QUARTERLY STATUS REPORT No. 2

Period 23 December 1964 - 22 March 1965

DESIGN, DEVELOPMENT, FABRICATION AND INSTALLATION OF 105-INCH LUNAR AND PLANETARY TELESCOPE AT McDONALD OBSERVATORY

Contract NASr-242

FACILITY FORM 602

N 65-85282 (ACCESSION NUMBER)

13 (PAGES)

CR 63069 (NASA CR OR TMX OR AD NUMBER)

(THRU)

None (CODE)

(CATEGORY)

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A. Brief review of progress prior to this reporting period

Prior progress has included selection of the design engineering firm (C. W. Jones Engineering), choice of basic design parameters (cross-axis design similar to the McDonald 82-inch), consideration of the question of increasing the size of the telescope from 84- to 105-inches; selection of fused silica as the mirror material and entering of negotiations with Corning for production; and the beginning of staffing of the telescope project.

B. Writing of initial subcontracts

Jones' willingness to undertake work on the design prior to formal signing of a subcontract had the unfortunate effect of making it more difficult to exert successful pressures to obtain the finally signed contract from the responsible offices. By State regulations, all University building projects must be handled through the Comptroller's Office. With many other duties during the present phase of active building at the University, this office is quite pressed with a wide range of responsibilities, and is understaffed. A draft contract did not come from our Comptroller's Office until the middle of the current reporting period, with an additional month then required to obtain agreement of the NASA Contract and legal offices. Accordingly, during this reporting period, design work proceeded more slowly than might have been the case had the contract and funding for the engineering work been available.

Signing of the subcontract with Corning also encountered delays. In this case, they were primarily a result of difficulties experienced by our Comptroller's and legal offices in obtaining the necessary information on details of government provisions required as an appendix to the subcontract. It proved necessary for these to go through several stages of approximation, after which the contract was then not entirely suitable to Corning. But by early March, differences were sufficiently ironed out to make it possible for Corning to agree to undertake full-scale work on our mirror without further delays.

C. Progress in Design

After procurement of the mirror blank (successfully undertaken as outlined above), design of the telescope to a degree sufficient for bid drawings is the next longest lead-time item in construction of a large

telescope. Accordingly, almost all the progress during this report period concentrated on problems of design.

1. Basic Mechanical Configuration

Much more work was done on the initial details and first calculation of stresses for the two-pier English mounting provisionally decided on during the previous reporting period. The polar axis bearings offer no serious difficulty; an initial design for the declination bearing was laid out for further study. This declination bearing is the most critical element in the design, since the size and large eccentric loading lead to very high torques which may make it difficult to drive the telescope about the declination axis as smoothly as desired. Several possible solutions to this problem are being considered.

2. Basic Optical Design

Contrary to the trend of most modern telescope designs, we decided to restrict our primary F/ratio to a value not lower than 4. This shallow curve of the primary mirror leads to the requirement of a relatively long tube and correspondingly relatively larger dome. But compensating advantages are enormous. These consist initially of the ability to obtain a finished mirror in a substantially shorter time (since the problems of the optician increase exponentially as the F/ratio drops below 4, forcing him to create ever deeper and steeper curves with ever smaller tools). Also, with present techniques of figuring, it is almost impossible for even the best optician to avoid small local "accidents" near the edges of zones where the tools are working; these constitute regions of relatively steep slope in the optical surface and have the effect of scattering significant light around even a properly-produced overall image from a good average figure of the mirror. The less steeply curved the mirror, the less serious is this trouble. In addition, requirements on stability of position of the optical elements are somewhat relaxed with the longer F/ratios. Finally, correcting lenses for the prime and Cassegrain focal positions, designed to produce good images over a wide field, can attain significantly wider fields the longer the primary F/ratio. In operation with modern emulsions, the F/4 ratio at the prime focus is amply fast to permit sky-limiting exposures in reasonable times (substantially less than an hour), yet coupled with good scale and fainter limiting magnitude than can be achieved by the shorter F/ratio systems which reach the sky sooner.

Selection of an F/4 primary in turn places a limit on the practical shortness of the Cassegrain F/ratio. Anything less than F/9 requires so large a secondary as to obstruct too much of the entering light beam. Anything much larger than F/11 generates so slow a system for wide-field work as to be quite undesirable with present emulsions. The final selection will probably be F/9.5 or F/10 for the principal Cassegrain mirror. It is possible that for special

projects, including high resolution planetary work, a special F/16 Cassegrain mirror may prove desirable.

The design includes a coude focus around F/30. For planetary work this will be the most important focus, since here would be located the very large coude spectrograph which when complete should make this instrument more effective for planetary spectroscopy than any other ground-based instrument. An unusually large coude field of some 10' of arc is being provided toward the day when it may be possible to use image tubes of relatively large size to profit directly from the large scale at the coude focus for work on planetary surface features, in densely populated regions of stars, etc. Details of the coude are discussed later.

