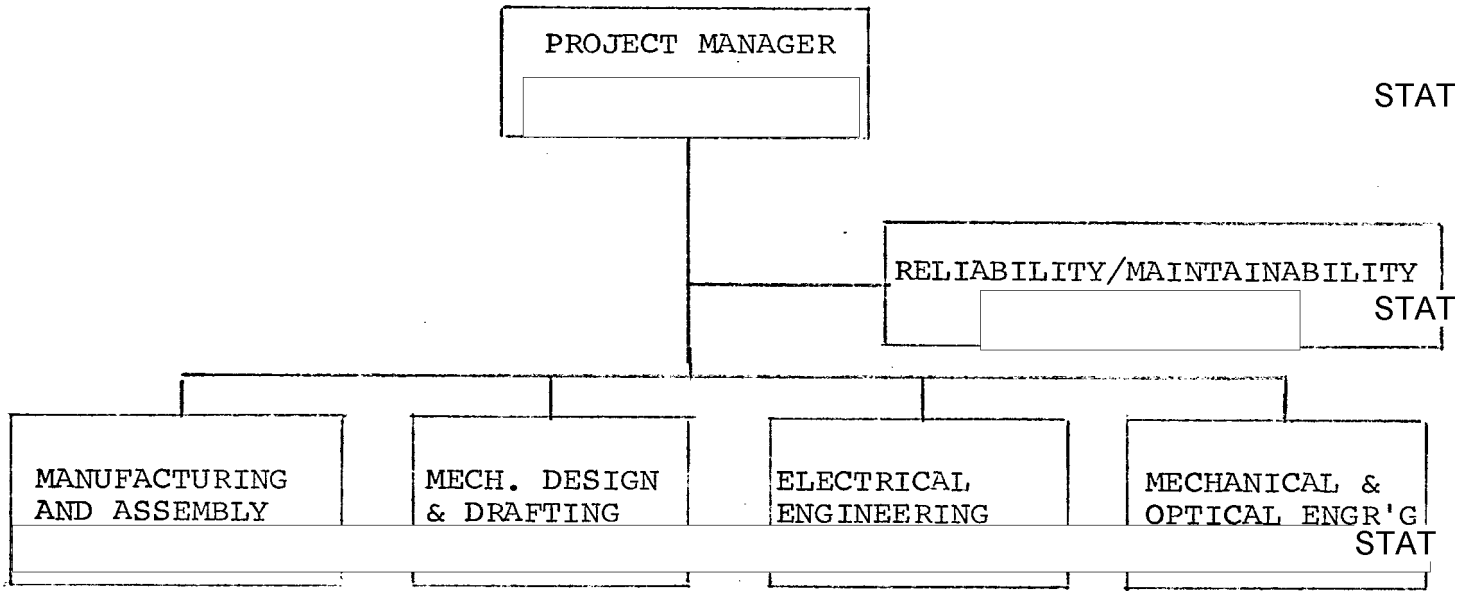
PROGRAM ORGANIZATION



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SECTION X
COMPANY CAPABILITY

A brief profile of [redacted] along STAT with a listing of company facilities follows. It is not contemplated that any additional facilities or equipment will be required in development or subsequent production of the Photometer. Additionally, included are descriptive literature relating to products previously delivered by [redacted] which are related STAT to the Photometer.

STAT

June 1970

The company facilities are housed in a completely air conditioned and humidity controlled plant of 25,000 square feet, assigned as follows:

Engineering	5,000 square feet
Office and Administration	3,500 square feet
Manufacturing; includes; Product Assurance, Purchasing Production Control, and Manufacturing Engineering	16,500 square feet

Included in the Engineering facilities are:

Completely equipped Optical Laboratory
Interferometer Test Laboratory
Photographic Laboratory and Darkroom
Drafting Room (18 boards)
Programmable Calculator with Storage
Cam-Share Time Sharing Computer Terminal

Contents

STAT

MACHINING FACILITIES - 6500 SQUARE FEET

FULLY AIR CONDITIONED

(All Machines are Fully Equipped)

SHOP EQUIPMENT

LATHES - Capacity to 20 1/2" Swing, 54" Between Centers

2 Sebastian Engine Lathes - 14" Swing
1 Lodge and Shipley Lathe - 20 1/2" Swing
1 SAG #49 - Gap Bed Engine Lathe 18" Swing
1 Sheldon Precision Engine Lathe 10" Swing
2 Hardinge High Speed Precision Lathes with Tail Stock Turrets
1 Logan Engine Lathe 10" Swing

MILLING MACHINES - Capacity to 48" X 48" X 144"

1 Kearney & Trecker Model 307-S12 Universal
1 Cincinnati Hypro-Planer-Miller 48" X 48" X 144"
1 Van Norman Ram Type #12
1 Van Norman Ram Type #22L
4 Bridgeport Vertical Millers
2 Bridgeport Vertical Millers with Optics
1 #12B Vertical Miller and Profiler - Pratt and Whitney
1 Nichols Tool Room Horizontal with Vertical Head
1 Groton 3U Pantograph Engraver

DRILLING MACHINES - Table Size Capacity 36" X 48"

1 (4) Spindle Avery No. 1 VMA Variable Speed Sensitive Drill Press with Super Sensitive Tapping Head
1 Walker-Turner (2) Spindle Drill Press

STAT

Drilling Machines (Continued)

1 Burgmaster Bench Model - (6) Spindle Auto-Indexing Turret and Tapping Machine

3 Delta Single Spindle Drill Presses

1 Caser F35 Model 915 Radial Drill Press

1 Delta Radial Drill Press

1 Walker-Turner Radial Drill Press

1 [redacted] Layout and Drilling Machine STAT

1 Dumore Sensitive Drill Press

JIG BORERS - Capacity to 11" X 24"

1 Moore Model Number 3 Precision Jig Borer

2 Linley Jig Borers

INDEXING EQUIPMENT

1 Moore 10" Ultra-Precise Rotary Table (2 sec. total error)

1 Rotary table with locating pilots and 12" Auxiliary Table - Six second accuracy

2 Hartford Super Spacers 5", 10"

1 16" Rotary Table

1 12" Rotary Table

1 9" Rotary Table

2 [redacted] 10" Pi-Dex Rotary Tables STAT

SURFACE GRINDING MACHINES - Capacity to 14" X 48"

1 G&L Surface Grinder Model Number 660 - 14" X 48" (.0001 Overall Accuracy)

1 Jones-Shipman 6" X 18" Surface Grinder

STAT

SAWING AND CUTOFF MACHINES

1 DoAll Vertical Band Saw 16"
1 DoAll Vertical Band Saw 14"
1 Kalamazoo Band Cutoff Saw
1 Stone Abrasive 5" diameter Cutoff Machine
1 Power Hack Saw

Sheet Metal Equipment

PUNCH PRESSES - Capacity, 35 Ton Piercing - 70 Ton Forming

1 Wales Strippit #15A With Duplicator Attachments
1 10 Ton, 24" Throat Whitney-Jensen Punch Press
1 75 Ton, Dake, Hydraulic Press
1 Wabash Heated Platen Hydraulic Press - 30 Ton
1 #12 Famco, Foot Press
1 Dake Mandress Press

