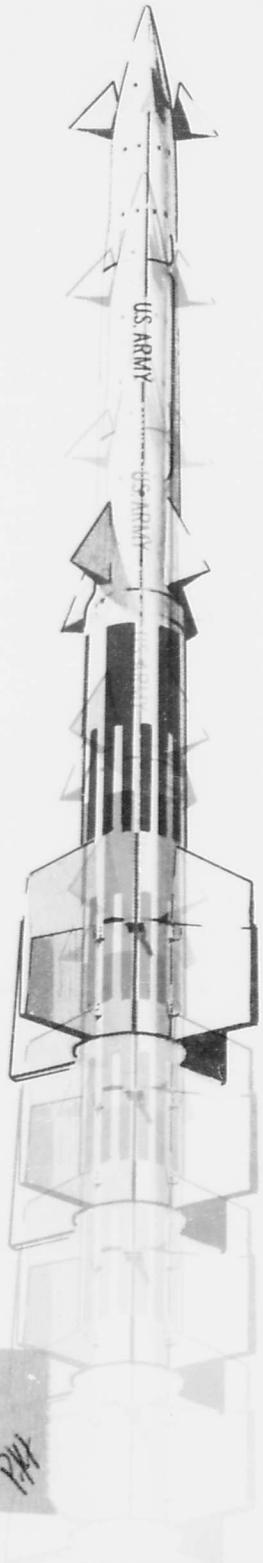
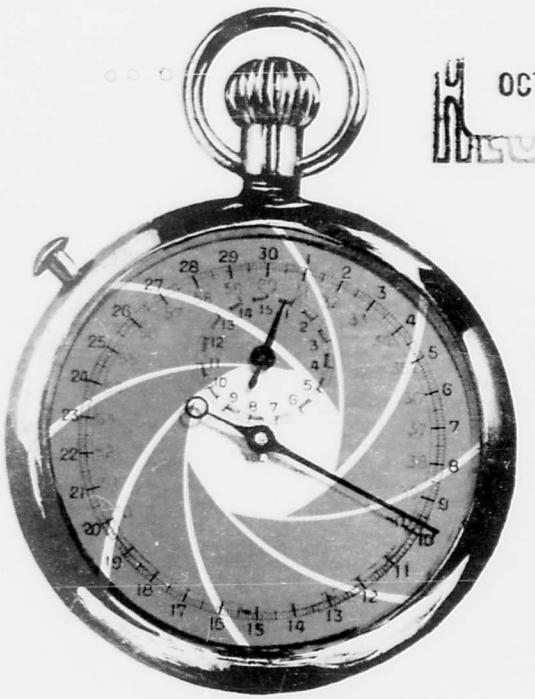


BALLISTIC CAMERA SYNCHRONIZATION & CONTROL SYSTEM

CONTRACT NUMBER DA-30-069-ORD-3291

Progress Report No. 6



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LINK DIVISION
GENERAL PRECISION, INC.

BALLISTIC CAMERA SYNCHRONIZATION

& CONTROL SYSTEM

Contract Number DA-30-069-ORD-3291

Progress Report No. 6

Link Division
General Precision, Inc.

October 15, 1961

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LIST OF ILLUSTRATIONS

FOREWORD

This progress report is submitted in accordance with Article I, paragraph c(1) of Contract No. DA-30-069-ORD-3291. This sixth report documents the period from 1 September 1961 to 30 September 1961.

SUMMARY

The Camera Shutter Detector, Time Base Generator, Precision Delay Circuit, Pulse Generator, and One Millisecond Delay Circuits have been checked out. The redesigned G-4 Averaging Circuit is covered in the report.

1. Introduction

This is the sixth in a series of monthly reports covering the progress of the Ballistic Camera Synchronization and Control System. These reports will provide a technical record of the development program. The work completed in the previous month will be covered, and an outline given of the work to be done for the next reporting period. Major problems that arise will also be reported.

