

(April 14, 1932)
1103.1

CALIFORNIA INSTITUTE OF TECHNOLOGY

Observatory

Pursuant to resolutions adopted by the Members of the Board of Trustees of the International Education Board on May 25, 1928, and by the Executive Committee on October 18, 1928, the executive officers executed Pledge No. 7, dated January 21, 1929, which was accepted by the California Institute of Technology on February 5, 1929.

<u>Allocations by</u> <u>Executive Committee</u>	<u>Payments</u>	<u>Balance</u>
October 18, 1928 \$ 215,000		
June 13, 1929 400,000		
April 16, 1930 460,000		
March 27, 1931 580,000		
<u>\$1,655,000</u>	\$1,390,201.08 (includes \$100,000 advance)	\$ 264,798.92

Of the maximum sum of	<u>\$6,000,000</u>
authorized by the International Education Board, there	
remains unallocated	\$4,345,000,
and unpaid on account of previous allocations by the Inter-	
national Education Board	<u>\$ 264,798.92,</u>
a total of	<u>\$4,609,798.92</u>

At the meeting of the General Education Board held April 14, 1932, the Executive Committee was empowered in its discretion to commit the Board from time to time to appropriations to the California Institute of Technology of sums not to exceed in the aggregate

\$4,609,800.00.

copy of this
was sent by Gage to MM

1103.1

CORNING GLASS WORKS

CORNING, NEW YORK



SALES DEPARTMENT
J. L. PEDEN
DIRECTOR OF SALES

EXECUTIVE COMMITTEE
ALANSON B. HOUGHTON
ALEXANDER D. FALCK
GEORGE B. HOLLISTER

April 27, 1932.

T. A.	APR 28 1932	sch RDC 4/29/32	
Files		5 a.	
WWB		✓	
		MM	

No further reply necessary
as MM wrote Anderson,
as requested by Hale,
that this met with
approval MM + T.A.

Mr. Trevor Arnett,
General Education Board,
61 Broadway,
New York, N. Y.

Dear Sir:

At Dr. Hale's request, we are sending you a copy of a letter just sent him. This letter is our interpretation of the agreement between the California Institute of Technology and the Corning Glass Works for the construction of a series of PYREX discs for telescope mirrors.

Very truly yours,

CORNING GLASS WORKS,
Aviation & Optical Division

By

O. A. Gage
In Charge

OAG:FMM

C O P Y

April 25, 1932.

Dr. George E. Hale,
University Club,
1 West 54th Street,
New York, N. Y.

My dear Dr. Hale:

This letter is our interpretation of the agreement covering the manufacture of glass disks for telescope mirrors. It is intended to summarize your letters of November 17th and February 5th and ours of October 24th, January 30th and March 22nd.

The Observatory Council of the California Institute of Technology wishes to secure:

One circular disk, 26" in diameter, 4 1/2" thick, approximately,
solid design

One circular disk, 30" in diameter, 5 1/2" thick, approximately,
ribbed design

One circular disk, 60" in diameter, 8" thick, approximately (it
is probable that two other 60" disks will be wanted immediately
after the completion of the 200" disk)

One circular disk, 120" in diameter, 18" thick, approximately

One circular disk, 200" in diameter, 30" thick, approximately

One elliptical disk, 60" by 80" by 8", approximately.

All of the figures given represent the finished minimum dimensions.

This list indicates the order of manufacture.

The design of each disk, whether solid, ribbed, or other, will be studied by you and your associates and finally determined by mutual agreement with our Laboratory.

April 23, 1932.

The material to be used is one of our PYREX brand glasses having an expansion of approximately 0.0000032. The glass may, of course, be changed by mutual agreement. We understand that near one surface the disks are to be as free from bubbles as we can produce them. The thickness of this region of minimum bubbles will depend upon the size and ultimate form of the mirror. Below this depth, many bubbles of moderate size, if not distributed too irregularly, will do no harm.

We are to use the best possible annealing practice known to us in order that strain may be reduced to the minimum. The annealing schedules for all the disks are being recalculated and will be sent you. Experiments to determine the possibility of crystallization during the long annealing periods are now under way in our Laboratory.

We are not expected to do any grinding or polishing unless this should prove necessary to determine whether a disk is apparently suitable for shipment to you. We shall attempt to shape roughly the concave surface in the 200" disk by sand-blasting.

The final tests will be made by you after the mirrors have been figured for optical use. We are to be notified promptly in writing of the results of your final tests and whether you accept or reject the disk.

We are confident that a 60" disk can be successfully produced. Disks larger than 100" in diameter have never been made as far as we know, and some unanticipated difficulties may arise which will prevent the making of even the 120" blank.

Our study of methods of manufacture leads us to believe such discs can be made at a cost between \$150,000 and \$300,000. These figures are not a quotation, but represent our best estimate based on experience in the manufacture of disks less than 30" in diameter. Unexpected and unforeseen difficulties may increase the cost over the figures mentioned, or it may be reduced, for example, by the use of less annealing equipment and fewer auxiliaries than contemplated. Apparatus now at West Lynn

will be used whenever possible. Further reduction in cost may be made by designing the disk to eliminate weight, as by casting the disk with a central hole or by using a ribbed design which will not sacrifice rigidity.

We estimate a minimum period of 19 months for the making of these disks if each first attempt is successful. We believe that thirty months should see the work completed unless serious difficulties are encountered. This time estimate applies after agreement has been reached upon design and may have to be modified by complications in the casting process introduced by ribbing.

Corning Glass Works is willing to undertake the manufacture of these disks at actual cost (direct expense plus usual overhead) plus 10 percent for disks successfully produced and at actual cost where acceptable disks are not produced.

By "direct expense" is meant that part of the cost devoted directly and exclusively to the article in question. Under this heading we include materials consumed, power used, labor employed, etc.

"Overhead" covers necessary outlay which is devoted partly to the disks and partly to other articles and which must be distributed on some proper basis. For detailed statement, see our letter of March 22, 1932. In accordance with our standard practice, overheads will be computed on a percentage basis. The figures used are our "standard" percentages of overhead which are employed in all cost computations of ware manufactured under the same conditions. These "standard" percentages are estimated as the average value over a business cycle and are less than the actual overheads under present conditions. Our estimates of cost given earlier in this letter include overhead.

Major equipment purchased for manufacture of the disks will be the property of the California Institute of Technology and will be billed at the price at which it is purchased. Its cost will not be included in computing 10 percent profit on accepted disks.

Itemized bills are to be presented to the California Institute of Technology monthly (in duplicate) and any information desired regarding the costs involved will be supplied. Opportunity will be given to make periodical inspection of the work and the methods

Dr. George E. Hale

-4-

April 25, 1932.

employed. The usual Corning Glass Works' terms are to apply:- thirty days net from date of billing, package charges extra.

We understand that our responsibility ends when the disks are ready for delivery to the transportation company at Corning. Any further responsibility will be assumed by you. We are to investigate actively various possible means of transportation and will report results to you.

Our estimate does not include package charges but we will cooperate in packing these disks according to methods mutually worked out and in accordance with your instructions. Our charges for such service will be at actual cost and are not to be included in computing profit.

At the end of June and December of each year, we are to submit our estimated expenditures for the ensuing twelve months by six month periods.

Since there is some uncertainty regarding success in making these large disks, either party shall have the right to withdraw at any time, it being understood, however, that in such event we are to receive our actual cost on all work done to the date of withdrawal, plus 10% of the cost of any disks accepted.

Very truly yours,

CORNING GLASS WORKS,
Aviation & Optical Division

By

O. A. Gage
O. A. Gage
In Charge

OAG:FMM

CC: Dr. Max Mason
Dr. J. A. Anderson
Mr. Trevor Arnett

1103.1

May 9, 1932

Dear Mr. Barrett:

Thank you very much for your telegram of May 7th and also the letter of May 6th signed by Mr. Fleming and you on behalf of the Board of Trustees, regarding the intention of California Institute of Technology to release the International Education Board from all obligations to the Institute under the Board's Pledge #7, upon receipt by the Institute of an agreement from the General Education Board providing for the payment by it to the Institute of the amounts and at the times and under the conditions provided in that pledge to the Institute of the unpaid items of that pledge.