BRAKES - Capacity to 8' Length

1 96" - 36 Ton, Chicago Press Brake - Counterbalanced for Whistler Dies
1 60" - 12 Gage Whitney-Jensen Box Hand Brake
1 24" - Di-Acro Box Hand Brake
1 2" - Post Multi-Bender Model 5HDSB
1 #2 - Di-Acro Bender
1 Pexto Model 416E Slip Roll Former
1 1" X 12" Diameter Di-Acro Hand Roller

SHEARING EQUIPMENT - Capacity to 6' Length - 1/8" Thick Steel

1 6' Wysong Power Shear 14 Ga.
1 3' Pexto No. 187 Foot Shear 16 Ga.
1 12" Di-Acro Hand Shear Model #3, 16 Ga.
1 6" X 6" Di-Acro Hand Notcher

STAT

WELDING EQUIPMENT - (Aluminum, Alloy and Stainless Steel)

1 300 Amp. P&H A.C. Heliarc Welder
1 Airco Welding and Cutting Outfit (Oxy-Acetylene)
1 Automatic Gas Welding Unit (Smith Aircraft)
1 Peer Spot Welder
(Welding Personnel certified per MIL-T-5021C)

MISCELLANEOUS

1 Groton #256 Cutter Grinder
1 Hammond (No Dust Grinder) Model ND-10
1 Hi-Speed Dumore Grinder
1 Stanley Pedestal Grinder-Model 286B
1 Delta Carbide Pedestal Tool Grinder
1 #27A Wyco Portable Grinder
1 All American Filing Machine
1 6" Hammond Belt Sander
1 Porter Cable Vibrating Sander
2 Polishing Bench Motors
1 Chromemaster Plating Unit
1 Temco Heat Treating Oven
1 Westinghouse Industrial Compressor
1 Model RA-2 Rollabrader Tumbling Barrel

SHOP INSPECTION TOOLS

Granite Surface Plates and Surface Plate Layout and Inspection Tools for Shop Use, Maintained on Scheduled Calibration per MIL-I-45208 and MIL-C-45662

STAT

ASSEMBLY FACILITIES - 7000 SQUARE FEET

FULLY AIR CONDITIONED

INCLUDES:	SQUARE FEET
General Mechanical Assembly Area	4600
Electrical Assembly Area	600
White Room (Federal Class 100) Assembly Area	200
Gray Lab (Constant Positive Pressure) Assembly Area	600
Project Labs Assembly Area	1000

MECHANICAL ASSEMBLY AREA:

Portable Granite Surface Plates up to 6' X 8' for setup, alignment and pinning of assemblies

200 Lineal Feet of Assembly Bench Area

Clausing Variable Speed Drill Press

Mobile Delta Radial Drilling and Pinning Machine

All American Vibrating Test Table - Capacity: 100 pounds @ 10 g. 15" X 18"

Grueneberg 27 Cubic Feet - Temperature Controlled Environmental Test Oven

50 and 400 cycle motor generator units

All Peripheral Equipment required for precision mechanical assembly

ELECTRICAL ASSEMBLY AREA:

100 Lineal feet of specially illuminated electrical assembly benches

Completely Equipped Electronic Test Facility

Complete Electronic Assembly Hand Tools (Supplied under Tool Cribe Control)

All Peripheral Wiring Equipment Required

PROJECT LABORATORIES:

All equipped with assembly work stations, concentrated lighting, exhaust systems

STAT

ASSEMBLY FACILITIES

Continued

"GRAY LABORATORY"

Maintained under constant positive pressure

Special lighting, exhaust systems, power 110-220 VAC Single and Three Phase

Vinyl Wall Panels, Ceilings, Floors

"WHITE ROOM"

Federal Class Number 100 - Laminar Flow Laboratory

Temperature maintained at 68° ± .5°

Humidity maintained at 50% ± 5%

[redacted]

INSPECTION EQUIPMENT

Pratt & Whitney Supermicrometer Model B
Gaertner Tool Makers Microscope
Metro-Surf II, Surface Finish Indicator
Wilson Superficial Rockwell Hardness Tester
Van Keuren 6" and 12" Optical Flats with Reflex Viewers
Brown & Sharpe 9" Hite Set With 9" Base
Brown & Sharpe 36" Super Electronic Hite Check
Do-All Electronic Trans-Check
Federal Electro-Check Model 230P-123
Veeko-Probe Electro Sensing Device
Taft-Pierce 12" Cylindrical Square & Transfer Stand
Pratt & Whitney and Fonda 81 Pc. Gage Block Sets
Solid Steel Squares to 24"
Micrometers from 1" to 12"
Steel and Granite Parallels from 1/2 X 1 X 6 to 1 1/2 X 3 X 18"
Brown & Sharpe and Starrett Vernier Height Gages
Vernier Calipers to 24"
Vernier and Micrometer Depth Gages
Mahr Bore Gages from .280" to 6" w/.000050 Indicator
4' X 6' and 4' X 8' Granite Surface Plates
Matched Angle Plates and Vee Blocks for Precision Inspection
Torque Tools - Torque Watch, Torque Screwdrivers, Dynamometers
Thread and Gear Checking Wires
Plug and Ring Thread Gages
Cylindrical Plug Gages
Mechanical Dial Indicators .001" and .0001"
[redacted] Laser Interferometer Lead Screw and Scale ChecSTAT
133 Co-ordinate Inspection Machine

STAT

ELECTRONIC TEST EQUIPMENT

(On Scheduled Calibration per MIL-R-45662)

Tektronix Model 422 Oscilloscope
Tektronix Model 453 Oscilloscope
Tektronix Model 564 Oscilloscope
Tektronix Model 531 Oscilloscope
Tektronix Model 543 Oscilloscope
Tektronix Plug In Units, Models CA; D; M; 3A6 and 3B4
Tektronix Scope Camera Model C-27
Consolidated Electro-Dynamics Recording Oscillograph, Type 5-124
Hewlett-Packard, Model 500B, Frequency Meter
Hewlett-Packard, Model 521A, Counter
Ballantine Precision Calibrator, Model 420
Ballantine V.T. Voltmeter, Model 3000
Ballantine Sensitive D.C. Volt/Ammeter, Model 365
General Radio Impedance Bridge, Type 1650A
General Radio Decade Voltage Divider, Type 1454A
General Radio Resistance Decade, Type 1432M
General Radio Pulse Generator, Type 1217C
Hewlett-Packard Variable Oscillators
Federal Signal Generator 8 to 330 MC
D.C. Power supplies to 2500 volts
Simpson Volt-ohm-milliammeter, Type 261
R.C.A. D.C. Micro Ammeter, Vacuum Tube and R.C.A. V.T.V.M.
Weston D.C. Micro Ammeters, Model 931
Miscellaneous Laboratory Equipment

[redacted] STAT

OPTICAL AND CALIBRATION LABORATORY EQUIPMENT

Granite Surface Optical Table, 4 foot X 15 foot, vibration mounted - 7 ton mass

Macbeth-Ansco Electronic Densitometer, Model 12A

Leitz Labolux Research Microscope with microdensitometer attachment

Three Gaertner Precision Optical Benches, Model L-360NA

Davidson Optromics Coordinate Autocollimator, Model D-638, measures angles to 1/2 second of arc and other collimators 15" focal length

Hilger Watt TA-3 Electronic Autocollimator, Optical Square and alignment mirror

Hilger Watt Microptic .1 second autocollimator

Kollmorgan Dual Axis Autocollimator

[redacted] Sub-Second Positioner-Temperature compens STAT angle measuring device - measures angles to 0.1 second of arc