3. Layout of Focal Positions

The telescope will be designed so that all of the conventional and several unconventional focal positions will be at least potentially available. These comprise:

a. Prime focus cage

b. A set of six Newtonian positions, spaced around the telescope tube near its center, the Newtonian mirror being angled back down toward the primary. Selection among these positions will be made by rotating the Newtonian secondary mirror to fixed auxiliary instruments for various exit ports. (This Newtonian arrangement will probably appear in the bids as an optional extra to be realized if budget and needs are appropriate.)

c. Ordinary Cassegrain position

d. Three broken Cassegrain (Nasmyth) focal positions, respectively at the extension of the declination axis and ±90° to it; these positions are to be reached by installing the coude tertiary flat and rotating it respectively 90° to each desired exit port.

e. Direct coude position lying along the 30° inclined polar axis angle of the McDonald Observatory.

f. A succession of broken coude positions reached by a small flat mirror just above the direct coude focus, redeflecting the beam approximately horizontally into a large coude room area where a variety of observational equipment and apparatus can be set up.

The above flexibility and versatility, even though not all of it need be initially installed with the telescope on its first completion, is a very important element of design which should make the instrument considerably more versatile, flexible, efficient, and slow to obsolesce.

D. Design of Coude Spectrograph

Preliminary studies were begun on the configuration and general nature of the coude spectrograph desirable for and appropriate to this 105-inch telescope. The three most desirable criteria are speed of the spectrograph, obtainable dispersion and resolution, and versatility of operation. In a large coude spectrograph, speed is obtained for stellar work in proportion to the size of the collimated beam; for planetary objects, in proportion with the square of the diameter of the collimated beam (for a given dispersion at the plate). In turn, the larger collimated beams require longer optical paths and hence an extremely large spectrograph, also gratings of sizes comensurate with the collimated beam. Preliminary layout of the dome indicates that a collimated beam of at least two feet diameter should be possible; preliminary inquiries to Bausch & Lomb suggest that it should be possible within two or three years to produce a successful mosaic grating of about 24 x 36 inches. Accordingly, the initial design of the coude spectrograph has proceeded under the assumption that it will be possible to install such a system, if not initially then at least very shortly after the completion of the telescope. However, in view of the ready availability of smaller gratings, and the possible financial limitations restricting the initial coude spectrograph to more conventional dimensions, the design has also undertaken to make it possible to begin operation with a smaller unit which can then grow to the larger size without significant wastage of already installed equipment. With good gratings, optics, and adjustment, a very high resolving power follows automatically for so large a spectrograph.

Another relatively novel feature of the new instrument will be the location of the coude spectrograph as a horizontal unit occupying almost the entire floor directly below the observing floor of the telescope. This design has at least three major advantages:

1. First, it partially returns the cost of the construction of the coude room in extra elevation for the telescope, thereby placing it a bit farther above ground-level seeing effects.

2. The horizontal layout is much more convenient for the design, construction and operation of the coude equipment itself.

3. The ability to hang the enormous spectrograph frame directly from the piers of the telescope, close to the telescope itself, and entirely independently of the dome, insures that the coude spectrograph and telescope form one integral structure which should be relatively immune to some of the differential motions and twists which have occurred with existing large spectrographs.

E. Conversion from one focus to another

A principal difficulty in the use of most existing telescopes is the extreme labor required to shift from one observing position to another. This has the serious drawback that when the telescope is set up for any

function (e.g., prime focus photography), it is not possible later that night to go over to any other focal position for any cause (e.g., moonrise or seeing deterioration); hence a substantial amount of observing time is wasted. The new telescope will be designed to make it possible for a number of conversions to be achieved quite rapidly. It will retain the successful flip-flop between two principal secondaries, the Cassegrain and the coude. Change to other modes, specifically prime focus cage, Newtonian cage, and possibly the special Cassegrain secondary cage will be made by means of the dome crane and, if possible, will be an operation which can be conducted by the two night assistants and an astronomer in a relatively quick and efficient manner. The coude tertiary mirror, required to deflect the beam down the declination axis, will be motor-driven into position for coude work and into a stow position where it offers almost no interference with the ordinary prime or Cassegrain focus beam. Thus it should be possible to switch from Cassegrain to coude operation in about 10 minutes, and to change cages entirely to go from one function to a radically different one in a period of about 45 minutes.

F. Personnel Connected with the Contract

The same personnel remained as in the previous quarterly status report.