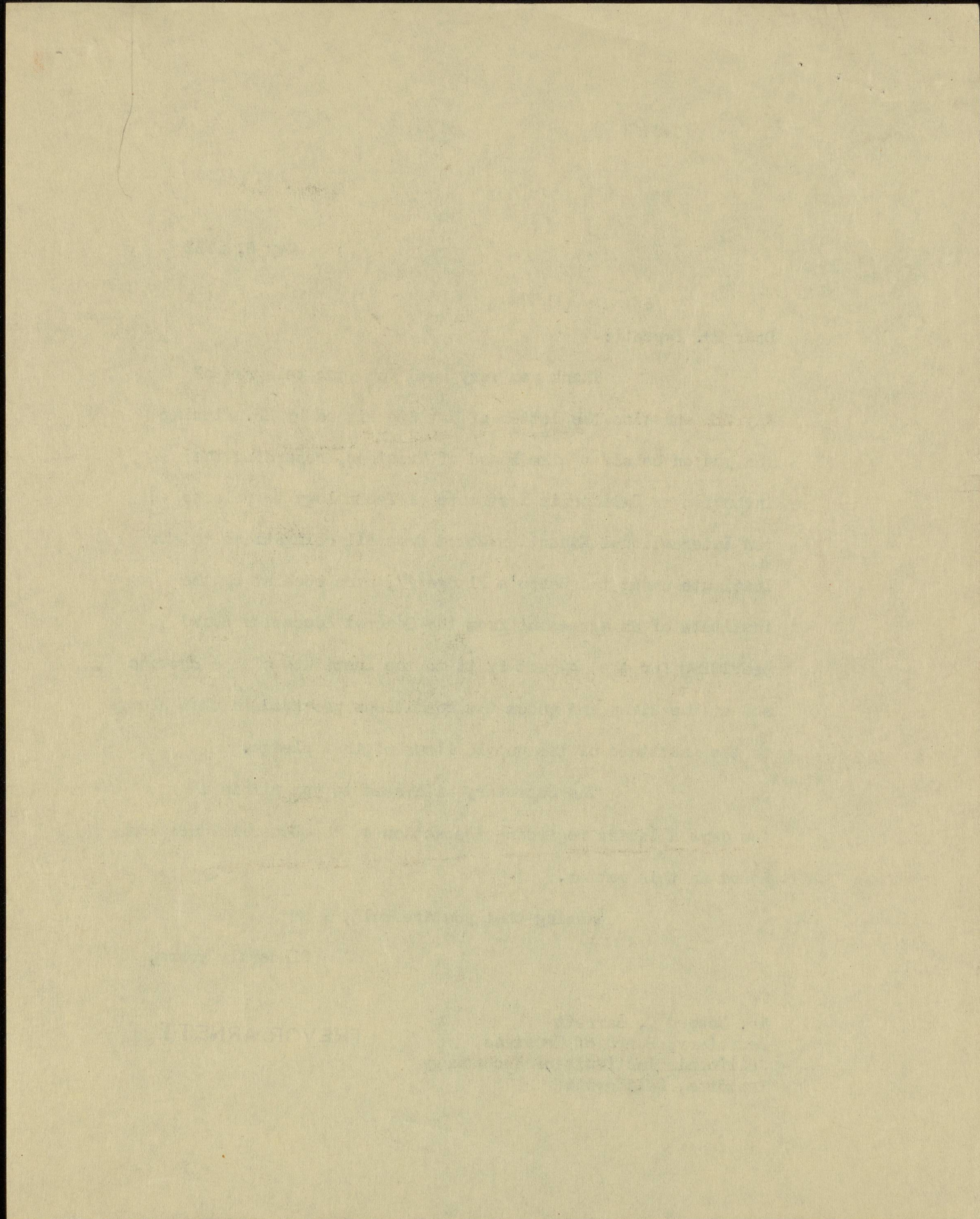
The Secretary will send to you within a few days a letter regarding the action of the General Education Board in this matter.

Hoping that you are well, I am

Sincerely yours,

Mr. Edward C. Barrett
Secretary, Board of Trustees
California Institute of Technology
Pasadena, California

TREVOR ARNETT



1103.1

May 16, 1932

Dear Mr. Debevoise:

I enclose a draft of a formal letter of notification to the authorities of the California Institute of Technology covering the action of the General Education Board on April 14, 1932. Mr. Arnett would appreciate it if you would read this draft and make any suggestions which occur to you preparatory to the formal letter going forward.

In this connection I enclose also

Docket item of the General Education Board of
April 14, 1932

Formal letter of notification of the International
Education Board dated November 7, 1928

Agreement of the International Education Board,
with a letter from the President and Secretary
of the Board of Trustees of the California
Institute of Technology, dated May 6, 1932, re-
leasing the International Education Board from
all obligations under its pledge, + T A's reply

Sincerely yours,

W. W. BRIERLEY

Mr. T.M. Debevoise
26 Broadway, New York

WWB:KEO

1103.1

May 19, 1932

Dear Doctor Hale:

At a meeting of the Executive Committee of the General Education Board held May 9, 1932, it was reported that sums required by the California Institute of Technology for the Astrophysical Observatory would be as follows:

For the period January 1, 1931 through June 30, 1932:

Original estimate covering requirements	\$ 670,000.00
Sum obtained from other sources	<u>505,201.08</u>

Balance required for period ending June 30, 1932	\$ 164,798.92
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For the period July 1, 1932 to January 1, 1933	<u>307,300.00</u>
(as set forth in a letter dated April 23, 1932, from the Chairman of the Observatory Council)	\$ <u>472,098.92</u>

In accordance with the foregoing and pursuant to the Board's authorization at its meeting held April 14, 1932, as reported to you in my letter of today's date, the Executive Committee released the sum of \$472,098.92, or so much thereof as may be needed, to the California Institute of Technology for the undertaking.

The Auditor will make arrangements for payment.

A copy of this letter is being sent to Doctor Millikan and Doctor Anderson for their information.

Very truly yours,

W. W. BRIERLEY

Doctor George E. Hale
c/o The Royal Society
Burlington House
London, W. 1, England

WEB:KEO

May 19, 1932

Dear Doctor Millikan:

At a meeting of the Members and Trustees of the General Education Board held April 14, 1932, a report was submitted covering the undertaking of the California Institute of Technology, through the Observatory Council, to construct a 200-inch reflecting telescope, involving the following:

- 1) a 200-inch reflecting telescope,
- 2) a site, including land and land improvements,
- 3) an observatory and other necessary buildings,
- 4) auxiliary apparatus, and
- 5) other expenses in connection with making the observatory available for use,

estimated to cost \$6,000,000.

The Board was informed that of the original estimate of \$6,000,000, as itemized below, \$1,390,201.08 had been provided from other sources, so that approximately \$4,609,800 would be needed to complete the undertaking:

I. Expenses of Committee	\$ 128,584.21
II. Expenses of experimentation and manufacture of reflectors, including \$450,000 for 17-foot grinding machine and other equipment for optical shop, if approved	2,066,106.22
III. Expenses of land and land improvements	350,000.00
IV. Expenses of buildings and telescope mountings	2,699,232.05
V. Expenses of other equipment	241,786.77
VI. Contingent expenses	<u>514,290.75</u>
	\$6,000,000.00.

May 19, 1932

I desire to notify you that the General Education Board took formal action authorizing the Executive Committee in its discretion to commit the Board from time to time to appropriations to the Board of Trustees of the California Institute of Technology, Pasadena, California, of sums not exceeding in the aggregate \$4,609,800 for the purchase of a site and the construction of an observatory, including a 200-inch reflecting telescope with accessories, and any and all other expenses incurred in making the observatory available for use. This action was taken with the stipulation:

- 1) That the Trustees of the California Institute of Technology will provide the funds required for the upkeep and maintenance of the observatory, including the telescope, if constructed; and
- 2) That commitments by the Executive Committee of the General Education Board shall not be made more rapidly than developments justify.

It is expected that early in June the Executive Committee will authorize the executive officers to execute a formal agreement to cover the action of the Board herein reported.

A copy of this communication is being sent to Doctor Hale and Doctor Anderson for their information.

Very truly yours,

Doctor Robert A. Millikan
California Institute of Technology
Pasadena, California

WVB:KBO

LAW OFFICES
OF
THOMAS M. DEBEVOISE

26 BROADWAY

NEW YORK, May 19, 1932.

1103.1
California Inst. of Technology

Mr. W. W. Brierley,
61 Broadway,
New York City.

Dear Mr. Brierley:

The papers received with your letter
of the 17th instant are returned herewith.

The proposed letters to Dr. Milliken,
Dr. Hale and President Hutchins all seem to cover the ground
fully. I shall be glad when the formal agreements have
been made and the old IEB. agreements returned for cancell-
ation.

Sincerely yours,

Thomas M. Debevoise

Encs.

1103.1

Docket item April 14

Nov. 7, 1928 - W. W. B. to R. M. M. M.

May 6, 1932 - A. Fleming to T.A. + T.A.'s reply

Page No. 7

U. of Chicago

Docket item April 14, 1992

R.M. Hutter's letter of May 13, 1932 to TA + his reply June 11, 1929 (2)

letters of commitment, Dec. 6, 1928; June 11, 1929 (2);

April 26, 1929; June 19, 1930; June 3, 1931 + acknowledgment

Page No 11

May 17, 1932

Dear Mr. Debevoise:

Enclosed are drafts of letters to be written to the President of the University of Chicago and of the California Institute of Technology, covering the actions of the Board on April 14 and of the Executive Committee on May 9. It is planned to have the Committee authorize the execution of formal agreements at a meeting to be held early in June.

May we have your suggestions before
sending the letter of notification?

Sincerely yours,

Mr. T.M. Debevoise
26 Broadway, New York

COPY TO MILLIKAN AND ANDERSON

Dear Doctor Hale:

At a meeting of the Executive Committee of the General Education Board held May 9, 1932, it was reported that sums required by the California Institute of Technology for the Astrophysical Observatory would be as follows:

For the period January 1, 1931 through June 30, 1932:

Original estimate covering requirements	\$ 670,000.00
Sum obtained from other sources	<u>505,201.08</u>

Balance required for period ending June 30, 1932	\$ 164,798. ⁰²
--	---------------------------

For the period July 1, 1932 to January 1, 1933 (as set forth in a letter dated April 23, 1932, from (Doctor George E. Hale) Chairman of the Observatory Council)	307,300.00
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	\$ <u>472,098.⁰²</u>
--	---------------------------------

In accordance with the foregoing and pursuant to the Board's authorization at its meeting held April 14, 1932, as reported to you in my letter of today's date, the Executive Committee released the sum of \$472,098.⁰², or so much thereof as may be needed, to the California Institute of Technology for the undertaking.

The Auditor will make arrangements for payment.

A copy of this letter is being sent to Doctor Millikan and Doctor Anderson for their information.