2.0 Present Program Status

During the month of September, 1961, the designs of the Camera Shutter Detector, Time Base Generator, Precision Delay Circuit, Pulse Generator, and One Millisecond Delay were completed. The mechanical assembly of the one electrical rack is proceeding on schedule and three of the drawers are now in the rack. A preliminary design of the new G-4 Averaging Circuit has been completed; this design is described elsewhere in this report.

Link, Palo Alto, has responded to White Sands Missile Range Technical Exhibit B during September, 1961.

3.0 G-4 Averaging Circuit

The G-4 Averaging Circuit has been redesigned to average G-4 pulses when there is missing pulses. Figure 1 is a block diagram of the proposed G-4 Averaging Circuit.

The major change is the inclusion of a Timer that counts the G-4 pulses. The Timer opens the accumulated error gate for 20 G-4 pulses. The G-4 pulse opens a gate that allows clock pulses to flow into the divide-by-20-circuit. The gate is closed by the P-2 pulse (derived from the 2×10^5 divider.) For the system to be in synchronization, the P-2 pulse must follow the G-4 pulse by one-half of a second. The output of the "divide-by-20-circuit" that is open during the accumulate error time. The Counter is in the count-up mode at this time. After 20 G-4 pulses, the Accumulated Error Gate is closed and an interpolate pulse samples the counts in the "divide-by-20-circuit". If the count exceeds ten, a pulse is sent into the Up-Down Counter. This results in the Up-Down Counter storing the time spacing between the G-4 pulse and the P-2 pulse.

When the P-2 pulse lags the G-4 pulse by more than one half of a second, the 10^5 Up-Down Counter will recycle. At the recycle time, a flip-flop is put in the set position. The position of this flip-flop controls the up-down modes of the 10^5 Up-Down Counter during the correct error mode. The Add or Subtract Pulse Gates are also controlled by the flip-flop. If the P-2 pulse lags the G-4 pulse by less than one half of a second, the Up-Down Counter is in the count up mode and the Subtract Pulse Gate is open. If the P-2 lags the G-4 pulse by more than one half of a second, the Up-Down Counter is in the count down mode and the Add Pulse Gate is open. When the Timer puts out the correct error signal, the Counter is run out to zero counts. At zero counts, the Add Pulse or Subtract Pulse Gates are closed. At this time the P-2 pulse lags the G-4 pulse by one half of a second and the system is in synchronization.

After synchronization is achieved, the whole system is reset and is now ready to begin averaging G-4 again. The total time required for the operation is 24 G-4 pulses.