Two Axis Interferometer - 1 micron accuracy with grazing angle capabilities

Leeds and Northrup Portable Temperature Potentiometer, Model 8693

Gurley Transit

Edgerton Sensitometer

Prichard Photometer, Spectra brightness meter, Photovolt Photometer, Model 520M

Several standard Light Sources

Light Meters: SEI Visual Photometer, Gossen Low Light Level and Color Temperature

Nikon - 12" Profile Projector

STAT

OPTICAL AND CALIBRATION LABORATORY EQUIPMENT

(Continued)

Cameras: Leica, Polaroid, Graphic, Fastax, 16,000 frames per second, Bolex 16mm, Polaroid Scope Camera, and solenoid

Several Bausch and Lomb Optical Bench Microscopes

One Two Axis Beck Measuring Microscope

One Gaertner Measuring Microscope full assortment of microscope eyepiece and objectives including filar micrometer

Stereo Zoom Microscope

A.O. Spencer Microtome

Light Sources: Zirconium arc, xenon, helium, mercury, quartz, iodine and monochromatic sources

Large Collection of Lenses: Includes condensers, achromats, mirror objectives, prisms, filters, photographic objectives, oculars poraboloids, tillyer ophtalmic trial set, optical flats up to 8" diameter 1/20 wave accuracy, - Van Keuren reflex housing and optical inspection interferometer calibrated density wedges

Resolution Charts and Test Patterns for lens evaluation - to 800 lines per mm resolution

Continuous Coherent Laser Light Sources, Mercury Hg 198 Sources

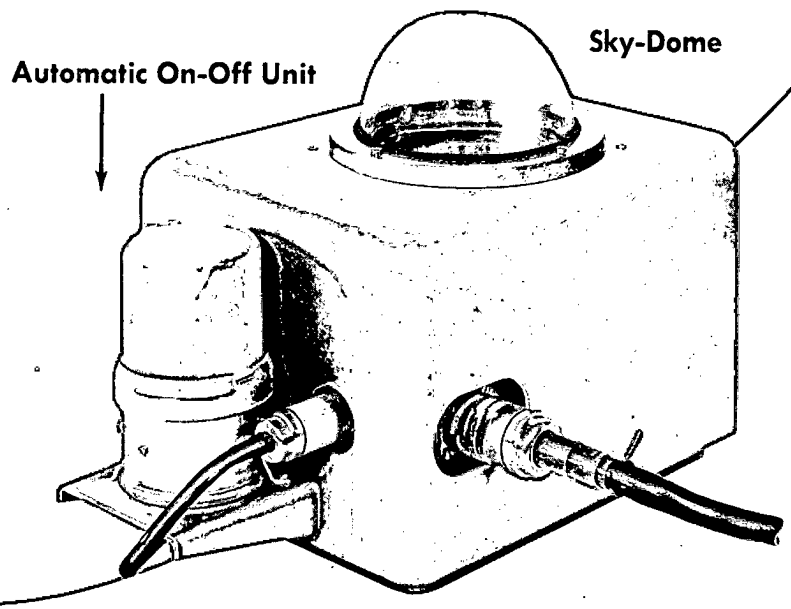
Complete Photographic Darkroom; Slide Projectors, microfilm viewers and Omega Enlarger

Kreonite sinks with built-in water temperature control and water filtering system - Leedal Autotemperature control photo processing unit

Image Splitting Eyepiece

Low Level QUICK RESPONSE PHOTOMETER with Self Calibrating and Check Out

Model 356



Model 356, PHOTOMETER, is a highly sensitive instrument for measuring light levels between the ranges of 10^{-6} to 10^{-1} foot lamberts or higher. The accuracy of the instrument is 5% within the total range. Ten ranges of measurements are provided:

RANGE	FOOT LAMBERTS	
1st	10^{-6}	to 3×10^{-6}
2nd	3×10^{-6}	to 10^{-5}
3rd	10^{-5}	to 3×10^{-5}
4th	3×10^{-5}	to 10^{-4}
5th	10^{-4}	to 3×10^{-4}
6th	3×10^{-4}	to 10^{-3}
7th	10^{-3}	to 3×10^{-3}
8th	3×10^{-3}	to 10^{-2}
9th	10^{-2}	to 3×10^{-2}
10th	3×10^{-2}	to 10^{-1}

The output of the unit may be applied to recorders, indicating meters, or integrating photometric systems. The field of view may be selected by changing objective lenses. (Maximum wide field: 135°.) (Minimum narrow field: ½°.)

The light level being measured automatically selects the correct operating range without any other influence. Consequently, a high degree of accuracy is maintained.

Bulletin No. 356

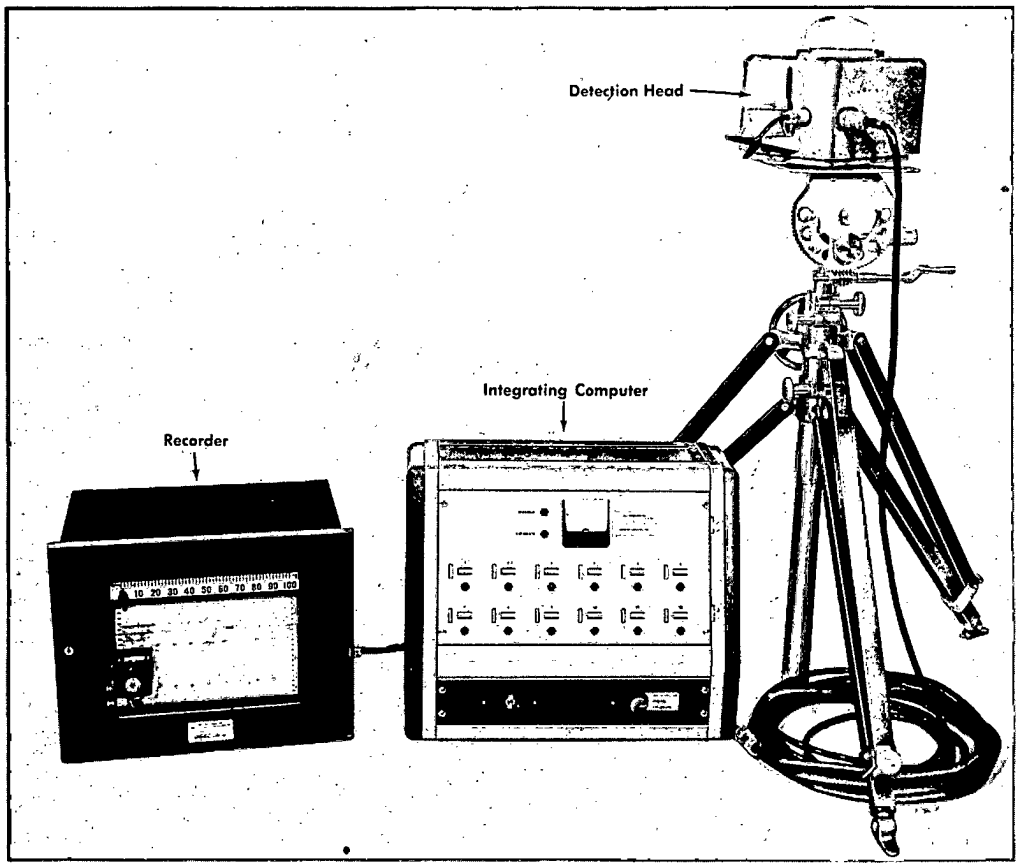
STAT

OPTICAL — MECHANICAL — ELECTRONIC — RESEARCH AND DEVELOPMENT — PRODUCTION — MANUFACTURING — SPECIAL CAMERAS — PHOTOMETRIC DEVICES — OPTICAL TACHOMETERS — RAPID FILM PROCESSORS — PROJECTORS — OPTICAL TRACKERS — STEREO VIEWERS — SATELLITE DETECTORS — MEASURING INTERFEROMETERS — STEREO COMPARATORS — NEGATIVE TO POSITIVE FILM VIEWERS — ANGULAR MEASURING DEVICES — FIBER OPTICS APPLICATIONS