Very truly yours,

Date

Dear Doctor Millikan:

At a meeting of the Members and Trustees of the General Education Board held April 14, 1932, a report was submitted covering the undertaking of the California Institute of Technology, through the Observatory Council, to construct a 200-inch reflecting telescope, involving the following:

- 1) a 200-inch reflecting telescope,
- 2) a site, including land and land improvements,
- 3) an observatory and other necessary buildings,
- 4) auxiliary apparatus, and
- 5) other expenses in connection with making the observatory available for use,

estimated to cost \$6,000,000.

The Board was informed that of the original estimate of \$6,000,000, as itemized below, \$1,390,201.08 had been provided from other sources, so that approximately \$4,609,800 would be needed to complete the undertaking:

I. Expenses of Committee	\$ 128,584.21
II. Expenses of experimentation and manufacture of reflectors, including \$450,000 for 17-foot grinding machine and other equipment for optical shop, if approved	2,066,106.22
III. Expenses of land and land improvements	350,000.00
IV. Expenses of buildings and telescope mountings	2,699,232.05
V. Expenses of other equipment	241,786.77
VI. Contingent expenses	<u>514,290.75</u>
	\$6,000,000.00.

I desire to notify you that the General Education Board took formal action authorizing the Executive Committee in its discretion to commit the Board from time to time to appropriations to the Board of Trustees of the California Institute of Technology, Pasadena, California, of sums not exceeding in the aggregate \$4,609,800 for the purchase of a site and the construction of an Observatory, including a 200-inch reflecting telescope with accessories, and any and all other expenses incurred in making the Observatory available for use. This action was taken with the stipulation:

- 1) That the Trustees of the California Institute of Technology will provide the funds required for the upkeep and maintenance of the Observatory, including the telescope, if constructed; *and*
- 2) That commitments by the Executive Committee of the General Education Board shall not be made more rapidly than developments justify.

It is expected that early in June the Executive Committee will authorize the executive officers to execute a formal agreement to cover the action of the Board herein reported.

Very truly yours,

2.

It is expected that early in June the Executive Committee will authorize the ~~executive~~ officers to execute a formal agreement to cover the action of the Board herein reported.

A copy of this communication is being sent to Doctor Hale and Doctor Anderson for their information.

Very truly yours,

1103.1

LAW OFFICES
OF
THOMAS M. DEBEVOISE

26 BROADWAY

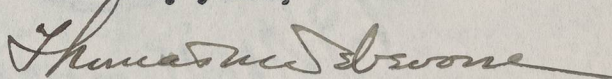
NEW YORK, May 26, 1932.

Mr. W. W. Brierley,
61 Broadway,
New York City.

Dear Mr. Brierley:

It was impossible for me to go over the enclosed draft this morning, but I have just finished it now and am returning it at once by messenger. I have no suggestions to make, except for the omission of the word "ending" in the second whereas on the fifth page.

Sincerely yours,



Enc.

1103.1

May 26, 1932

Dear Mr. Debevoise:

Enclosed is a draft of the docket for the meeting of the Executive Committee of the General Education Board to be held June 3. I do not wish to hurry you, but we would appreciate it if you would return the draft with your suggestions this morning, inasmuch as it has to be stencilled today and mailed to the members tomorrow.

Sincerely yours,

W. W. BRIERLEY

Mr. Thomas M. Debevoise
26 Broadway, New York

WFB:KEO

JUL 15 1932

1103.1

CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA

ASTROPHYSICAL OBSERVATORY

W. W. Brierley	JUN 20 1932	1111	-
June 15, 1932	RECEIVED DEPT.	✓	
TA		7a	
DHS		8/13	

Mr. W. W. Brierley
Secretary, General Education Board
61 Broadway
New York.

Dear Mr. Brierley:

I still owe you my thanks for your letters of May 19, which reached me in London. Probably these have been acknowledged by Dr. Millikan. However, I now see, on rereading the letters, that the original of the one relating to the appropriations made on May 19 was addressed to me, and that I should have acknowledged it before. In any case, I wish to assure you and the other officers of our great appreciation of the generous action of the General Education Board, which we are making every effort to reciprocate by securing the advice and assistance of the leading authorities in this country and abroad.

In this connection you may be interested to learn that while in London, as the result of several conferences with Sir Herbert Jackson and his assistants in the British Scientific Instrument Makers Research Association, we found a method of making a new type of spectrograph lens which may have the effect of doubling the power of the 200-inch telescope in researches on remote nebulae, and thus of greatly extending our recent investigations on the extraordinarily rapid outward flight of nebulae in the "expanding universe".

Since my return to Pasadena I have learned of other new devices, invented by members of our staff since I left home, which will also result in making the telescope much more powerful than we originally expected for other classes of work.

Very sincerely yours,

Gay. S. Hale

GEH:G

✓ Listed by GLEN - 20. 1103.1

	W.W.E.	AUG 8 1932	Glen	D
FILING DEPT				
E OF TECHNOLOGY				
ENA	H P		ID	8/11/32 ✓
		August 4, 1932		

OFFICE OF THE SECRETARY

Dear Sirs:

This will acknowledge with the thanks of the California Institute of Technology the receipt from you of formal agreement No. 430 covering the General Education Board's appropriation of \$4,609,800 for the telescope project. Acceptance of this agreement was formally authorized at a meeting of the Board of Trustees held July 29, 1932. The pledge has been accepted and the duplicate is returned herewith to you.

very truly yours,

Edward Charnett

Edward C. Barrett
Secretary, Board of Trustees

ECB:P
Encl.
Registered.

JUL 19 1932

1103.1

LAW OFFICES
OF
THOMAS M. DEBEVOISE

✓	WWD	July 15	1111	0
✓	Seq	to page	159	

26 BROADWAY

NEW YORK, July 15, 1932.

See page #430

Mr. W. W. Brierley,
61 Broadway,
New York City.

Dear Mr. Brierley:

I think the fifth paragraph on page 2
of the proposed telescope pledge should read as follows:

"Provided that if at any stage of the project it be
decided that the construction of the telescope is not
feasible, this pledge, as to any remainder of the
amount thereof not then due and payable according to
the terms above prescribed, shall be and become null
and void."

Sincerely yours,

Thomas M. Debevoise

If you are motoring around Cornwall and Somerset this
summer don't fail to take a look at Fowey in Cornwall and
Dunster in Somerset.

T.M.D.

WHEREAS, The aforementioned Observatory Council adopted a definite plan of organization for its guidance and appointed representative committees to deal with all phases of the project; and

WHEREAS, The Carnegie Institution of Washington, District of Columbia, and the Mount Wilson Observatory, Pasadena, California, gave their approval and indicated their willingness to assist and cooperate in carrying out the project; and

WHEREAS, pursuant to authorization of the General Education Board (hereinafter referred to as the "Board"), on April 14, 1932, the Executive Committee of the Board on May 9, 1932, released to the Institute for this undertaking Four hundred seventy-two thousand ninety-eight Dollars and Ninety-two Cents (\$472,098.92) to cover the estimated requirements for the period, April 1, 1932 to January 1, 1933;

THEREFORE, To enable the Institute to proceed with the undertaking without interruption and in consideration of the Institute's agreement to carry out this project, the Board agrees to provide the Institute with funds not exceeding in the aggregate Four million six hundred nine thousand eight hundred Dollars (\$4,609,800), including the aforementioned sum of Four hundred seventy-two thousand ninety-eight Dollars and Ninety-two Cents (\$472,098.92), from time to time, but not more rapidly than developments of the project justify for (a) the purchase of a site and the construction of an Observatory, including a 200-inch reflecting telescope, with accessories, in general conformity with the outline of purposes above set forth, and (b) any and all other expenses incurred in making the Observatory available for use;

PROVIDED That, if at any stage of the project it be decided that the construction of the telescope is not feasible, any remainder of the amount hereby pledged by the Board, according to the terms above prescribed, shall be ^{released} (and become) null and void *and this pledge shall thereupon be and become null and void as to such remainder*

It is mutually understood and made a condition of this agreement that said Institute will provide the funds required for the upkeep and maintenance of the Observatory, including the telescope, if constructed.

M.H.P.

JUL 18 1932

1103.1

July 15, 1932

My dear Mr. Barrett:

As instructed by the officers, I am enclosing original and duplicate of formal agreement No. 430, covering the General Education Board's recent appropriation of \$4,609,800 to the California Institute of Technology for the telescope project. If this agreement is acceptable to the Trustees, will you kindly have the form of acceptance on the fourth page filled in and signed and the duplicate agreement so executed returned to us. The original is intended for your files.

Very truly yours,

GENERAL EDUCATION BOARD

By

IRENE E. GOLDEN

Mr. Edward C. Barrett
Secretary, Board of Trustees
California Institute of Technology
Pasadena
California

IEG MVK

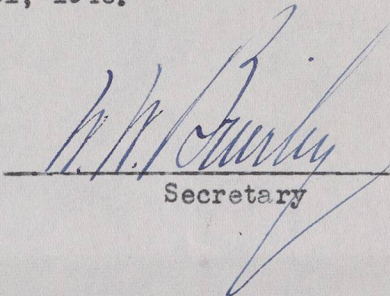
Enc.

JUL 24 1952

7/14/52

1103.1

Under authorization GEB 44005, dated February 2, 1944, the termination dated of the Board's appropriation to California Institute of Technology was extended from January 1, 1945, through December 31, 1946.