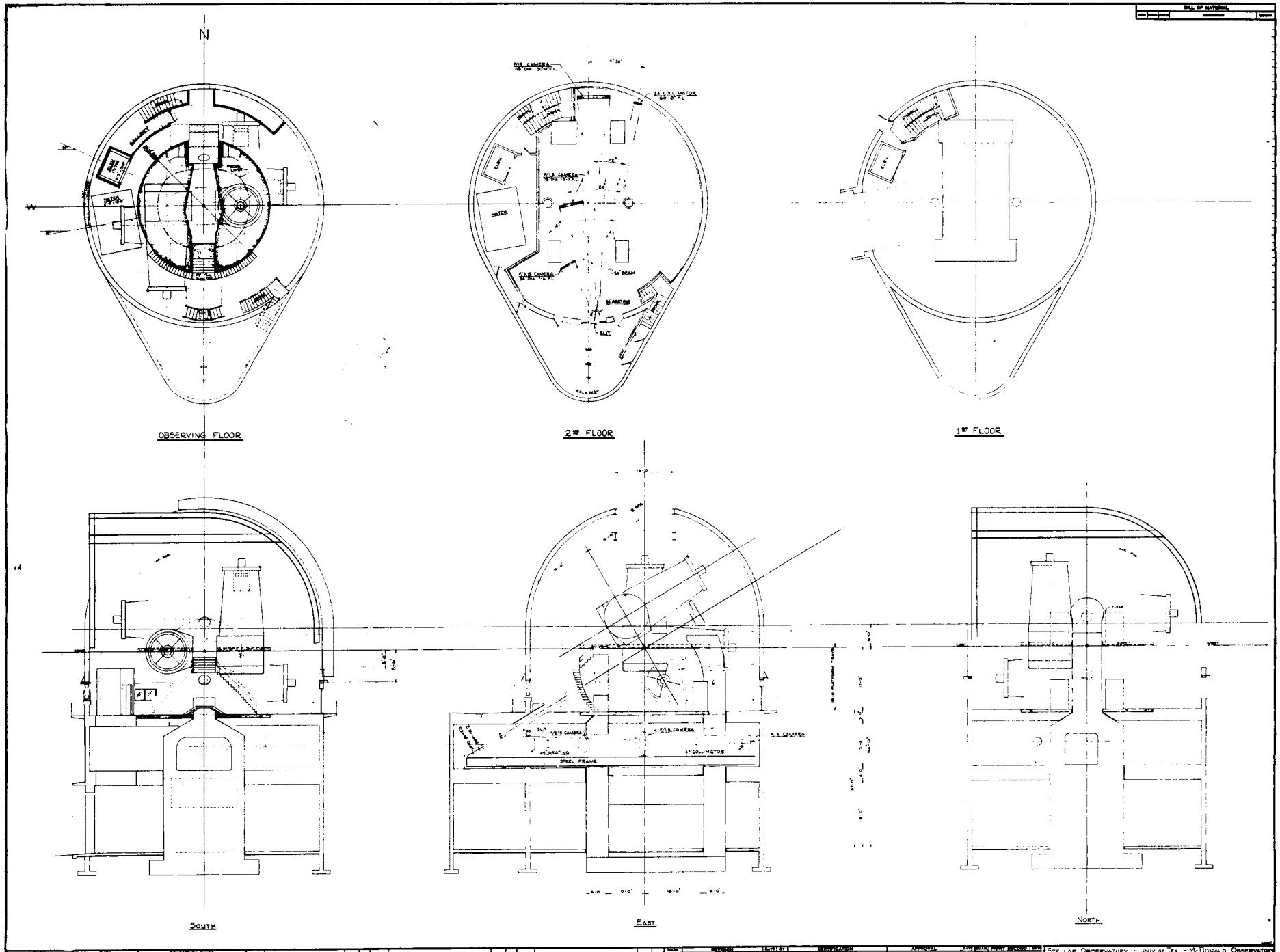
G. Financial Report

NASA Form 1030 (2-64) for this contract is submitted quarterly by the Auditor's Office of The University of Texas.