FEATURES

- Automatic on-off shutter system for protecting the sensing element from possible damage due to the sunlight or other very bright objects.
- Automatic range selection system for maximum accuracy.
- Complete automatic provision available for readout into an integrating system or paper recorder.
- Internally located light source for calibration and checkout.
- Filter holder for spectrum analysis.
- Interchangeable photomultipliers with S-4, S-5, or S-8 Spectral response.

INTEGRATING OR AUXILIARY EQUIPMENT



STAT

"AUTO-PULSE"
PHOTOELECTRIC MICROSCOPE

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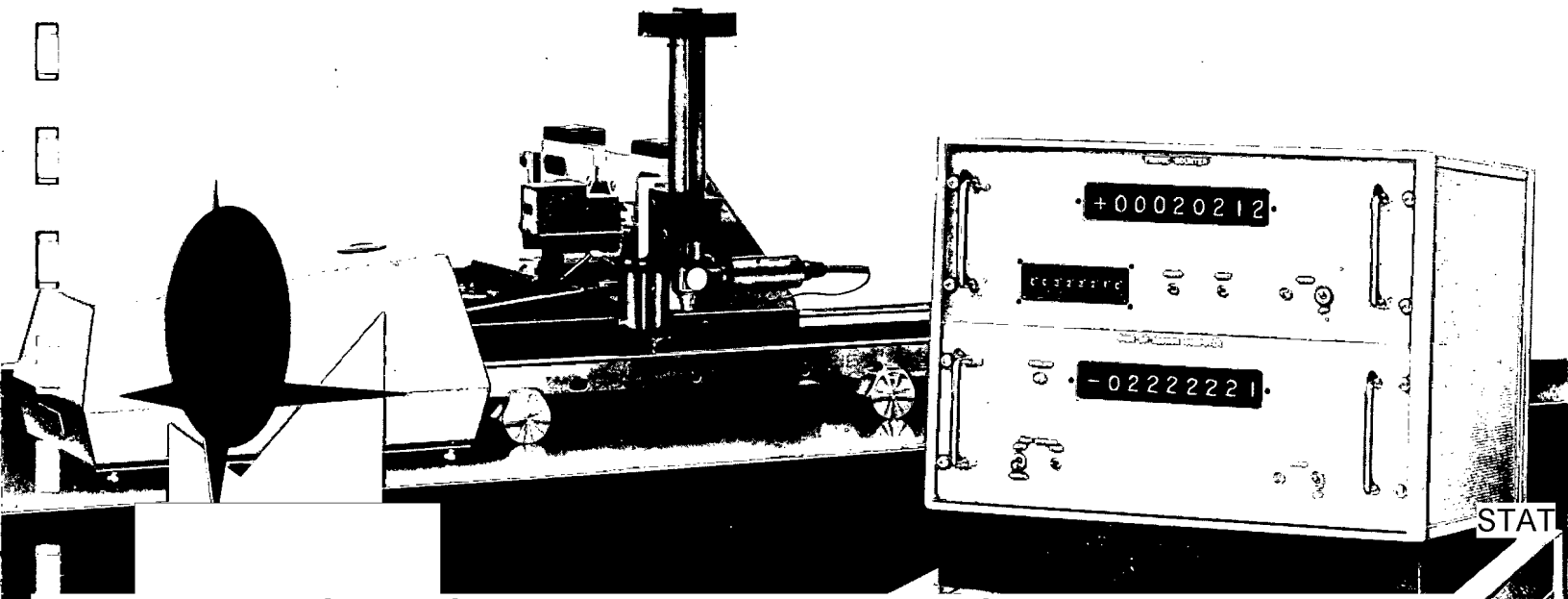
MODEL 671



STAT

"AUTO-PULSE"

PHOTOELECTRIC MICROSCOPE

Model 671

[redacted] *introduces the "Auto-Pulse" Photoelectric Microscope for the inspection of grids or scales "on-the-fly." Its purpose is to eliminate the time consuming operation of setting and measuring lines manually, whereby errors resulting from operator fatigue are causes for inconsistent performance. As many as 60 lines per second can be inspected automatically, at a maximum continuous speed of 0.1 inch per second.*

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COMPARISON OF MEASURING MICROSCOPES

The "Auto-Pulse" microscope is designed to accurately measure the distance between "grid lines" on a scale, fiducials, or images on a photograph by reflection or transmission. Present systems use microscopes with reticles to observe the scale's image in which the operator aligns the scale's image to the reticle and reads the coordinates of a measuring machine. This is a time consuming and tiring process, and at optimum is dependent on the operator who must stop precisely and repeatedly at each line. An alternative to the above is to utilize a photoelectric microscope where the operator views an oscilloscope to observe the deviation of the grid line or point from the optical axis after which each line is then positioned to individually and measured. The basic disadvantage of starting and stopping is required in this scheme. The greatest distinction of the "Auto-Pulse" microscope is that measurements are done "on-the-fly." Stopping at each line is not required. The instant the center of the image is passed through the optical axis, a pulse actuates the readout in which the "X" or "Y" coordinates are automatically stored for display or printout.

An ideal measuring system for use with the microscope is the laser interferometer, [redacted] Model 437L-512, with automatic temperature pressure and humidity compensation. The microscope-interferometer system can achieve accuracies of better than $\pm 1/4$ micron (0.00001"). The microscope may also be used on machines equipped with encoders, or digitized scales, with the added capabilities of remote-input and readout.

FEATURES

The Photoelectric Microscope possesses unique features, most important for the making of accurate measurements:

1 The coordinates of the exact *center* of the line or point are obtained. This has a distinct advantage over the measurement from an edge. It is not unusual to have lines of slightly unequal thickness, in which a large error will exist if the edge of the line is measured instead of the *center*. The edge contrast or gradient does not enter into the accuracy of measurement as it exists with conventional measurement techniques.

2 The measurement is independent of line contrast or light level, since illumination only at the "center" is measured. Signal level adjustment control is incorporated to achieve optimum detection. Opaque lines on glass, steel or clear lines on glass scales may be measured with equal accuracies.

3 The system contains a noise rejection gate whereby the microscope cannot trigger on spurious noise. Thus, if disturbances are present, they are prevented from actuating the mensuration system, unless their magnitude exceeds a level equivalent to that of the line or point being measured.

4 The system contains an automatic reset feature. It allows for the first pulse to establish "zero" onto a readout counter or "zero" reference. The second, third, etc. lines are read automatically without zeroing.