Secretary

AGREEMENT
GENERAL EDUCATION BOARD
and
CALIFORNIA INSTITUTE OF TECHNOLOGY

No. 430

\$4,609,800

WHEREAS, The Board of Trustees of the California Institute of Technology, located at Pasadena, in the State of California (hereinafter referred to as the "Institute"), through the Observatory Council, is engaged in an effort to construct a 200-inch reflecting telescope originally estimated to cost Six million Dollars (\$6,000,000), of which One million three hundred ninety thousand two hundred one Dollars and Eight Cents (\$1,390,201.08) had been provided from other sources up to April 1, 1932, so that approximately Four million six hundred nine thousand eight hundred Dollars (\$4,609,800) would be needed to provide for the completion of the undertaking, involving the following:

- a) A 200-inch reflecting telescope;
- b) Site, including land and land improvements;
- c) Observatory and other necessary buildings;
- d) Auxiliary apparatus;
- e) Other expenses in connection with making the observatory available for use;

and

WHEREAS, On July 5, 1928, said Institute took formal action substantially as follows:

- 1) Creating an "Observatory Council" with full powers to represent and act on behalf of the Institute in all dealings relating to the proposed observatory;
- 2) Approving the proposed scheme of organization, construction, and operation, subject to any amendments made by the Observatory Council;
- 3) Agreeing to assume full responsibility for building the Observatory, including the telescope, and to provide the necessary funds for operating it after its completion;
- 4) Authorizing the Observatory Council to set up a regular organization, hold meetings, and report quarterly to the Institute; and
- 5) Providing for payments of all expenses upon requisition and agreeing to render an accounting of all expenditures each six months, or more frequently, as desired;

and

M.H.P.

WHEREAS, The aforementioned Observatory Council adopted a definite plan of organization for its guidance and appointed representative committees to deal with all phases of the project; and

WHEREAS, The Carnegie Institution of Washington, District of Columbia, and the Mount Wilson Observatory, Pasadena, California, gave their approval and indicated their willingness to assist and cooperate in carrying out the project; and

WHEREAS, Pursuant to authorization of the General Education Board (hereinafter referred to as the "Board"), on April 14, 1932, the Executive Committee of the Board on May 9, 1932, released to the Institute for this undertaking Four hundred seventy-two thousand ninety-eight Dollars and Ninety-two Cents (\$472,098.92) to cover the estimated requirements for the period, April 1, 1932 to January 1, 1933;

THEREFORE, To enable the Institute to proceed with the undertaking without interruption and in consideration of the Institute's agreement to carry out this project, the Board agrees to provide the Institute with funds not exceeding in the aggregate Four million six hundred nine thousand eight hundred Dollars (\$4,609,800), including the aforementioned sum of Four hundred seventy-two thousand ninety-eight Dollars and Ninety-two Cents (\$472,098.92), from time to time, but not more rapidly than developments of the project justify for (a) the purchase of a site and the construction of an Observatory, including a 200-inch reflecting telescope, with accessories, in general conformity with the outline of purposes above set forth, and (b) any and all other expenses incurred in making the Observatory available for use;

PROVIDED, That, if at any stage of the project it be decided that the construction of the telescope is not feasible, this pledge, as to any remainder of the amount thereof not then due and payable according to the terms above prescribed, shall be and become null and void.

It is mutually understood and made a condition of this agreement that said Institute will provide the funds required for the upkeep and maintenance of the Observatory, including the telescope, if constructed.

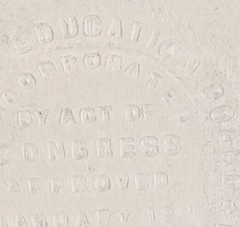
EDUCATIONAL BOARD
APPROVED
JANUARY 12, 1933

It is also mutually understood and made a condition of this agreement that, as to any remainder of the amount hereby pledged not due and payable according to the terms above prescribed by January 1, 1945, this pledge shall be and become null and void.

The Institute, by the acceptance of this pledge, agrees to comply with the conditions above set forth on which this pledge is made and on which the payments under it are to be made.

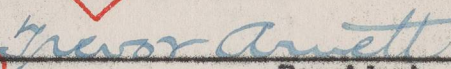
This pledge is executed pursuant to resolutions adopted by the General Education Board on the fourteenth day of April, 1932 and by its Executive Committee on the third day of June, 1932.

In Witness Whereof, the Board has caused this pledge to be signed and its seal hereunto affixed by its duly authorized officers this 14th day of July, 1932.



GENERAL EDUCATION BOARD

By


President

(Seal)

Attest:


Secretary

The foregoing conditional pledge of the GENERAL EDUCATION BOARD, No. 430, dated July 14, 1932, is hereby accepted by the Board of Trustees of the California Institute of Technology, located at Pasadena, in the State of California; and said Board of Trustees covenants and agrees that if the terms of the pledge are complied with and the money paid by the General Education Board, it will faithfully perform the covenants on behalf of said institution contained in the pledge.

This acceptance is executed pursuant to a resolution of the Board of Trustees of the California Institute of Technology dated the 29th day of July 1932.

In Witness Whereof the BOARD OF TRUSTEES OF the California Institute of Technology has caused this acceptance to be signed, and its seal hereunto affixed by its duly authorized officers this 2d day of August 1932.

BOARD OF TRUSTEES OF
CALIFORNIA INSTITUTE OF TECHNOLOGY

By A. C. Balch
Vice President.

(Seal)

Attest:

Edward A. Barnett
Secretary.

Duplicate

P- 2549
Paid

No. 430

\$ 4,609,800

Agreement

General Education Board

and

CALIFORNIA INSTITUTE OF
TECHNOLOGY

Dated, July 14, 1932

Authorized, April 14, 1932
June 3, 1932

1103.1

gfd		gm	

□ ?

June 13, 1932

Dear Doctor Millikan:

In accordance with my letter of May 19 and pursuant to authorization from the General Education Board on April 14, 1932, the Executive Committee at its meeting held June 3 authorized the officers to execute a pledge to the Board of Trustees of the California Institute of Technology, Pasadena, California, assuring said Institute that the General Education Board will provide funds from time to time as needed, not exceeding in the aggregate \$4,609,800, including \$472,098.92 released by the Executive Committee on May 9, 1932, toward the purchase of a site and the construction of an observatory, including a 200-inch reflecting telescope, with accessories, and any and all other expenses incurred in making the observatory available for use.

Mr. Arnett is expected to return from Europe about July 11, and shortly thereafter an agreement will be prepared for signature and forwarded to you.

A copy of this letter is being sent to Doctor Hale and Doctor Anderson for their information.

Sincerely yours,

W. W. BRIERLEY

Doctor Robert A. Millikan
California Institute of Technology
Pasadena, California

WVB:KEO

OCT 17 1932

1103.1

CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA

ASTROPHYSICAL OBSERVATORY

October 7, 1932

President Max Mason
Rockefeller Foundation
61 Broadway
New York.

mm	OCT 13 '32	mm	10/14

Dear Mason:

I am sure that you will be interested in the enclosed photographs and the accompanying copy of a letter from Dr. Day. The results, as far as can be determined from these preliminary tests, are certainly very satisfactory.

Kindly return the photographs at your convenience, as we have no other copies for reference.

With best regards,

Yours ever,

George E. Hale

GEH:G

COPY

GEOPHYSICAL LABORATORY
Washington, D.C.

September 30, 1932

Doctor George E. Hale,
Mt. Wilson Observatory,
Pasadena, California.

Dear Doctor Hale:

I have just returned from three days in Corning, during which I saw the 60" disc, which has just come out of the annealing furnace, and had opportunity for consultation with the Corning group on many of the details of preparation for the 120" disc.

The 60" disc is a beautiful piece of work. I am sending you a few photographs which will give you a better idea of its present appearance and of certain of the annealing details than I could possibly convey to you by description alone. The ribbed structure came through splendidly and did much to support our confidence in this plan for reducing the mass of the 200" disc. I can discover no reason for anticipating strain or inhomogeneity in the ribbed structure more than in a solid disc; indeed I am inclined to believe there is even less. That is to say, the annealing proves to be even better than we would expect to get in a solid disc of equivalent dimensions.

There is also much evidence here to dissipate any fear of devitrification, of which both you and Dr. Mason expressed some apprehension. I could discover no sign of devitrification at the mold contacts anywhere, although the material of the mold is well calculated to afford nuclei for such incipient crystallization. Neither do floating bits of silica powder, scum, or occasional bubbles show any sign of devitrification in their neighborhood.

The disc, when I saw it, was still resting in place upon the central portion of its mold, the sides and a few inches of the base had been removed so as to permit strain measurements in the outer zone, which is of course the only area in which stresses are uncompensated. More than 30 measurements were made in the half-inch band forming the outer rim (most of which will of course later be cut away). The highest measured strain amounted to $48 \text{ m}\mu$; the minimum $40 \text{ m}\mu$. The corresponding figures for the adjacent outer rib, which will remain permanently a part of the design, are $39 \text{ m}\mu$ and $31 \text{ m}\mu$ in an equal number of measurements. If I remember rightly these measurements average almost identically the same as those in the 30" disc, which is already in your hands. This corresponds exactly with theoretical expectations and is most satisfactory.

The amount of glass is sufficient to provide a clearance of about $3/8$ of an inch to the center of the final (convex) figure. Of course at the rim about 2" of glass will be removed in figuring. The face of the mold appears to show a very symmetrical distribution of glass over it, such that when the figuring is complete the effective thickness of the face plate will be uniformly 2" as planned.

Perhaps I should add, by way of explanation of the photograph of the disc, that the clear images of the mold segments give some idea of the quality of the glass for they are photographed through 3" or more of it.

The wavy surface lines need not be misleading. They are merely surface scum less than a millimeter in thickness which you will of course face off as soon as the

blank comes into your hands. The three parallel bands across the surface represent slight depressions due to the warping of the T beams which supported the bricks of the annealing cover. They will also disappear in the facing. It is rather interesting, though of course fortuitous, that this accidental contact of foreign material (iron) also left no trace of devitrification in the adjacent glass.

I hope this information may give you a fairly clear idea of the condition of the disc and the encouragement which it offers for the success of the larger ones to follow.