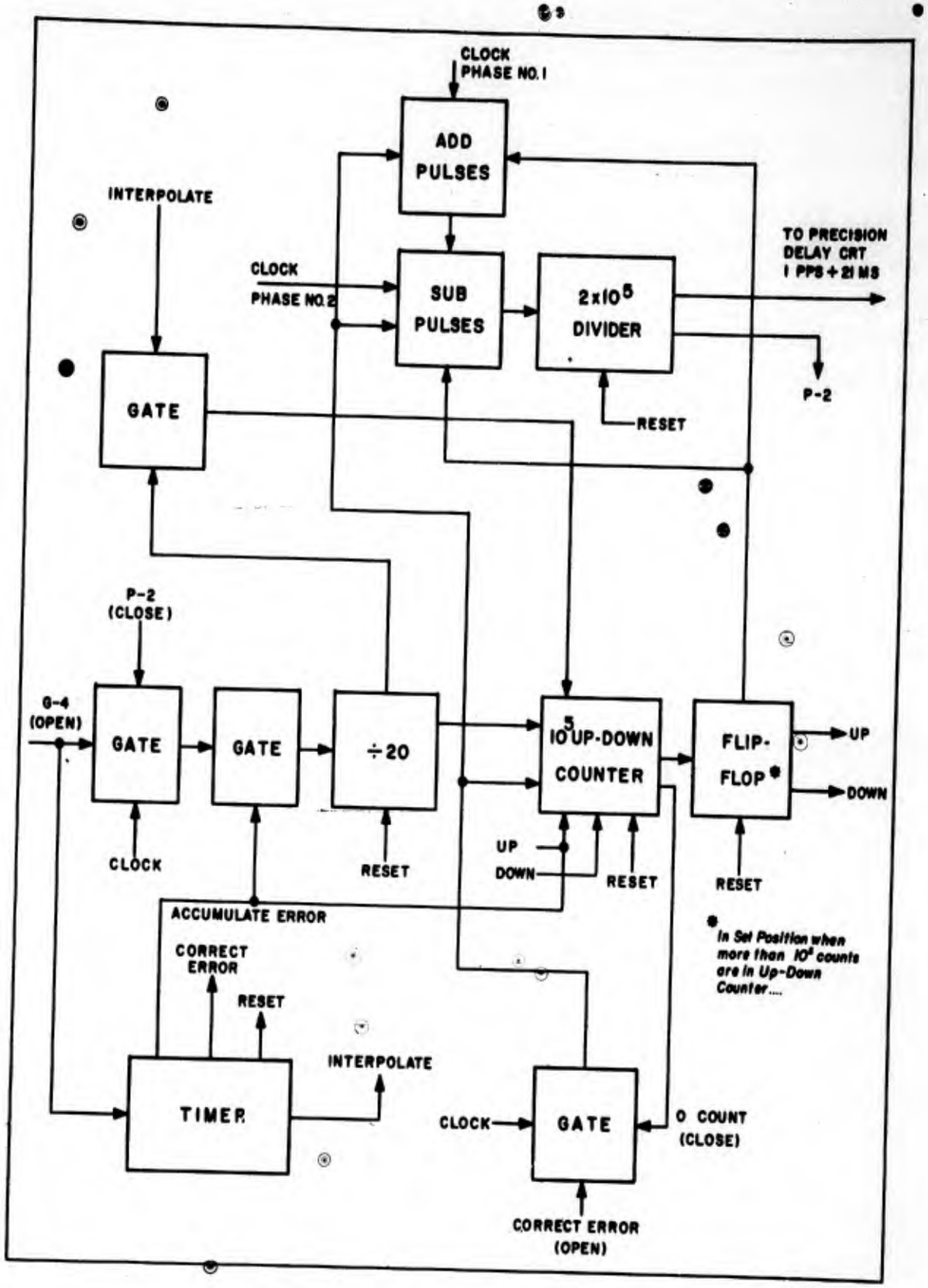


Figure 1 G-4 Averaging Circuit

4.0 Camera Shutter Synchronization System

A tentative circuit design for the complete Camera Shutter Synchronization System has been completed. This system is shown in block diagram form in Figure 2. A description of the operation of this system follows.

4.1 500 cps. Filter-Amplifier System

The two-phase precision 500 cps. square waves from the Time Base Generator (see Section 3.0, Progress Report No. 5) are passed through impedance-matching isolation amplifiers which provide a 600 ohm source impedance for driving the 500 cps lo-pass filters. The filters pass the 500 cps. fundamental sine wave, attenuating all harmonics.

The output of the filters is impedance matched by the 600 ohm input-impedance amplifiers, which provide voltage gain and low output impedance for driving the resolver. Feedback terminals are brought out from these amplifiers to permit the use of a resolver with feedback windings if this is found to be necessary.

The resolver output is passed through an isolation amplifier to provide 600 ohm output impedance for driving the 500 cps. band-pass filter, which attenuates low frequency noise and 500 cps. harmonics of the resolver output. The band-pass filter output is passed to the power amplifier. The 115V. power output from the power amplifier is fed, by cable, to the astrodome where it is connected to the 500 cps. synchronous camera shutter drive motor.

4.2 Resolver Servo Drive System

The resolver is mounted into a gear box assembly and its shaft is connected through a two-speed gear train to the 60 cps. servo motor shaft output. The servo motor reference winding is connected to 115V. 60 cps. power, and the control winding is driven by a servo amplifier which obtains its input from a 60 cycle chopper. Proper phasing of the control winding voltage will be obtained by adjusting the phase of the 60 cps. power to the chopper.