5 The system design provides accurate measurements independent of direction of travel (left to right, or right to left). The accuracy of the system is also independent of the speed of travel from zero to 0.1 inch/second.

GENERAL DESCRIPTION

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The Photoelectric Microscope provides a pulse output as its optical axis crosses the center point of a grid line or other scale mark. The pulse is used to actuate the readout system for automatic display. Since the pulses are produced "on-the-fly," there are no interruptions in the measuring operation, and readout or printout is completely automatic when used with an [redacted] Laser Interferometer System.

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The microscope housing contains the entire optical system along with an internal light source and a viewing eyepiece. Photo detectors and associated circuits are incorporated in the top portion of the microscope housing. The base of the microscope has provision to mount a corner cube reflector, when a laser interferometer is used for measurement.

The power supply for the internal light source along with additional pulse forming circuits are mounted in a separate cabinet.

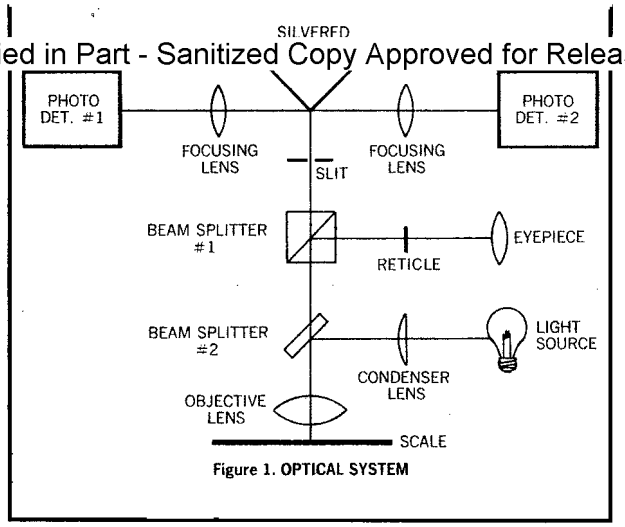


Figure 1. OPTICAL SYSTEM

OPTICAL SYSTEM DESCRIPTION

Figure 1. A high intensity light source and condensing lens provide the necessary illumination for the optical system. A beam splitter, No. 1, deflects the beam of light onto the object plane.

The microscope is provided with interchangeable objective lenses to accommodate various field coverages. The imagery, once it has reached the objective lens, is focused through the beam splitter and the aperture onto a silvered prism. In turn, the silvered prism reflects one-half of the image area to photodetector No. 1 through a focusing lens and the other half of the image area, to photo detector No. 2, similarly through another focusing lens. In this manner, a signal is produced at each photo-detector corresponding to each side of each optical channel; that signal is proportional to the average brightness of the image.

Beam splitter No. 2 is placed in the optical path to partially reflect the image to the viewing eyepiece for observation.

The aperture's slit is approximately .020 inches wide. The full line-width of the image at the aperture plane must be less than the width of the slit itself. At the same time, it must be wide enough to provide a signal of sufficient amplitude to override the noise rejection level of the electronic circuitry. The line-width at the aperture plane is the product of the line-width on the scale by the objective lens magnification factor.

DESCRIPTION OF ELECTRONICS

Figure 2 shows representative waveforms of the electronic system. The output of each photo detector is applied to a difference-amplifier, which provides a composite signal equal to the difference of the two photo detector signals (PD #1 and PD #2). The signal is then fed to a Schmitt Trigger circuit.

The composite signal is an "S" curve with a zero crossover at its center point which corresponds to the center of the grid line. The Schmitt Trigger circuit provides a pulse at the zero crossover through a gate circuit which is opened by the signal as it approaches its negative peak. This circuit prevents spurious noise pulses from triggering the system and provides a pulse only when the high level composite signal is present. The pulse generator and pulse shaper provide the required output pulse necessary to activate the readout system.

When the "Auto-Pulse" microscope is used with the Laser Interferometer, actuation of a reset-switch accessible on the front panel of the microscope power supply automatically provides a reset pulse for the interferometer readout system. At this point, the printer prints out 00.000000. As each line is scanned in succession, readout of interferometric measurement is printed out. The auto pulse may also be adapted to digitized scales or encoder-leadscrew type of measuring machines. It may also be used as an inspection tool in many other types of measuring instruments or as go-no-go gauge types of operation.

OPTIONAL ACCESSORIES

1—Skip-Counter—An optional accessory can be provided to sample discrete lines of equal spacing. (Example: every 10th line or every 100th line, etc.) A counter provided with the instrument allows the selection of readout at any one of the number of lines as selected by a three digit thumbswitch, which can be set to read between 1 and 999; the advantage of this feature may be illustrated when a closely spaced grating is being inspected. The number of measurements may be too voluminous, and the readout speed may necessarily be too slow due to the limitations of the printer. Using the skip-counter, the operator may then sample the scale, and expect rapid measurements without sacrificing accuracy.

2—Auto-Collimating Accessory—The Photoelectric Microscope can be used to provide a pulse every time a mirror is positioned perpendicular to the optical axis of the microscope. This optional feature provides a collimating lens in lieu of the microscope objective. In addition, auxiliary optics and a slit are inserted in front of the source of illumination. Consequently, a collimated image of the illuminated slit is reflected by the mirror back onto the microscope slit for photoelectric detection. The sensitivity and repeatability of the instrument is better than four seconds of arc. The maximum range is six feet between the auto-collimator and the mirror. The full advantage of this option can be realized in the checkout of moving rotary tables, when either one

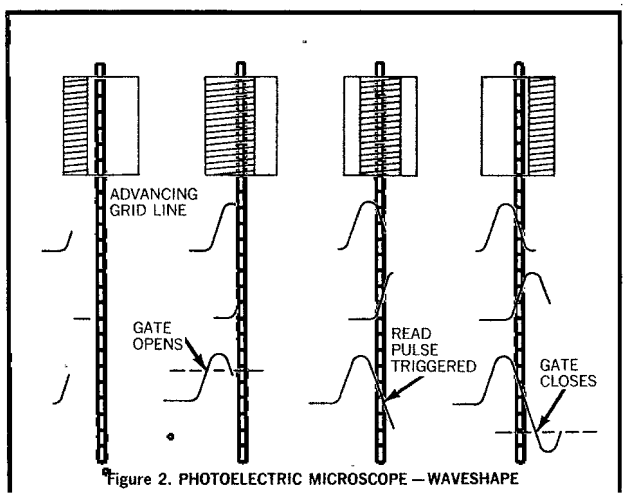
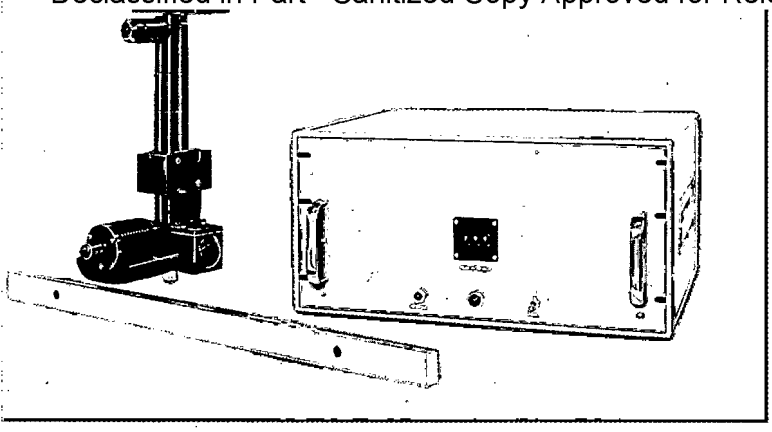


Figure 2. PHOTOELECTRIC MICROSCOPE—WAVESHAPE



mirror or a multiface mirror polygon is placed on the rotating member. In this application, a pulse is generated when the facets of the mirror block are perpendicular to the axis of the microscope.