Now in regard to the plans for the 120" disc, they are complete as shown in Dr. McCauley's drawing, which has been sent to you, save in one small detail of rib design concerning which Dr. McCauley will write to Dr. Pease. It has to do with the terminal point of the alternate ribs which do not reach the rim and is in the interest of a slightly greater symmetry in the distribution of rib mass. The suggestion probably has no important significance but any detail calculated to perfect symmetry of structure is obviously in the interest of safety in providing against uncompensated stresses.

Preparations for casting the 120" disc have gone as far as they can go until authorization is received for a hoisting mechanism. The program has been delayed in fact for several weeks pending the decision in regard to the crane now at West Lynn, which cannot be used in Corning on account of its dimensions, and the working out of a substitute mechanism which can be used in the space available there and which will have sufficient power to handle the 200" disc as well. You have been advised I think that a suitable hoist has now been found and bids have been obtained on it. I understood that the matter now awaits only your authorization. There will be some further delay even after the authorization is received, due to the time necessary to deliver and erect this hoist. Very possibly you will have given this authorization before this letter reaches you. I think all the other materials necessary for proceeding with the 120" are now in hand.

With best wishes, believe me,

Very sincerely yours,

(Signed) Arthur L. Day

ALD/E.

OCT 29 1932

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CORNING GLASS WORKS
CORNING, NEW YORK



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JAN 24 1935

DEVELOPMENT
AND
RESEARCH
DEPARTMENT

October 26, 1932

EXECUTIVE COMMITTEE
ALANSON B. HOUGHTON
ALEXANDER D. FALCK
GEORGE B. HOLLISTER

Dr. Max Mason
President, The Rockefeller Foundation
61 Broadway
New York City

Dear Dr. Mason,

If you can conveniently do so, I would appreciate very much having a few minutes of your time on Friday, October 28, in order to discuss a few points in connection with the telescope disc problem. I should imagine that fifteen minutes or so would be ample, and I could probably arrange to meet you during the late afternoon. At any rate if I could have a word from you mailed to our New York office, 501 Fifth Avenue, indicating something of your plans for Friday, I could then get in touch with you by telephone and make an appointment.

With kind regards and best wishes, I remain

Yours very truly,

J.C. Hostetter
Director, Development & Research

JCH:FRF

DEC 9 - 1932

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CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA

ASTROPHYSICAL OBSERVATORY

October 31, 1932

Dr. Max Mason
Rockefeller Foundation
61 Broadway
New York.

Dear Mason:

7
Thanks for your letter of October 15. I referred your question to Anderson, who has been making a general study of stellar scintillation, and has considered meteors as a possible cause of the residual effects observed telescopically under the best atmospheric conditions. I enclose his statement, which refers, you will notice, only to meteors easily seen with the naked eye.

It is very difficult, of course, to estimate the number of smaller particles in space, but in some regions they seem to be very numerous. Thus the extensive dark nebulae appear to be composed chiefly of fine dust. Seares, Hubble and others have found that the stars within or beyond them are almost invariably redder than average stars of the same spectral class. This might be due to gas, but fine dust particles would be much more effective. General interstellar space, however, away from such obscuring clouds, has thus far shown little or no evidence of general or selective absorption.

Since writing the above I have received your letter of October 25. Dr. Strong, who developed here the method of condensing quartz and metals on various surfaces, is a very able physicist, formerly a National Research Fellow. The thin layer of quartz does not seem to be such an effective means of protecting silver as we had expected, but if anyone can perfect a process for this purpose, Strong is certainly the man. As for the condensation of metals, he has had great success with small mirror discs, and probably the same method can be used for large mirrors. One of the advantages is the great reduction of scattered light, a troublesome defect of the ordinary silvering process, because of the countless fine scratches due to the unavoidable burnishing.

Very sincerely yours,

GEH:G

George E. Hale

A star viewed through a small telescope (2 in. or smaller) fluctuates in brightness sometimes as rapidly as 30 to 50 times per second. The cause of this is supposed to be optical striae in our atmosphere. The magnitude of the oscillations in brightness varies from very small up to two or three magnitudes.

The number of meteors striking the earth in 24 hours, which are bright enough to be seen comfortably with the naked eye, is estimated at about 20,000,000. Since the volume of the space traversed by the earth in 24 hours is around 7.5×10^{13} cubic miles, this gives for the density of meteors in the neighborhood of the earth's orbit, one meteor per 3,000,000 cubic miles.

J.A.A.

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CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA

OFFICE OF THE SECRETARY

November 23, 1932

Mr. W. W. Brierley,
Secretary, General Education Board,
61 Broadway,
New York, N. Y.

W.W.B.	NOV 25 1932	MMB
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Vg	NS	11/28/32

Dear Mr. Brierley:

As the work in connection with the 200-inch telescope project has been moving forward rapidly during the last few months, the balance in this account has again been drawn down. I am, therefore, sending you statement showing expenditures from July 30, 1932, to October 31, 1932, amounting to \$66,281.72 for which we would be pleased to receive remittance at your convenience.

With cordial regards, I am

Very sincerely yours,

Edward C. Barrett

Edward C. Barrett
Secretary

ECB:P
Encl.

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JAN - 6 1933

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CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA

ASTROPHYSICAL OBSERVATORY

Mr. Trevor Arnett
President General Education Board
61 Broadway
New York.

Dear Mr. Arnett:

I enclose our budget for the period January 1 to December 31, 1933, requesting an additional appropriation of \$175,000. This amount, plus our estimated balance of \$55,440.47 on December 31, 1932, should carry us through the whole of next year.

I am glad to report that the outlook for the successful completion of the 200-inch telescope has never appeared so favorable as it does at the present time. The enclosed copies of two letters from Dr. Hostetter indicate the present conditions at Corning, where the tests of the 60-inch Pyrex disc cast last July show that its internal strains are far below any previously observed in large discs for reflecting telescopes. The results thus obtained have led several observatories, which expect to build telescopes with apertures ranging from 80 to 120 inches, to favor the Corning Glass Works for the production of their mirror discs. As we hoped when planning for the 200-inch telescope, many of the results of our experiments, relating both to large mirror discs and to auxiliary apparatus, have thus become available for widespread use.

At present we are engaged upon the study of a remarkable new design for large reflecting telescopes, which we hope

December 22, 1932

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Mr. Trevor Arnett

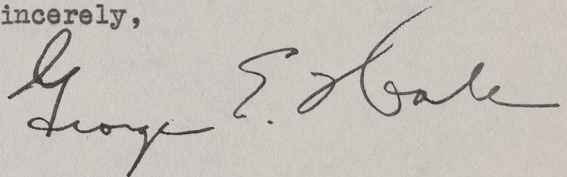
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December 22, 1932

will greatly increase their efficiency and also reduce their cost. A full report upon this design will be presented as soon as the drawings and model have been completed and tested.

Assuring you that we are doing everything in our power to make adequate return for the generosity of the Rockefeller Boards, and with best wishes for the New Year, I am

Yours very sincerely,



GEH:G

P.S. I will send under separate cover a photograph showing the present condition of the interior of the Optical Shop.

ack. by
R.H.

JAN - 6 1933

CALIFORNIA INSTITUTE OF TECHNOLOGY

Astrophysical Observatory

Budget for the period January 1 to December 31, 1933

Total appropriations to May 19, 1932 \$1,862,300.00

Total expenditures to December 1, 1932 \$1,565,073.70

Outstanding contracts and commitments, including completion of Optical Shop, equipment of Astrophysical Laboratory, final payments to General Electric Company, work at Corning to December 31, 1932, and miscellaneous items	<u>241,785.83</u>	<u>1,806,859.53</u>
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Leaving balance applicable to next year	\$ 55,440.47
---	--------------

The sums needed from January 1, to December 31, 1933 are:

I	Site Investigation	\$1500	
	Salaries and office exp		
	penses.....	6200	
	Supplies, etc.	<u>1300</u>	\$9,000
II	Opticians	6500	
	Corning Glass Co.	60000	
	Phillips Lamp Works (in-		
	cluding 36-inch coelostat		
	mirror plus duty)	5000	
	120-inch Grinding Machine	15000	
	Operation and Maintenance		
	of Optical Shop	<u>15000</u>	101,500
III	-0-		
IV	Instrument design	15000	
	Machine Shop (operation		
	and supplies)	<u>62500</u>	77,500
V	Instrument development	10000	
	Miscellaneous work and		
	contingencies	<u>25000</u>	35,000
			<u>\$223,000</u>
	Total		\$223,000

Additional appropriation now requested \$175,000

This amount, added to the unexpended balance of \$55,440.47, should carry us through 1933.

ILLINOIS INSTITUTE OF TECHNOLOGY

Astrophysical Observatory

Budget for the period January 1 to December 31, 1933

Total expenditures to December 1, 1933 \$1,562,075.70
Total appropriations to May 13, 1933 \$1,562,800.00

Outstanding contracts and commitments, including completion of Optical Shop, equipment of Astrophysical Laboratory, final payments to General Electric Company, work at Corning to December 31, 1933, and miscellaneous items

\$41,765.03

\$5,440.47

Leaving balance applicable to next year

The sums needed from January 1, to December 31, 1933 are:

I	Site Investigation	1500	
	Salaries and office exp	6300	
	Travels.....	1300	9,000
	Supplies, etc.....		
II	Opticians	6500	
	Corning Glass Co.	60000	
	Phillips Lamp Works (in- cluding 36-inch coelostat mirror plus entry)	5000	
	180-inch Grinding Machine	15000	
	Operation and maintenance of Optical Shop	15000	101,500
III	-0-		
IV	Instrument design	15000	
	Machine Shop (operation and supplies)	62500	77,500
V	Instrument development	10000	
	Miscellaneous work and contingencies	25000	55,000
	Total		223,000

\$175,000

Additional appropriation now requested
This amount, added to the unexpended balance
of \$5,440.47, should carry us through 1935.