High or low speed gear drive is obtained by switching power on or off to the magnetic clutch, and fine or coarse servo motor control is obtained by switching the input to the chopper to the Fine or

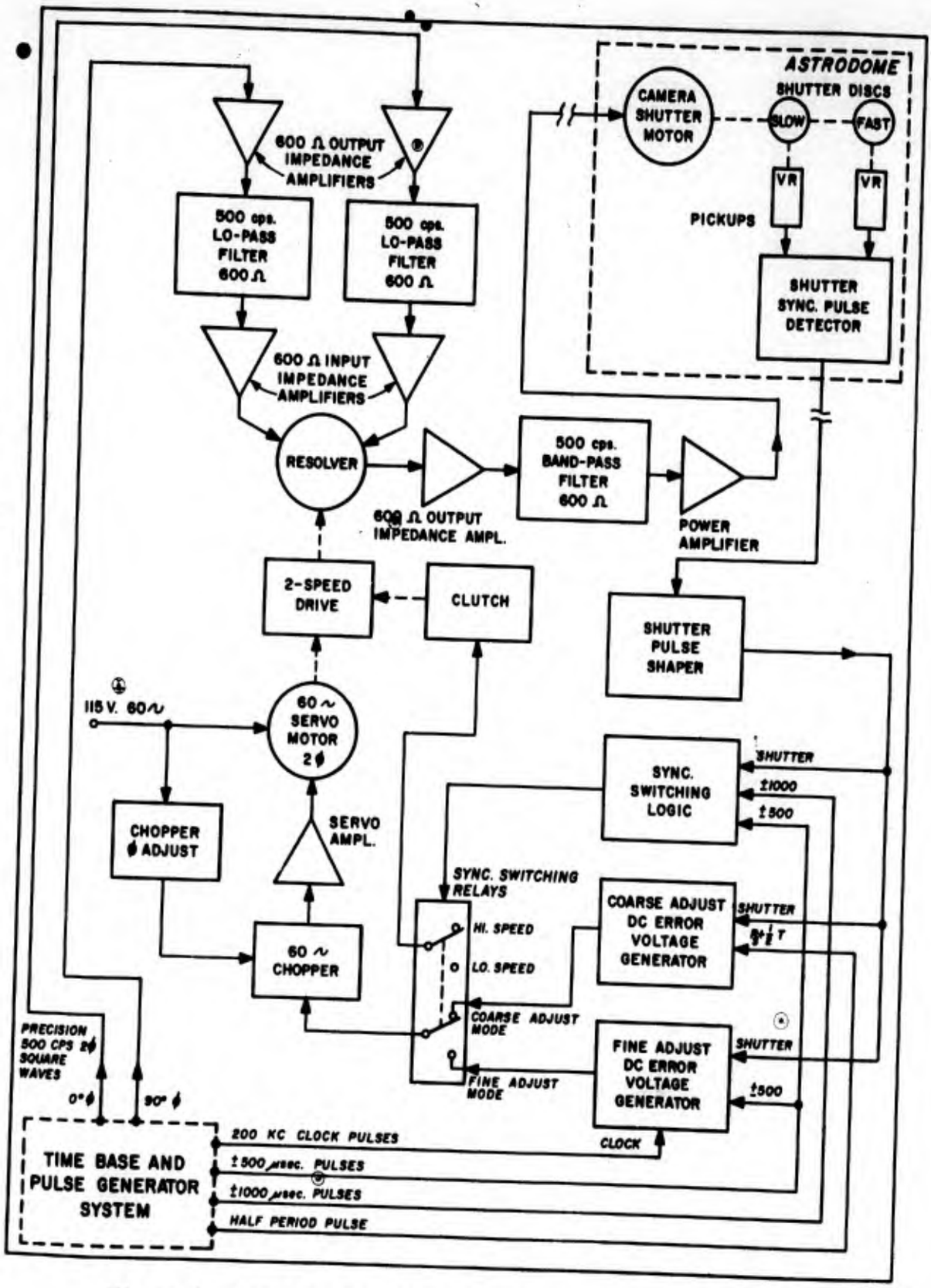


Figure 2 Ballistic Camera Shutter Synchronization System

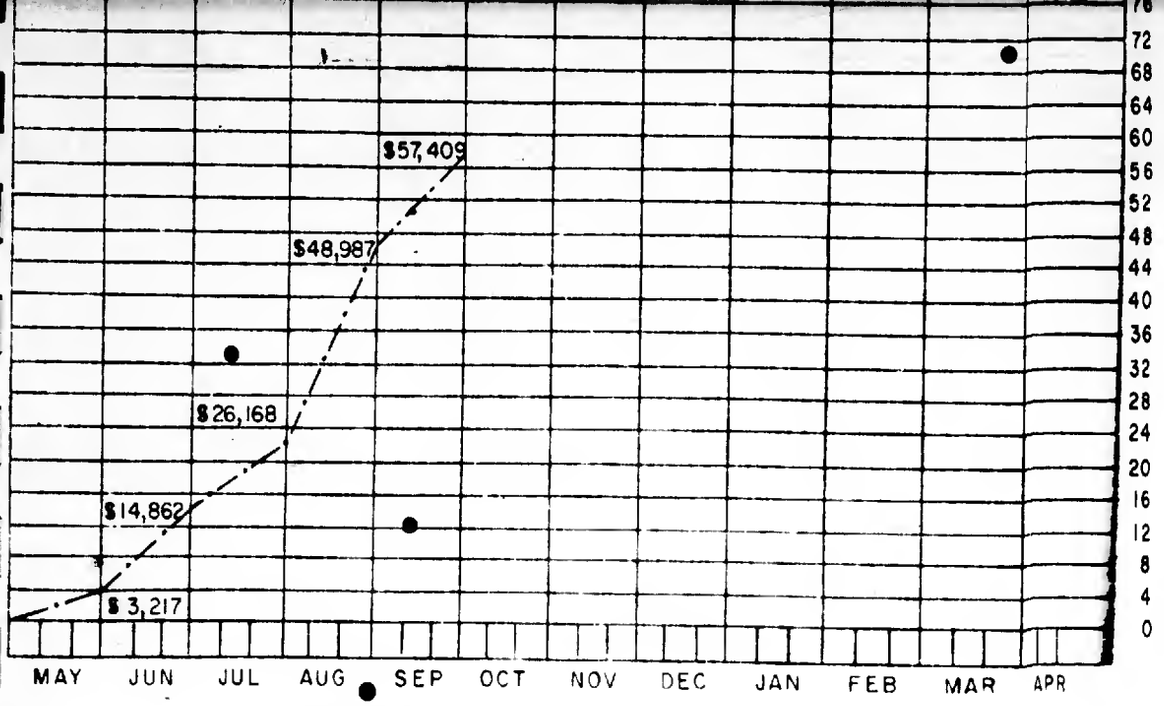
Coarse Adjust D. C. Error Voltage Generator outputs. Switching is accomplished by the Sync. Switching Relays, which are controlled by the Synchronization Switching Logic Circuits. This and tentative Coarse and Fine Adjust Error Voltage Generator Circuits were described in Figures 2 and 3 of Progress Report No. 3.

5.0 Program for Subsequent Reporting Period

Link, Palo Alto, will continue to "push" all work that is a part of the original contract. It is hoped that the approval of Technical Exhibit B will occur during this time; so that all long lead time can be ordered. The camera synchronization servo system will be checked out during the next reporting period.

6.0 Program Schedule

Figure 3 shows the planned program for the design and construction of the prototype of the Ballistic Camera Synchronization and Control System as of September 30, 1961.