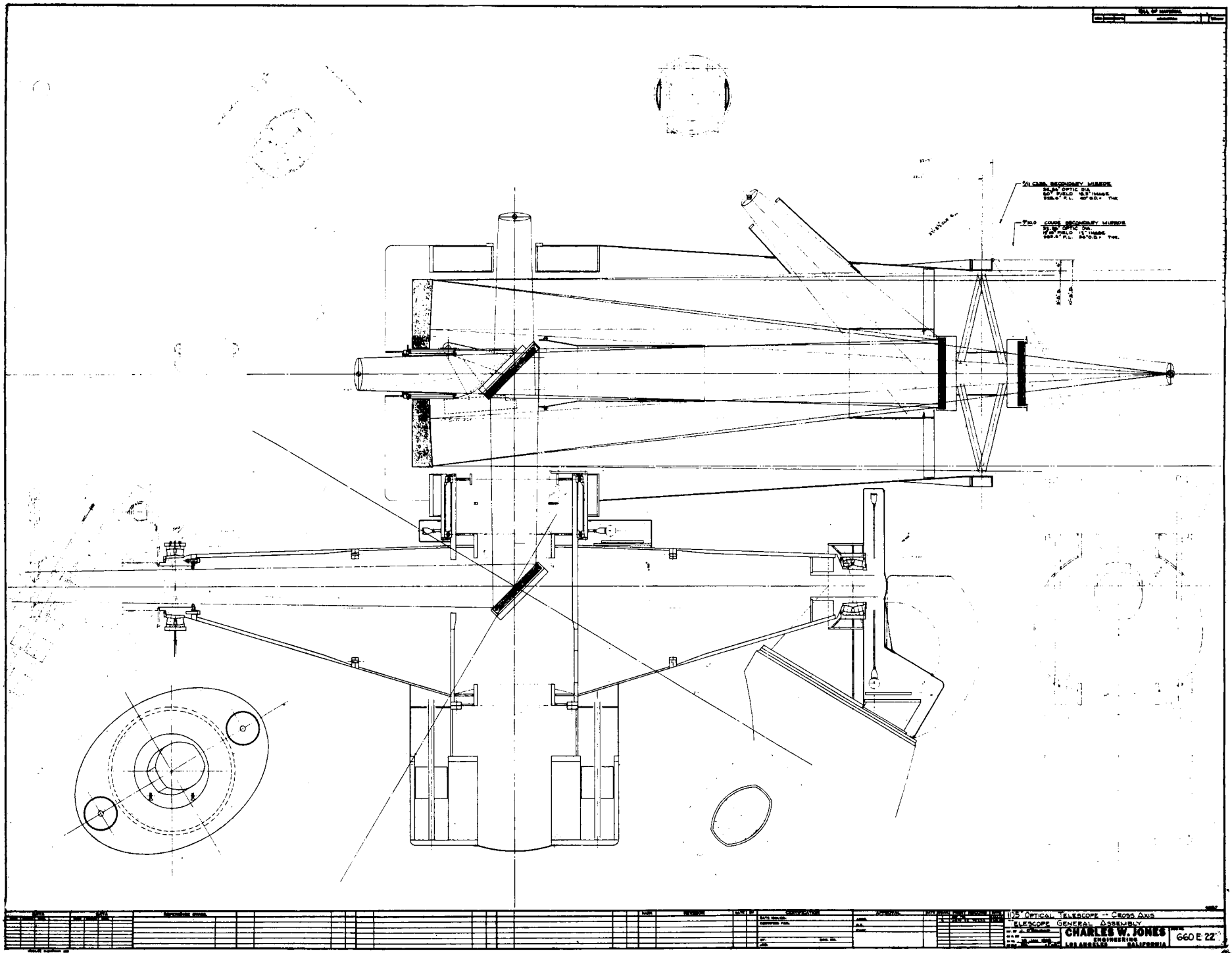
H. Illustrative Appendices

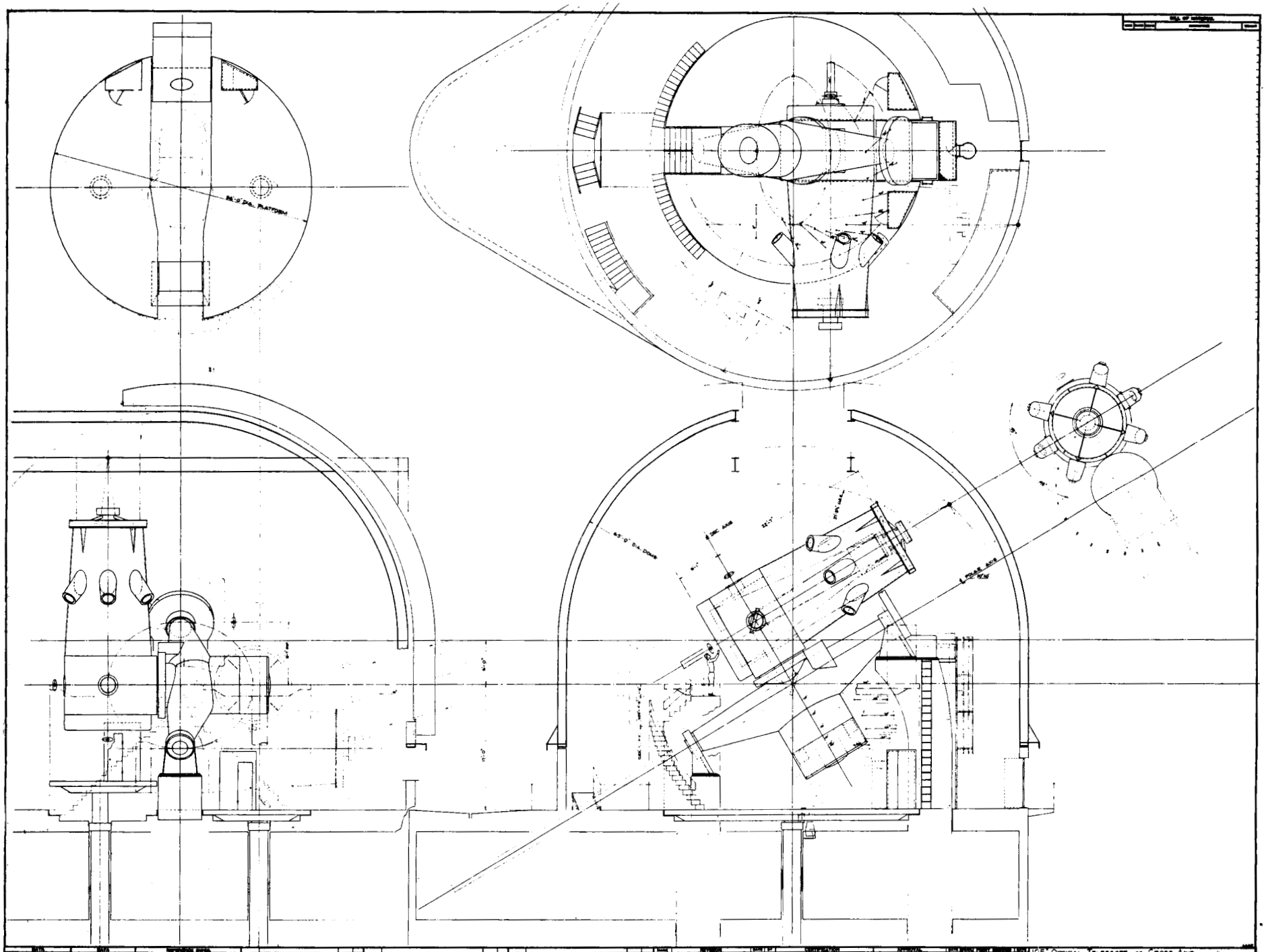
Several additional samples of the design drawings and sketches indicating progress of the work are appended:

1. Print 660E21 - Stellar Observatory - 65 ft. Dome
2. Print 660E23 - 105-inch Optical Telescope - Cross Axis General Assembly F/4 Primary, F/10 Cassegrain, F/30 Coude
3. Print 660E22 - 105-inch Optical Telescope - Cross Axis Telescope General Assembly
4. Print 660E24 - 105-inch Optical Telescope - Cross Axis Optical Diagrams
5. Print 660E25 - 105-inch Optical Telescope - Cross Axis General Assembly - F/4 Prime Focus Cage Alternative
6. Print 660E26 - 78-foot Dome
7. Print 660E28 - 65-foot Dome



STELLAR OBSERVATORY - UNIV. OF TEX. - McDONALD OBSERVATORY
65 FT. DOME
CHARLES W. JONES
ENGINEERING
LOS ANGELES CALIFORNIA
660E21


FIN CAMS SECONDARY MIRROR
30.4" OPTIC DIA
50" FIELD 15.5" IMAGE
388.5" F.L. 40" O.D. THK
FIN CONVEX SECONDARY MIRROR
32.50" OPTIC DIA
17.5" FIELD 15" IMAGE
388.5" F.L. 30" O.D. THK
125" OPTICAL TELESCOPE -- CROSS AXIS
TELESCOPE GENERAL ASSEMBLY
CHARLES W. JONES
ENGINEERING
LOS ANGELES CALIFORNIA
660 E 22