JAN - 6 1933

C O P Y

CORNING GLASS WORKS
Corning, New York

December 15, 1932

Dr. George E. Hale
Astrophysical Observatory
California Institute of Technology
Pasadena, Calif.

Dear Dr. Hale,

Replying to your letter of December 8, which I find on my desk after a week's absence from the city, I wish to say that our plans in regard to the 120-inch disc are that it will be poured within the next month. We have been delayed somewhat in the delivery of our lifting device, but we are doing our utmost to install this with the minimum delay. The annealing equipment is progressing nicely and I hope to be able to report that the disc has been cast by January 15.

In regard to delivery date on this disc, I believe that our present annealing schedule would call for nine months, and then, assuming the disc was satisfactory, there would be some time required for inspection, measurement of strain, and packing for shipment. With these points in mind I believe that a delivery date of November, 1933, is indicated at the present time.

I had a few minutes with Dr. Adams last week in Washington and mentioned to him that we are awaiting information in regard to your tests on the 30" disc. I trust that they will be satisfactory.

We have received some inquiries for large discs, and have recently had a letter from Professor Struve indicating that he would order an 80" Pyrex disc for the University of Texas Observatory. However, the final order will come through the instrument makers rather than from him and as yet we have not received this order. From present indications we would expect to receive orders for several additional discs within the next two years.

Thanking you for your hearty cooperation, and with kind personal regards, I remain

Sincerely yours,

(Signed) J. C. Hostetter
Director, Development & Research

JCH:FRF

JAN - 6 1933

CORNING GLASS WORKS
Corning, New York

November 29, 1932

Dr. George E. Hale
Astrophysical Observatory
California Institute of Technology
Pasadena, Calif.

Dear Dr. Hale:

Permit me to thank you for your kind letters of November 7 and 8 in which you have stated the policy of your group in regard to the use of equipment belonging to the California Institute of Technology in the production of telescope discs for others. This outline of policy answers the questions I discussed informally with Dr. Weaver, and clarifies the situation with reference to our negotiations with other observatories. As you undoubtedly know, there seems to be a live interest in large discs at the moment, and, since the Chicago-Texas group asked for an immediate quotation, your prompt expression of policy has been of real assistance to us.

At present it appears as though the Chicago-Texas disc must be made in the near future. The use of the annealing equipment for your 120 and 200-inch discs is therefore ruled out. The cleanest cut program then is that Corning build independent suitable equipment for the 81-inch disc, and it was on this basis that we submitted the quotation.

Referring to your specific questions on estimated costs, permit me to say that since receipt of your letter of October 4 we have reviewed our costs, and our program on disc production, from many angles, and believe that the figures presented below are sufficiently accurate for the purpose of setting up your budget accounts. In using these figures please keep in mind that they are estimates representing our best judgment with present information. They do not include any sums for possible failures but I believe that our technic is now sufficiently developed to have reduced the probability of failure considerably.

Our original estimate of \$150,000 to \$300,000 represented the minimum with 100 percent added for contingencies. My telegram of September 29 did not include the amount previously invoiced to you so that the total estimated at that time was roughly \$220,000 for the completion of the contract "assuming no grief." We are doing our utmost to keep within this total. However, discs of this size have never been made and the ribbed structure has added considerably to the problem, and, I may add, to the cost. All of us believe that the ribbed structure is sound and we hope that your tests at Pasadena will confirm this. It has added to the problem but with our experience gained with the 60-inch disc we believe that we will be well within the maximum of our original estimate and not greatly beyond the minimum.

For the balance of 1932 we estimate a cost, exclusive of
October billing, of ----- \$60,000

For the period Jan. 1 to June 30, 1933,
we estimate ----- 25,000

For the period July 1 to Dec. 31, 1933
we estimate ----- 35,000

The 200-inch disc will probably require
annealing throughout 1934 at an estimated cost of -- 25,000

Estimated total to complete, without
necessity of recasting either disc ----- \$145,000

Adding the amount billed to Oct. 18,
inclusive, \$46,000, gives an estimated total of
about ----- \$190,000

In the above estimate you have probably noted that the indicated annealing schedules are longer than those first estimated. We are contemplating a degree of annealing throughout the discs, with the exception of the extreme rims, equal to that considered "excellent" in our work on optical glass during the war; that is, strain-birefringence of 5 μ per cm. glass ~~either~~ path or less. Measurements on the 60-inch disc indicate about 3 μ throughout the disc with the exception of the rim where the strain is about 30 μ . We have carried out tests on the low-temperature annealing of Pyrex and have now established data permitting a more accurate determination of annealing schedules than hitherto possible. On these new schedules the 120 and 200-inch discs, at equal thicknesses of 16 inches, will require a total of 265 days for annealing and cooling. If the larger disc is made 20 inches thick, instead of 16 inches, the time required will be increased to a total of 420 days.

Trusting that the above information will serve your purpose,
and thanking you for your hearty cooperation, I remain, with kind regards,

Sincerely yours,

(Signed) J.C. Hostetter

Director, Development & Research

JCH:TRF

October billing, of -----
For the balance of 1933 we estimate a cost, exclusive of

we estimate -----
For the period Jan. 1 to June 30, 1933,

we estimate -----
For the period July 1 to Dec. 31, 1933

The 300-inch disc will probably require
annealing throughout 1934 at an estimated cost of --

Estimated total to complete, without
necessity of re-annealing either disc -----

Adding the amount billed to Oct. 15,
inclusive, \$46,000, gives an estimated total of

about -----
\$190,000

In the above estimate you have probably noted that the indicated
annealing schedules are longer than those first estimated. We are content
with the degree of annealing throughout the discs, with the exception of
the extreme rim, equal to that considered "excellent" in our work on optical
glass during the war; that is, at a single annealing of 5 days on glass
about 100 inches in diameter. Measurements on the 300-inch disc indicate about 5
days on the rim or less. The exception of the rim where the strain is about
throughout the disc with the exception of the rim where the strain is about
50%. We have carried out tests on the low-temperature annealing of Pyrex
and have now established data permitting a more accurate determination of
annealing schedules than hitherto possible. On these new schedules the
150 and 300-inch discs, at equal thicknesses of 16 inches, will require a
total of 845 days for annealing and cooling. If the larger disc is made
30 inches thick, instead of 16 inches, the time required will be increased
to a total of 420 days.

Trusting that the above information will serve your purpose,
and thanking you for your hearty cooperation, I remain, with regards,

Sincerely yours,

(Signed) J. C. Hostetter

Director, Development & Research

101:101

JAN 23 1933

JAN 24 1935

CORNING GLASS WORKS
CORNING, NEW YORK



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SALES DEPARTMENT
J. L. PEDEN
DIRECTOR OF SALES

January 13, 1933

EXECUTIVE COMMITTEE
ALANSON B. HOUGHTON
ALEXANDER D. FALCK
GEORGE B. HOLLISTER

Dr. Warren Weaver
Room 2701
61 Broadway
New York, N. Y.

My dear Warren:

It is a great pleasure to hear from you and I certainly shall take advantage of the invitation extended by Mary and you to visit you on my next trip to New York. Just when that will be is somewhat uncertain.

We are delighted at the prospect of a visit from you this month, particularly since the assembling of the equipment to make the 120" has taken more time than we anticipated. Just when we will be able to pour this disc is still uncertain but we doubt if we will be ready much before the 1st of March. We will be particularly glad to have you come so that we can talk over our program with you.

Unfortunately, I have promised to meet a group of General Electric men in Boston on the 24th and have to be in Syracuse early next week. I will be in Corning, however, from the 19th to the 23rd and will be here the week of January 30th. I hope it will be possible for you to come at a time when I am here but, if this is not convenient, both Dr. Hostetter and Dr. McCauley now expect to be in Corning until February and they would be glad to show you what we have done and what we hope to do.

Mrs. Gage asks if it would not be possible for Mary to come with you. We would be more than delighted to have you at our home and would be particularly glad if you could spend a weekend with us.

Cordially yours,

CORNING GLASS WORKS
Aviation & Optical Division

By

O. A. Gage

O. A. Gage
In Charge

OAG:FMM

JAN 23 1933

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JAN 24 1935

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January 12, 1933

Dear Mr. Gage:

We seem to have very poor luck in getting together when you are in New York. Mary and I would be very much pleased if, the next time you find it necessary to be in town for a couple of days, you would let us know in advance so that you can come out and stay with us and we can get a little chance to visit.

I have been expecting to hear from you relative to the probable date of pouring of the 120". I am expecting to be out of the city for the first half of February, and I would rather like to run over to Corning sometime during the remaining portion of this month.

Very cordially,

WARREN WEAVER

Mr. O.A. Gage
Corning Glass Works
Corning, N.Y.

WW:PH

JAN 24 1935

JAN 23 1933

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CORNING GLASS WORKS

CORNING, NEW YORK



SALES DEPARTMENT

J. L. PEDEN
DIRECTOR OF SALES

January 21, 1933

EXECUTIVE COMMITTEE

ALANSON B. HOUGHTON
ALEXANDER D. FALCK
GEORGE B. HOLLISTER

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Dr. Warren Weaver,
The Rockefeller Foundation,
61 Broadway,
New York, N. Y.

My dear Warren:

We are very much disappointed here at Corning that you plans and mine did not coincide so that we could have the pleasure of seeing you some time in January.