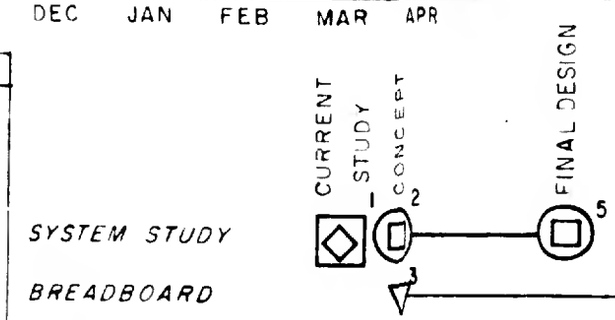


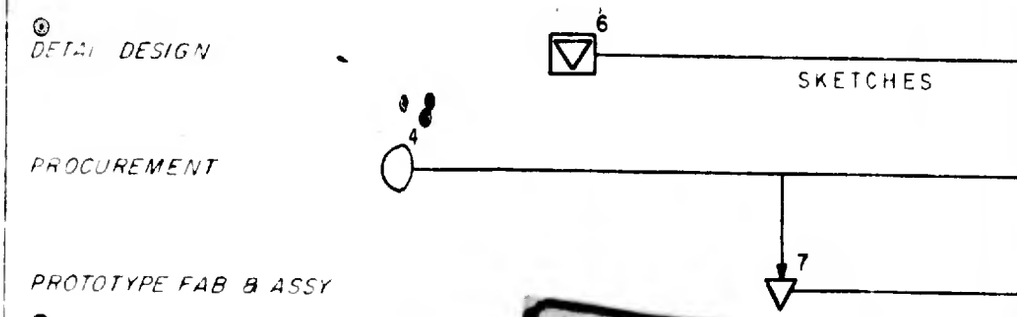
1. GENERATION OF SPECIFICATIONS
2. START SYSTEM DESIGN
3. START BREADBOARD
4. " PROCUREMENT of PARTS
5. COMPLETE DESIGN
6. START DRAFTING
7. " FAB PROTO TYPE UNIT No 1
8. " TEST & ADJUST
9. COMPLETE BREADBOARD
10. COMPLETE MFG. SKETCHES / DWGS.
11. COMPLETE PROCUREMENT
12. COMPLETE FINAL ASS'Y (Prototype)
13. " TEST & ADJUST SUB-ASS'Y'S
14. " FINAL DWGS
15. " REWORK, TESTING, & ADJUST SYST
16. SHIP 1st PROTOTYPE
17. CUSTOMER ACTION
18. 1st FOLLOW-ON UNIT DUE 60 Days AFTER ACCEPTANCE BY CUSTOMER

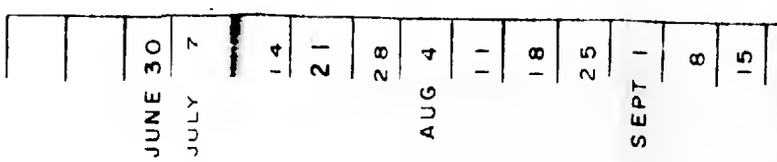
BALLISTIC CAMERA

(PROTOTYPE ONE UNIT)