3—Power Supply Cabinet—The cabinet can be supplied as an accessory.

SPECIFICATIONS

Built-In Illuminator

High brightness, 18 watt illuminator is supplied with condensing optics for high contrast. Heat deflectors and fixed housing minimize temperature rise of microscope housing. Optional fiber optics illuminator is supplied on special order.

Slit Reticle

.020" x .125" is normally supplied. Interchangeable slit widths from .030" to .005" are available on special order.

Objective Lenses

The objective lenses are interchangeable and can be focused for optimum performance. The following objectives can be supplied:

50X (Use with .0001" to .0005" line widths)
20X (Use with .0003" to .001" line widths)
10X (Use with .0006" to .002" line widths)
One Objective, 10X is supplied with the microscope.
5X (Use with .001" to .004" line widths)
3X (Use with .002" to .006" line widths)
1X (Use with .005" to .020" line widths)

Adjustment of Background Noise Rejection Circuits and Signal Levels

Provisions are made to allow adjustment of noise rejection circuit to eliminate spurious outputs or background noise caused by dirt, dust and imperfections in the part to be measured.

Electronic Chassis

A standard 19" rack mounting, 7" x 14" deep. It contains regulated power supply for lamp, low voltage amplifiers for the electronic system, and plug-in solid state logic and amplifier circuits.

Output Signals

1—Readout Command Pulse—Negative going from zero to —15 volts, 10 microseconds duration. The leading edge occurs at the exact center of the measured line.

2—Reset Pulse—The first scale pulse may be selected to be a reset pulse (to zero a counter) by depressing the "reset" switch on the front panel on the Remote Reset Switch.

3—Pre-amplifier Output Signal—This is an electronic signal supplied as the difference between the two detectors. It can be supplied to a scope or meter for visual setting of zero.

Reset Switch

Push-button pendant switch is supplied (15 feet long), to allow resetting of the system. The first scale pulse after switch is energized, will reset the readout counter to zero.

Maximum Speed of Travel

0.1 inch per second.

Cable Length

Standard length of cable between microscope and console is 12 feet.

Accuracy

The accuracy of the photoelectric microscope when used with [redacted] Laser Interferometer is ±¼ micron (10 microinches). The errors introduced by the measuring machines and environment must be combined with the errors introduced by the photoelectric microscope to obtain total system errors.

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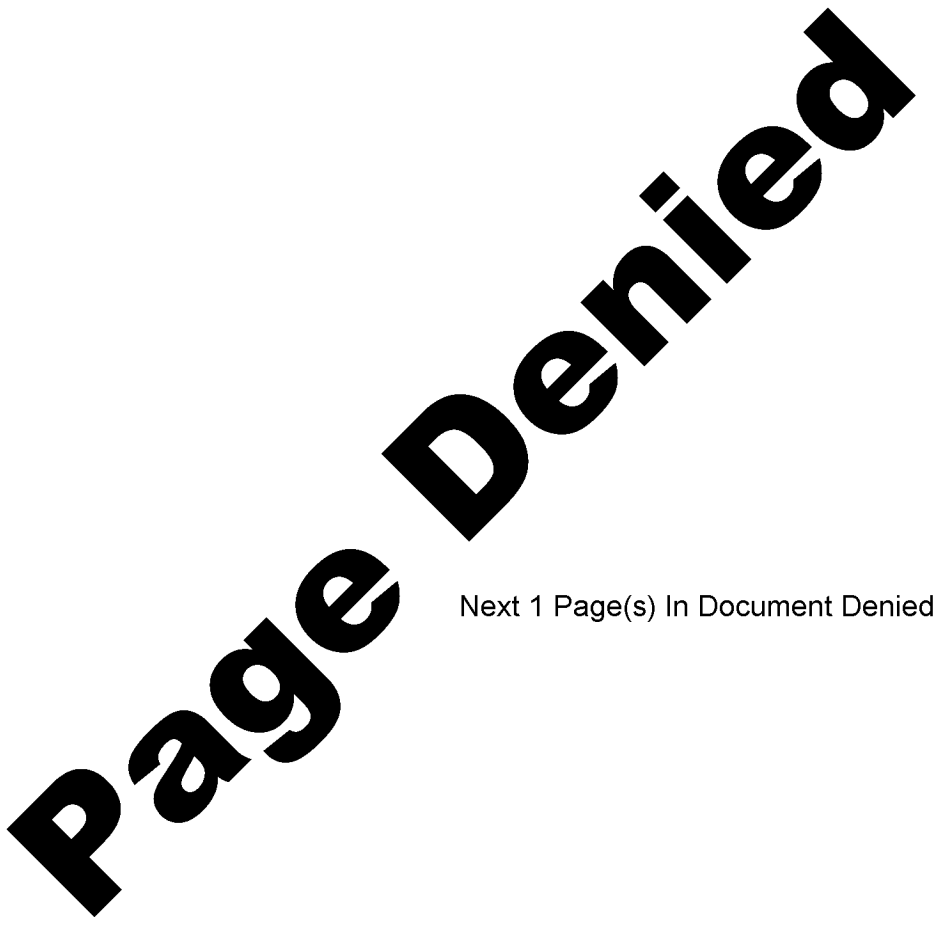