For about two months the General Electric Company has been trying to arrange a conference at West Lynn and the appointment finally was made for Tuesday next week. If this trip had been a routine business trip I could have changed my plans but, since it was a definite appointment, this could not be done.

There seems to be a "hoodoo" on your trips to Corning and I certainly hope that next time we will be successful in having you reach here.

Cordially yours,

Amos Gage

OAG:FMM

JAN 23 1933

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JAN 24 1935

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January 16, 1933

Dear Mr. Gage:

Thank you for your letter of January 13.

It is not possible for me to be away from the office this week, and I am planning to leave New York, for about fifteen days, on Thursday, January 26, so it seems clear that I had better not try to come to Corning just now.

I am planning to be back by the 8th or 10th of February, so that I think I would like to plan to come over, around the first of March, when you are ready to pour the 120".

In the meantime, be sure to keep in mind the suggestion that you are going to visit us as soon as possible. It would be a very great pleasure to us if Mrs. Gage could come along and spend a few days with us. Won't you urge this on her very strongly?

Yours sincerely,

WARREN WEAVER

Mr. O. A. Gage
Corning Glass Works
Corning, New York

WW:PH

GENERAL EDUCATION BOARD
INTER-OFFICE CORRESPONDENCE

G.E.B. No. 368
January 23, 1933

Pursuant to authorization from the Executive Committee on January 20, 1933, the executive officers hereby release the following appropriations and instruct the Secretary to write suitable letters covering said releases and other matters mentioned below:

1 - West Virginia University, Morgantown, West Virginia

Granted an extension of time from December 31, 1932 to December 31, 1933 in which to secure subscriptions on account of the Board's conditional agreement No. 402, dated December 18, 1928.

2 - Wiley College, Marshall, Texas

Granted an extension of time from December 31, 1933 to December 31, 1933 in which to secure subscriptions and from December 31, 1932 to December 31, 1934 in which to collect subscriptions on account of the Board's conditional agreement No. N-73, dated July 16, 1928.

3 - California Institute of Technology, Pasadena, California

\$175,000, or as much thereof as may be needed, for the Astrophysical Observatory.

4 - Emergency aid to Negro schools and colleges. Outright grants totaling \$9,500 to the following institutions for current expenses, particularly for payment of teachers' salaries, for the school year 1932-1933:

Florida Normal and Industrial Institute, St. Augustine, Florida	\$ 3,000
Snow Hill Normal and Industrial Institute, Snow Hill, Alabama	1,500*
Talladega College Talladega, Alabama	2,500
Virginia Union University Richmond, Virginia	2,500

*payable in accordance with Secretary's letter of notification dated January 24, 1933.

5 - Boy Scouts of America, New York, New York

\$7,500 for use by the Inter-racial Committee in conducting Scout Work among special racial groups for the year commencing January 1, 1933.

6 - National Council of Teachers of English

\$2,000, or as much thereof as may be needed, for expenses of holding a Conference of Committee on Report of Teaching of English in American Colleges and Universities preparatory to its publication.

7 - Association of Colleges and Secondary Schools of the Southern States

\$11,000, or as much thereof as may be needed, for the year beginning August 16, 1933, for salary, travel, stenographic assistance and incidental expenses of a person to serve as Visitor and Adviser to institutions for Negroes to be accredited by the Association.

8 - University of Chicago, Chicago, Illinois

Granted a moratorium on its obligation to provide funds toward the support of the School of Education during the fiscal year 1933-1934 as agreed to when the Board made its appropriation to the University of \$1,500,000.

Approved W. W. BRIERLEY
Secretary

D. H. STEVENS
Vice-President

TREVOR ARNETT
President

JAN 26 1933

1103.1

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AG17		Bea	

January 23, 1933

My dear Doctor Hale:

At a meeting of the Executive Committee of the General Education Board held January 20, the officers presented your letter of December 22, 1932, submitted on behalf of the Observatory Council of the California Institute of Technology, requesting the release of funds for the Astrophysical Observatory during the period January 1 to December 31, 1933. The Committee observed that the budget for this year would require approximately \$223,000 toward which could be applied an unexpended balance of about \$55,440.47 from 1932.

I desire to inform you that the Committee acted favorably on your request and released to the Board of Trustees of the California Institute of Technology a further sum of \$175,000, or as much thereof as may be needed, for this undertaking.

The Auditor will make arrangements for payment.

A copy of this letter is being sent to Doctor Millikan for his information.

Sincerely yours,

W W BRIERLEY

Doctor George E. Hale
California Institute of Technology
Pasadena, California

WWE:KEO

1103.1

CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA

ASTROPHYSICAL OBSERVATORY

January 30, 1933

Mr. W. W. Brierley
Secretary, General Education Board
61 Broadway
New York.

W.W.B.	FEB 3 1933	
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My dear Mr. Brierley:

I have just received your letter of January 23, informing me that the Executive Committee of the General Education Board, at its meeting held on January 20, released to the Trustees of the California Institute of Technology a further sum of \$175,000, or so much thereof as may be needed, for the Astrophysical Observatory during the period January 1 to December 31, 1933. This amount, as you state, is available to meet an estimated budget of about \$223,000, with the aid of an unexpended balance of about \$55,440.47 carried over from 1932.

Trusting that you will express to the officers and other members of the Executive Committee our great appreciation of their continued confidence and support, I am

Yours very sincerely,

George E. Hale

GEH:G

FEB - 7 1933

CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA

NORMAN BRIDGE LABORATORY OF PHYSICS

W.W.B.	FEB 6 1933	1103.1
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	February 2, 1933	

Mr. W. W. Brierley
General Education Board
61 Broadway
New York City

Dear Mr. Brierley:

I am writing to acknowledge receipt of your letter of January 23rd with the enclosures, and to express the deep appreciation of the officers and trustees of the Institute for the action of the General Education Board.

Sincerely yours,

Robert A. Millikan

RAM:IH

JAN 26 1933

1103.1

January 23, 1933

Dear Doctor Millikan:

I am sending you herewith for your information copy of a letter which has been forwarded to Doctor Hale concerning the General Education Board's release of funds for the year 1933 for the construction of the Astrophysical Observatory, including a 200-inch reflecting telescope at the California Institute of Technology.

Sincerely yours,

W W BRIERLEY

Doctor Robert M. Millikan
California Institute of Technology
Pasadena, California

KEO

1103.1

CARNEGIE INSTITUTION OF WASHINGTON

Geophysical Laboratory
WASHINGTON, D. C.

mm	2/28	mm	3/14
ww		ww	
ADDRESS			
2801 UPTON STREET			

ARTHUR L. DAY
DIRECTOR

February 25, 1933.

Personal

Doctor Max Mason, President,
Rockefeller Foundation,
61 Broadway,
New York City, N. Y.

Dear Doctor Mason:

In view of the fact that sometime ago I gave you rather definite assurance that Corning would be ready to pour the 120" disc about March 1st, it is incumbent upon me to advise you that there will be some further delay. I spent yesterday and the day before in Corning and have a number of details to report to you, some of which I am sure will please you.

First, in regard to the delay in the schedule, I think I wrote you at the time that the lift which is to handle both of the large discs, although contracted for October delivery, did not actually reach Corning until after the first of the year. Even then it was thought that March first would see the erection completed, the mold prepared and everything in readiness for pouring. It has in fact proved to be a considerably longer task.

The plan was (and is) to erect the lift, the pouring and annealing furnaces, for the 200" disc at this time and to use them without further change first for the 120" disc and then for the 200" disc. This plan would eventually save some time and also the cost of two separate installations. The trouble now arises only from the fact that the task of erecting this heavy equipment has proved to be considerably greater than was anticipated and will require at least another month for its completion. It is unfortunate that the time factors in the program could not be more accurately forecast, but the delay after all is not very serious in view of the magnitude and novelty of the undertaking. Moreover there is reason to expect, as stated above, that a part of the delay will be caught up later. Then too, there are certain new reasons for believing that the later stages of the process may be further shortened.

This long period required for erecting the heavy equipment left certain members of the laboratory staff in a "flat spot", so to speak, while waiting for this equipment. They accordingly undertook two investigations which it was thought might yield something of advantage for the great disc.

The first of these was the quality of the surface to receive and hold its silver coating. It has been known in Corning for a considerable time that the surface of Pyrex varies somewhat with the heat treatment in the upper temperature zones (i.e. above the annealing temperature). To investigate this in some detail we asked Doctor Adams to furnish us accurate information regarding the kind, the strength and the time of exposure of the various solutions used in silvering. This was provided

promptly and various samples of the glass to which different heat treatments had been applied were put through this process of silvering and re-silvering with a view to demonstrating the optimum surface quality which could be obtained.

The second investigation arose from the disappointment which Doctor Hale expressed, as you will recall, when we decided to use standard Pyrex glass of expansion coefficient about 33 when it was known that we had developed other glasses with expansion coefficient something over 20 only. The obvious reason for this choice at the time was the very much more extensive experience with the behavior of standard Pyrex, which has long been regularly manufactured for chemical and other purposes as compared with the newly developed glasses which had never been made in great quantity or in large sizes. Furthermore, discs of standard Pyrex had been in use at Pasadena for a number of years in the solar telescope and elsewhere and had been uniformly satisfactory.

Notwithstanding the obvious pertinence of this reasoning the "flat spot" gave opportunity for, and indeed inspired, further work on these glasses of lower expansion and more careful tests of their physical properties, including this detail of depositing and removing the silver surface. In all of these tests the superiority of the new glass over the old was very clearly and quantitatively demonstrated. The new glass has also been tried out for stability at the mold contacts and the other details of technique which had been developed for the 60" disc and in all of these also its superior quality was clearly shown. The danger of devitrification is also so much smaller with the new glass as to amount to a different order of magnitude. There is hardly a possibility of producing devitrification in it during any reasonable time of exposure at the higher temperatures.