CRN 71350



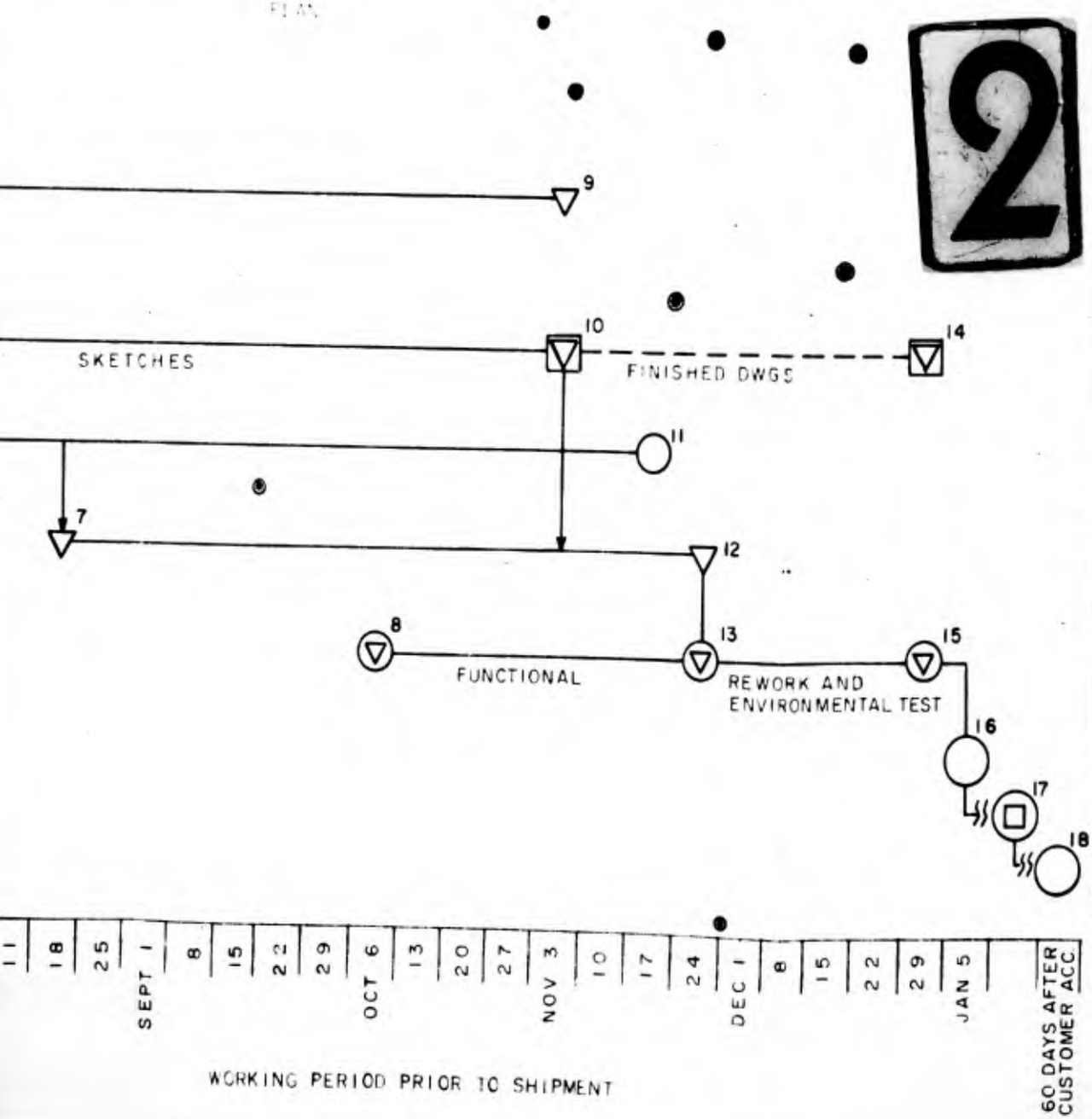




WORK

RL Peters 5/24/61

PLAN



WORKING PERIOD PRIOR TO SHIPMENT

LEGEND

- DELIVERY TO CUSTOMER
- CUSTOMER SUPPORT
- CUSTOMER ACTION
- VENDOR OR SUB-CONTRACT ACTION
- CONTRACTUAL ACTION
- PROCUREMENT ACTION
- FABRICATION OR ASSEMBLY
- PURCHASE PARTS
- COMPANY MADE PARTS
- REPORT TO CUSTOMER
- TEST OR INSPECT
- STUDY OR ANALYSIS
- SYSTEMS DESIGN OR DEVELOPMENT
- DETAIL DESIGN
- INTERNAL TRANSFER
- RAW MATERIAL

AD ____________ Accession No. ____________ UNCLASSIFIED

Link Division, General Precision, Inc., Palo Alto, Calif.
BALLISTIC CAMERA SYNCHRONIZATION AND CONTROL SYSTEM Progress Report No. 6 (September 1, 1961 to September 30, 1961) (Unclassified)

Ballistic Camera
Synchronization Optical Tracking System Design

6 pages and 2 illustrations
Contract No. DA-30-069-ORD-3291
OMS 5210.11.13506.05.55
DCN 110.095.006.006.1
Ser. No. 06-61173
No Distribution Limitations
Report is Unclassified

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