36'-0" DIA. PLATFORM
45'-0" DIA. DOME
DEC. AXIS
HR. ANGLE AXIS
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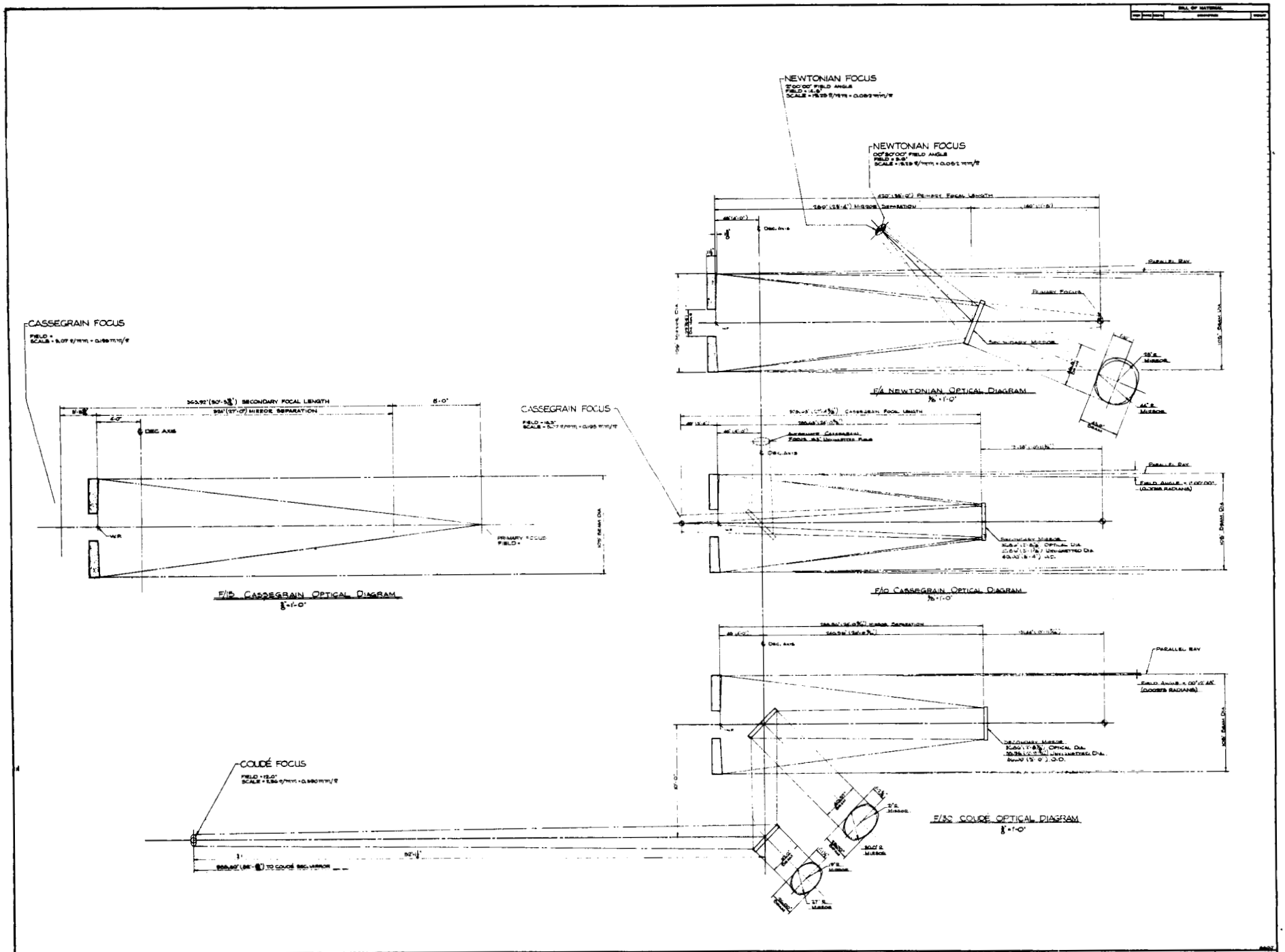
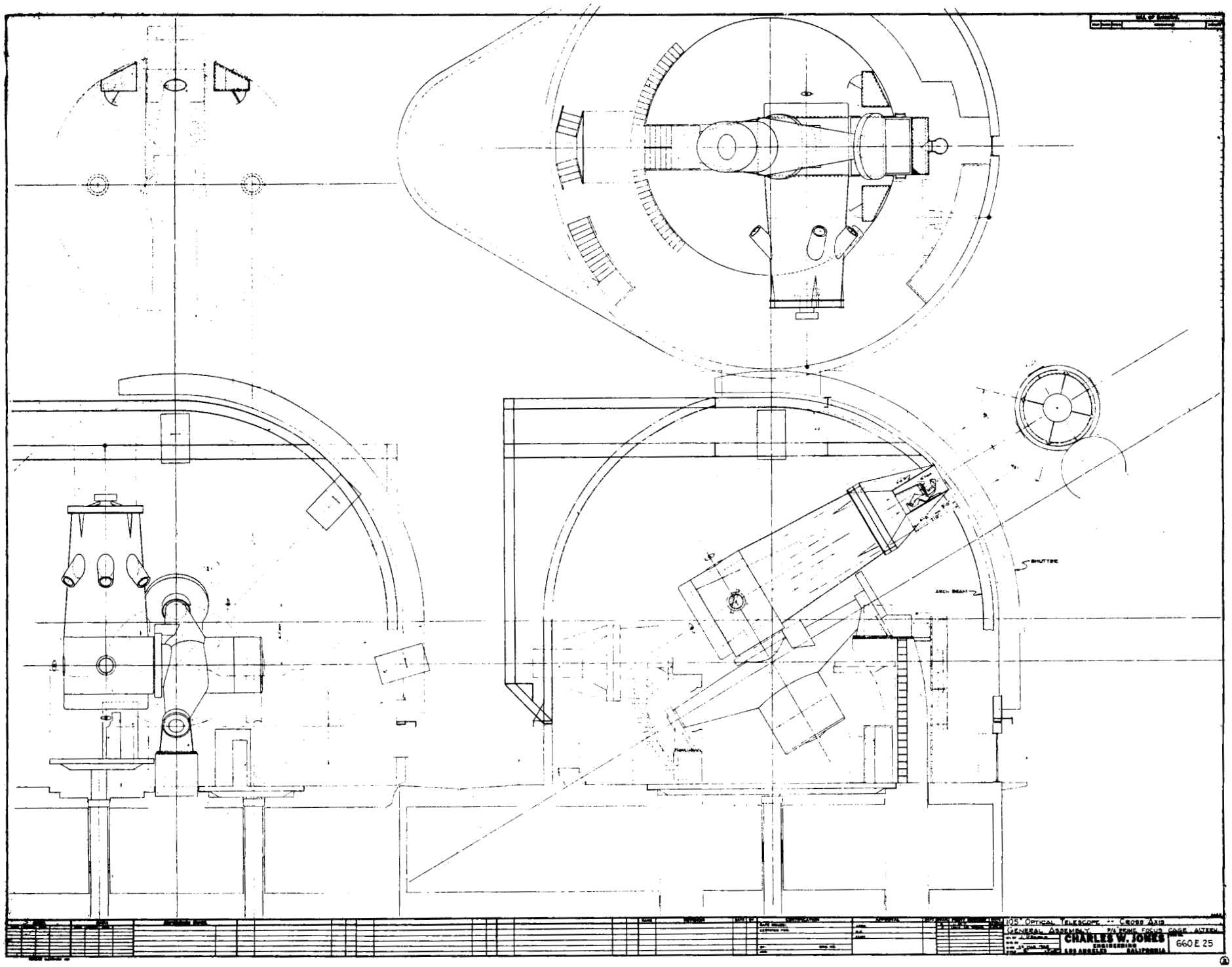
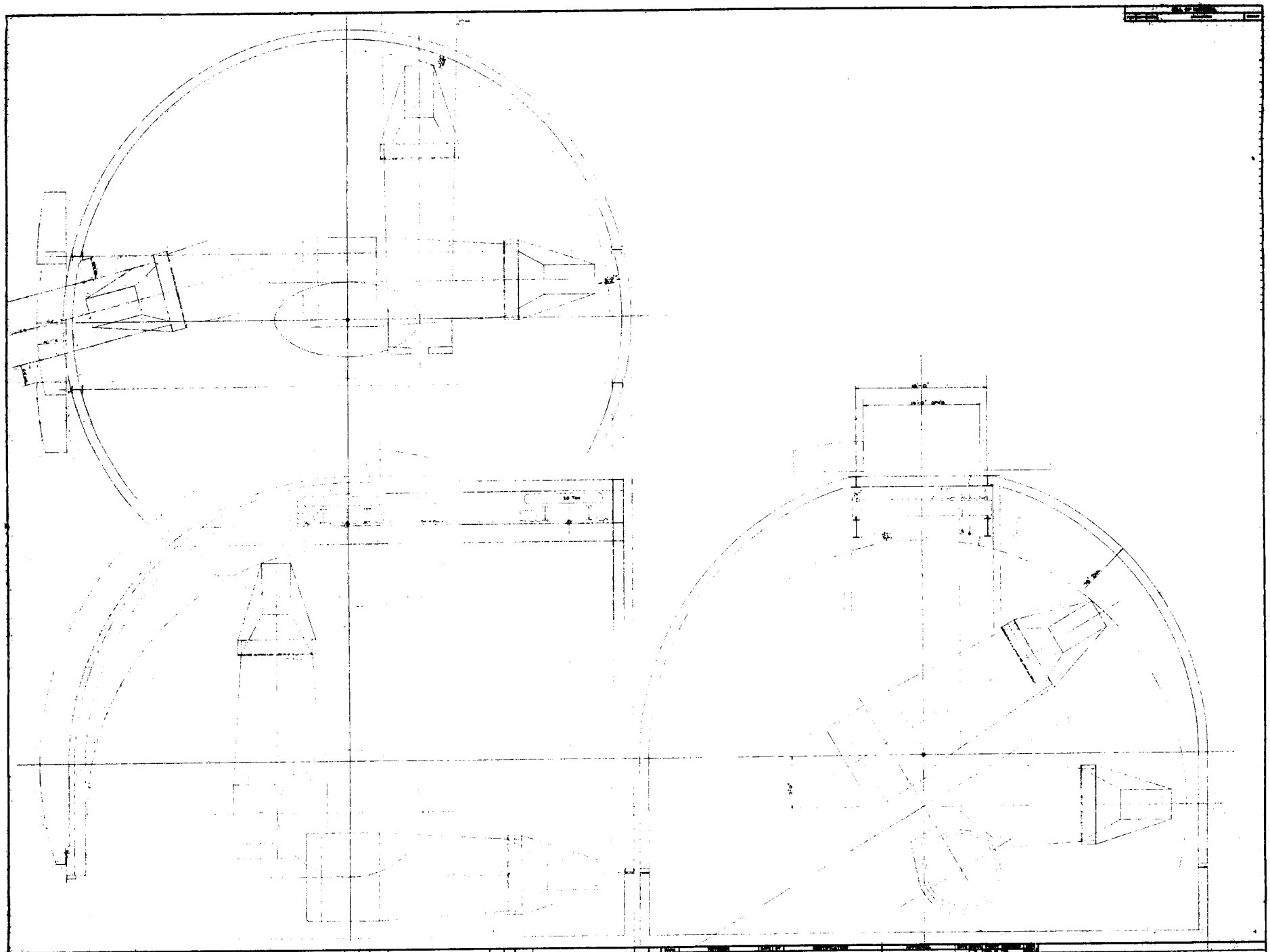
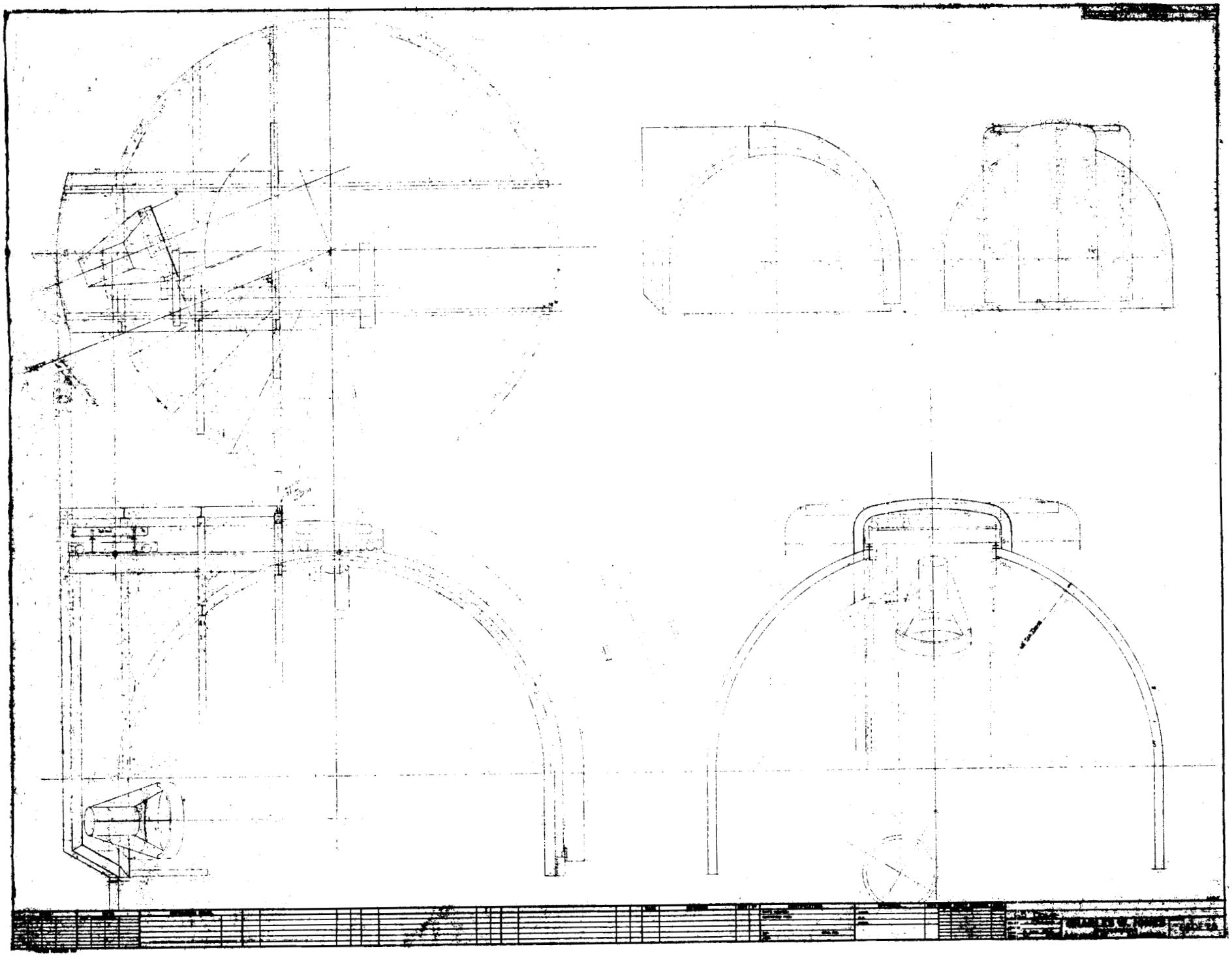

NEWTONIAN FOCUS
NEWTONIAN FOCUS
CASSEGRAIN FOCUS
CASSEGRAIN FOCUS
COUDÉ FOCUS
F/4 NEWTONIAN OPTICAL DIAGRAM
F/15 CASSEGRAIN OPTICAL DIAGRAM
F/10 CASSEGRAIN OPTICAL DIAGRAM
F/32 COUDE OPTICAL DIAGRAM
PARALLEL RAY
PRIMARY FOCUS
SECONDARY MIRROR
PRIMARY FOCUS
DEC. AXIS
W.R.
COUDÉ SEC. MIRROR
CHARLES W. JONES
ENGINEERING
LOS ANGELES CALIFORNIA
100" OPTICAL TELESCOPE -- CROSS AXIS
OPTICAL DIAGRAMS
660E24


SHUTTER
ARCH BEAM
105" OPTICAL TELESCOPE -- CROSS AXIS
GENERAL ASSEMBLY
CHARLES W. JONES
ENGINEERING
LOS ANGELES CALIFORNIA
660 E 25



78' DOME

CHARLES W. JONES
CONSULTING ENGINEER
LOS ANGELES, CALIFORNIA

660 E. 26