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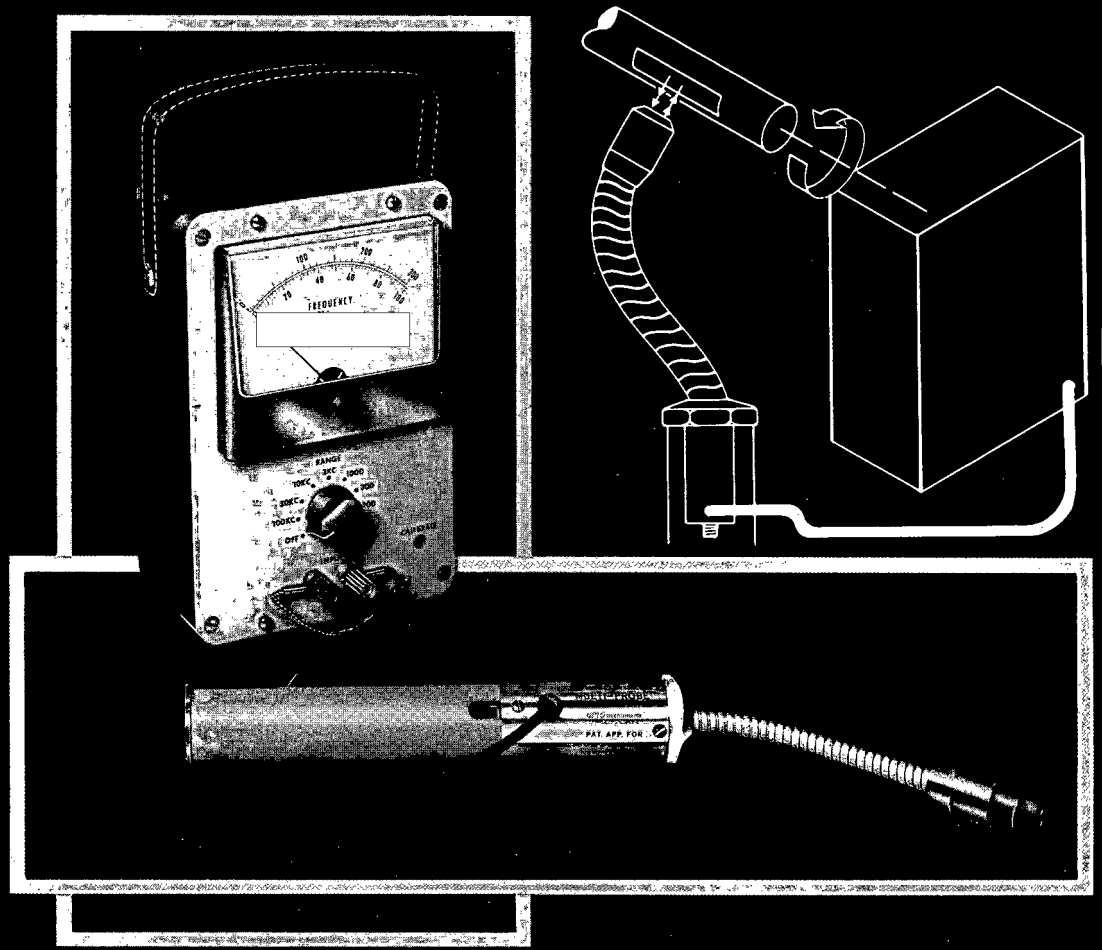
TRANSISTORIZED

OPTICAL FREQUENCY INDICATOR

WITH "BEAM-OF-LIGHT" SENSOR



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TRANSISTORIZED

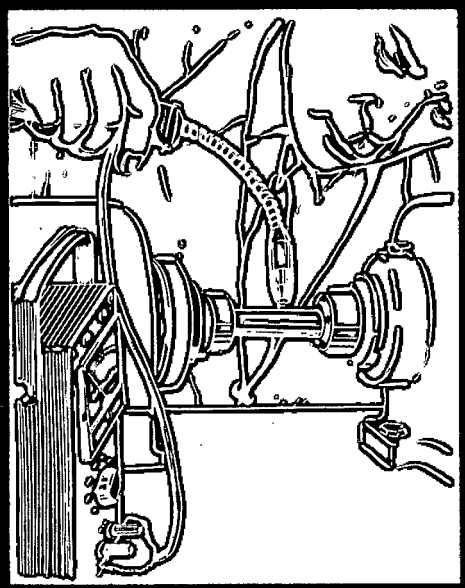
OPTICAL FREQUENCY INDICATOR WITH "BEAM-OF-LIGHT" SENSOR

FEATURES

- Measures shaft or disc rotation of all possible rotating machines
- Accurately senses intricate vibrations of test objects to meet new complex-wave environmental test requirements
- Senses frequency of vibration and relative amplitudes from 0 to 100 kc
- Multiple lines or tapes permit accurate low speed rpm tests
- Seven meter ranges from 10 cps to 100 kc
- Simple set-up, absence of physical coupling, speeds testing, increases accuracy
- Completely portable for field, production line or test lab
- Both sensor and frequency meter use flashlight cell power
- Optical sensor available separately for basic laboratory use

APPLICATIONS

The [redacted] Transistorized Optical Frequency Indicator is one of the most versatile measuring instruments yet devised for use in laboratories, research and development, industry and maintenance operations. Because of the complete absence of mechanical linkage between the tachometer probe and the device being measured for rotational speed, or amplitude and speed of motion, torque or damping are never introduced into the readout. A few of the many applications of the instrument are illustrated at right.



Precise measurement of rotational speeds of motor-generators.

Production line checkout and inspection test on tape recorders, phono turntables, etc.

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DESCRIPTION

The [redacted] Transistorized Optical Frequency Indicator is a portable, self-contained system for measuring rotational shaft speeds in rpm, or vibrational frequencies in cps. The system utilizes the Model 219A Transistorized Optical Probe, a "beam-of-light" detection sensor, to sense the contrast between a light line and dark area (or vice versa) on the object in motion. The observed contrast, in the form of pulse responses, is read out on the Model 220FM Frequency Meter on a seven range scale from 10 cps to 100 kc. No torque or damping is introduced since there is no mechanical linkage between the probe and the object under test, and an accuracy of ±2% of full scale is easily achieved.

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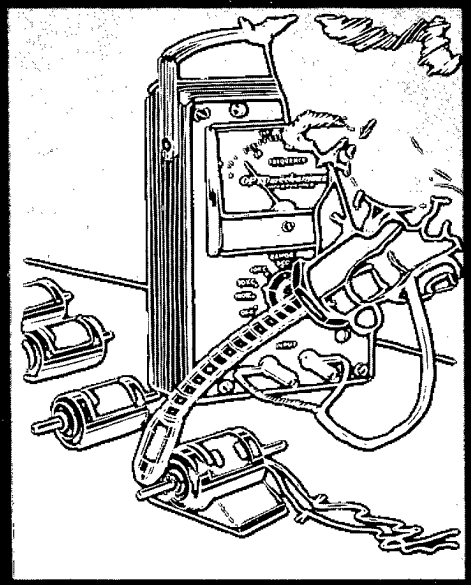
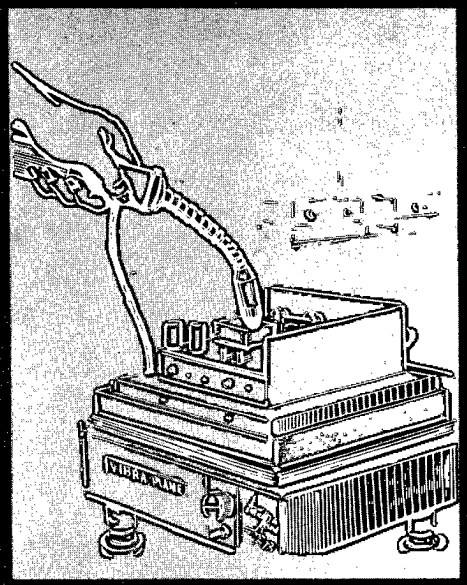
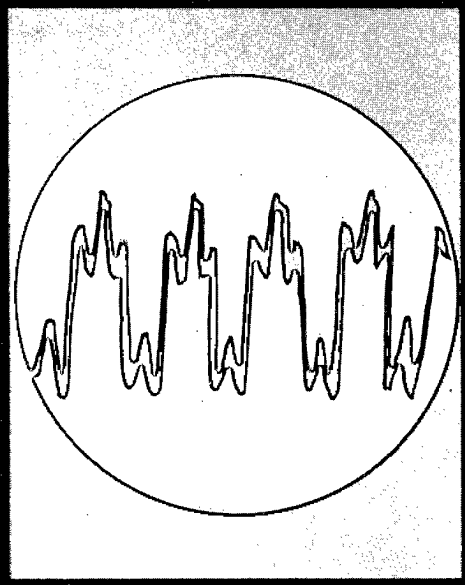


Analysis of servo motor speed and control.



Complex waveform vibration and amplitude analysis.



Typical waveform on oscilloscope, when used with the 219A Probe, showing components of mechanical vibration.

TRANSISTORIZED

OPTICAL FREQUENCY INDICATOR WITH "BEAM-OF-LIGHT" SENSOR

OPERATION

With the probe connected to the meter, the optical head is positioned steadily and aimed directly at the object under test at a distance of about 3/8". The constant light source in the optical head, powered by flashlight batteries, is reflected back to the phototransistor in the head, in accordance with the contrast of white and dark lines painted or taped on the moving shaft or object. Minimum detectable line is about 0.01" wide, 1/8" long, but careful set-up and alignment will permit the use of a smaller detecting surface. High ambient light environment will not affect accuracy or sensor sensitivity. Regardless of waveshape derived in pulse response, accuracy of meter reading is ±1% duty cycle. Rotational speed or frequency is read directly on the meter. Probe output can also be fed directly into an oscilloscope for relative vibration amplitude measurements.

SPECIFICATIONS

Optical Frequency Indicator System

Rotational Speed Range	All Possible Rotating Machines (Note Frequency Response)
Frequency Range	10 cps to 100 kc
7 Scale Ranges	0-100 cps; 100-300 cps; 300 cps to 1 kc; 1 kc to 3 kc; 3 kc to 10 kc; 10 kc to 30 kc; 30 kc to 100 kc.
Accuracy	±2% of full scale

Transistorized Optical Probe Model 219A

Input	Dark line, light background, reflected light (or vice versa)
Length	14¾" with gooseneck
Width	1⅜" diameter
Weight	1 lb. with batteries

Transistorized Frequency Meter Model 220FM

Size	8⅜" x 5¾" x 3⅛"
Weight	5 lbs.

STAT

MODULAR

PHOTOINTERPRETATION CENTER

SERIES 65500

MODULAR PHOTOINTERPRETATION CENTER (PIC)

1970-71 CATALOG

"DESIGNED TO ASSURE RAPID AND EFFECTIVE FLOW OF P I DATA BETWEEN EVENTS AND USERS."

STAT

AUTOMATIC SOLUTIONS TO

- Offset Aiming Point Coordinates
- Target Acquisition
- Photogrammetric Tasks
- Chart Annotations

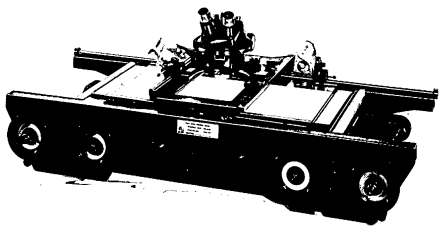
—and Photo Interpretation/Analysis tasks over the widest possible Range of Imagery, with accuracy to 8 parts per 100,000 per foot of film . . . sub-micron resolution.

Quick Delivery—Fully Tested

TYPICAL PACKAGE CONFIGURATIONS

Model 65500

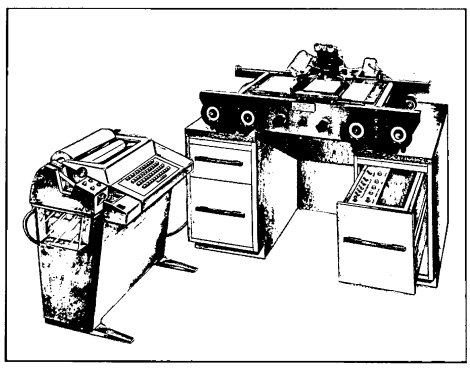
A Basic Film Table with Traveling X-Y Carriage, B & L Zoom 70 or similar Microscopes—Mechanical Dial Read-out—a ready-to-use, manual drive, economical work station.



Model 65610

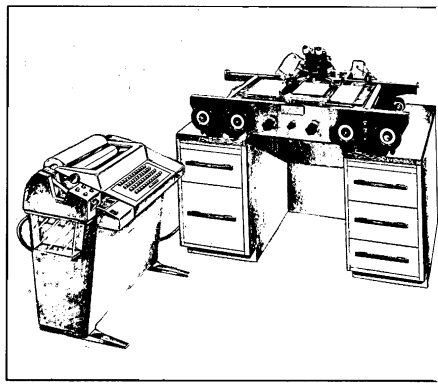
Our best and most complete P I station. Factory installed modules include electronically coupled microscope carriage, automatic logic console with I/O keyboard, and control tapes for automatically solving linear and geo/relative problems.

—A turn-key system—



Model 65600

Our Intermediate System—contains only those modules required for interface to all existing computers. May be ganged for multi-user or time-share installation. Computer Interface service provided upon request.



NOTE: In addition to programs supplied with the 65610, Programming Services are available for any special Metrics problems involving Photogrammetry, Photo Interpretation, Cartographic Control & Annotation, Infra Red, SLR, Radar, etc., plus translations into German, French, and certain other languages.

MODULES LIST

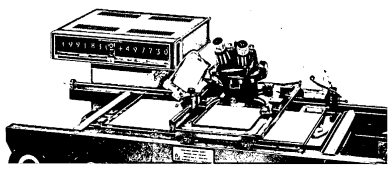
FOR EXPANDING THE UTILITY OF THE BASIC 65500 SYSTEM—

Model 65070

Motorized Film Drive Packages. Specify front spools only, or both front and rear spools.

Model 65550

Dual Axis Electronic Encoders with Digital Display. Converts 65500 into 65600 when equipped with keyboards. Costs to interface with existing computer quoted upon request.



Model 65570

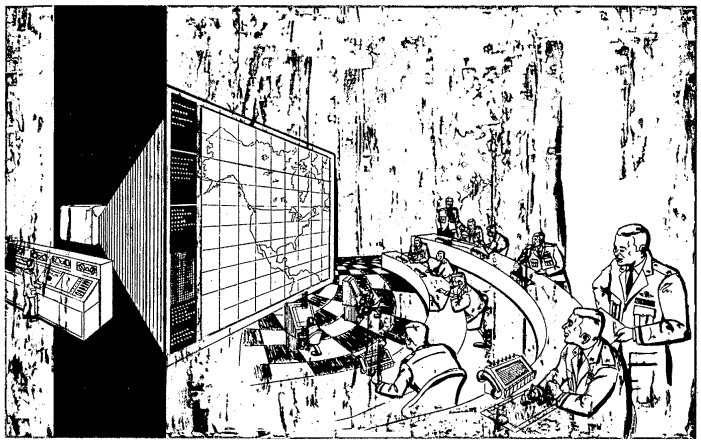
Artwork Logic Control Module, Encoders & Keyboard to retrofit 65550 into 65610 system. (Equivalent to 8K-16 Bit Word Computer.)

Model 65580

Teletype Keyboard.

NOTE: All Modules may be installed by the user. Interfacing to existing Computers requires to perform installation and check-out.

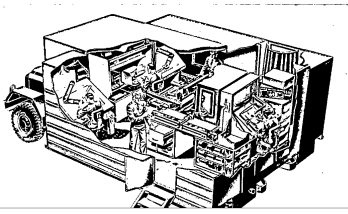
SPECIFICATION:



LABORATORY...

OR FIELD

The 65500 Series of Photointerpretation equipment is available in either standard commercial grade for fixed base use, or in Mil. Spec.grade for field use.



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