When all these facts were brought together at our conference yesterday it was concluded that these advantages were so considerable that we should assuredly fail in our duty to this problem if we did not make the effort to use this glass. Of course disadvantage lies in the fact that it must be melted in a special tank set aside for this purpose alone, but the additional cost thereby involved is hardly of sufficient moment to weigh against the advantages named above.

I think it will therefore please you to learn that a new glass of Pyrex type will be substituted for standard Pyrex in the remaining discs for the following reasons:

1. Its expansion coefficient is about 23 instead of 33, which in addition to the obvious advantages will reduce the annealing time by about 1/3rd.
2. Its chemical surface stability is so much greater than the older glass that re-silvering can be applied almost indefinitely without need for re-figuring the surface.
3. The danger of devitrification is eliminated.
4. Reducing the expansion coefficient by one-third not only reduces the annealing time in that proportion, but removes from the problem much of the sensitiveness and precise detail of the annealing operation and increases by that much the certainty of its success.

Doctor Max Mason,

-3-

February 25, 1933.

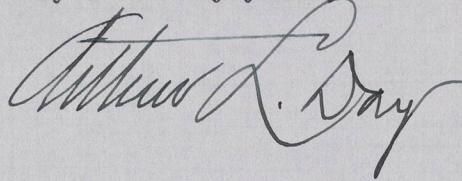
Indeed these advantages are so impressive and so fundamental to the success of the entire problem that I shall propose to Doctor Hale that we also cast a new 60" disc of this composition. This can be done in existing equipment alongside the large equipment without any loss of time and is, in my opinion, well worth while.

Personally I believe these results represent a distinct contribution by Corning to the success of the great disc and are sufficient I am sure to alleviate any impatience which may have been caused by the delays in erecting the heavy equipment.

I hope this news will please you.

With kind regards, believe me,

Very sincerely yours,

A handwritten signature in cursive script, reading "Arthur L. Day". The signature is written in dark ink and is positioned to the right of the typed name "ALD/E.".

ALD/E.

Copy for the
information of Dr. Mason.
Day

1103.1

February 27, 1933.

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Doctor George E. Hale,
California Institute of Technology,
Pasadena, California.

Dear Doctor Hale:

Sometime ago I suggested that Doctor Mason might enjoy the spectacle of the pouring of the largest disc hitherto attempted (the 120") and that he so arrange his engagements about March 1st that he could spend a day in Corning for that purpose. The event has proved that I am a very poor prophet in respect to the operations of riggers and boiler makers, whatever of success I might hope to have with a glass process. Accordingly I wrote Doctor Mason on Saturday to explain that the erection of the heavy equipment for the two large discs will take at least a month longer before we can even begin to place the mold for the 120" disc in position. The annealing furnace alone, which is beginning to take form, looks like one of the oil tanks which dot the California countryside.

We are very sorry indeed to tax your patience with such details which have the effect of delaying the consummation of your ambitions, but they seem to be an inevitable part of the process.

In this particular instance these details have contributed something of importance to the outcome, as I believe, and so after all should not be counted a net loss as you will see from the explanatory letter which I have sent to Doctor Mason and of which a copy is inclosed herewith. The details set forth therein represent real progress as I appraise it, and form an effective contribution to the ultimate success of the project.

I will not repeat in this letter the detailed steps which you may read in the letter to Doctor Mason, but I would like to assure myself that they have your approval and I would like to ask explicitly for authorization to withhold shipment of the 60" disc, which has been held at Corning awaiting your pleasure. In view of the distinct advantages possessed by the new glass in all the features esteemed most essential for the success of the great disc, I believe it would be much better economy to cast a replica of it out of the new glass than to expend a penny more on packing or shipping the present disc to California. Add to this the cost of figuring the disc and the probability that it will not withstand repeated re-silvering without re-figuring anything like the number of times that a long service will require, and is in this respect distinctly inferior to the new glass of low expansion coefficient just developed, and I think you will agree with me that it will be better to make the change now.

Doctor George E. Hale,

-2-

February 27, 1933.

The 60" casting and annealing equipment is still intact and when the new glass is ready for pouring the 120" disc a 60" disc can also be poured with little additional effort and no loss of time.

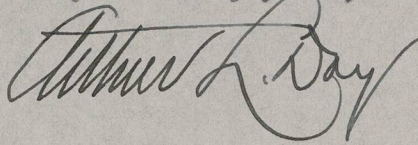
With this procedure I shall feel quite secure in my belief that everything has been done which can be done to furnish to you the most competent astronomical discs which can be made in the present stage of development of the glass art.

I shall be glad to hear your reaction to this proposal at an early date, particularly in view of the fact that Dr. Anderson is already in correspondence with Corning regarding shipment of the 60" disc.

I venture to hope that you also will be much pleased with the change to a glass from which the danger of devitrification in large masses is eliminated, which has a very much lower expansion coefficient and which can be effectively annealed in a shorter time and with less effort.

With kind regards, believe me,

Very sincerely yours,



ALD/E.

MAR 25 1933

Copy for Dr. Mason.

1103.1

March 2, 1933

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Doctor Arthur L. Day
Geophysical Laboratory
2801 Upton Street
Washington, D.C.

Dear Doctor Day:

I am delighted to receive your letter of February 27, and hasten to send ~~you~~ my hearty congratulations to you and your associates on the latest progress of your work. It will be a very great advantage to use for our mirrors a glass possessing all of the new and important properties you enumerate, and I think no one can question the advisability of the proposed change from ordinary Pyrex. Your letter amply indicates your complete conviction regarding the reliability of the low expansion glass, and we therefore assume that the tests made since last autumn settle the matter beyond the peradventure of a doubt. The lower expansion and the reduced annealing time are attractive enough, but I am impressed most of all by the confidence with which you state to Dr. Mason that "the danger of devitrification is eliminated". As for the matter of repeated silvering, as we have had no trouble with Pyrex after ten years of use in the solar telescopes, we certainly fear nothing from a glass in any degree superior in this respect. Surely the delay in completing the hoisting machinery has proved to be a fortunate thing for us, especially as the loss in time will be more than compensated because of the shortened annealing period.

As we work under a budget periodically presented to Dr. Mason and the General Education Board, I should like to secure their approval in advance of any change in our estimates due to the use of a separate furnace for the new glass, or to other reasons involved in the new plan.

Please hold the 60-inch disc, at least for the present, but be kind enough to send the 26-inch solid disc as soon as possible, as we are moving today into our new Optical Shop and wish to begin work on it very soon.

I may add that an entirely new and remarkably promising design for the 200-inch mounting, if adopted, will probably enable us to use a convex mirror of about 40 inches aperture instead of the 60-inch.

With kindest regards,

Yours very sincerely,

GEH:G

(Signed) George E. Hale

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March 14, 1933.

Dear Dr. Day:

I was very much interested in reading your letter of February 25th, which reached New York while I was away.

There are certainly compensations for everything, and if the slight delay which was caused by the hoisting apparatus has resulted in producing such corking research as the Corning group have done on the new glass, I think we ought seriously to consider a little sabotage at Corning in the interest of science. It is fine to know you consider that the danger of devitrification is completely removed, and to be able to have a glass of such low expansion coefficient with higher surface stability and much lower annealing time is a great piece of progress.

This recalls your kindness in saying that you might try on a small piece of glass the effect on annealing time of sonic or supersonic vibrations. If you have been able to have such a test made, I should be immensely interested in the outcome.

With hearty congratulations on the new glass, I am

Cordially yours,

MAX MASON

Dr. Arthur L. Day,
Geophysical Laboratory,
2801 Upton Street,
Washington, D.C.

MM:AEB

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March 25, 1933

Dr. George E. Hale
 Astrophysical Observatory
 California Institute of Technology
 Pasadena, Calif.

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Dear Dr. Hale,

Referring to your recent request for a revised estimate of the cost of the telescope disc, we have now had an opportunity to go into this subject thoroughly, and in this review we have also had the benefit of Dr. Day's advice and counsel. As you know he is intensely interested in this development project and his advice has been of great benefit to us.

To melt a special glass of an expansion lower than Pyrex will add somewhat to the cost of the project, because it will be necessary to bring in a melting furnace for this specific job. Furthermore, the melting conditions will be somewhat different and more costly. These factors will tend to increase the cost of the discs but, on the other hand, there is a partially compensating advantage with the use of the lower expansion glass in that the time of annealing will be cut down by a good margin. After weighing the various factors involved, we have revised the estimate as given to you in our letter of November 29, 1932, as follows:

As presented there we estimated an expenditure for the year 1932 of approximately \$114,500. As of March 1 we have billed approximately \$108,000, indicating that we are approximately two months behind our schedule, as indeed is the case because of the delay in receiving the large hoisting equipment. We believe that the billing for March and April will include the last major expenses for equipment. From then on operating charges such as casting and annealing, will represent the main expenditures.

Dr. George E. Hale, Page 2, March 25, 1933

Referring again to our letter of November 29, and also our telegram of September 29, 1932, we gave you estimated maximum costs of \$190,000 and \$220,000 respectively. With the extra expense due to the development of a new glass for this purpose, we believe that the latter figure of \$220,000 should be increased by approximately \$10,000 to \$15,000. There is, however, still the possibility of meeting the first figure of \$190,000. If we have no unusual "grief" we are inclined to believe that the figure of \$190,000 may cover the cost of the entire project, but for purposes of revising your budget, I would suggest at this time the maximum of \$235,000 as a probable upper limit.

Thanking you for your cooperation, and with kind personal regards, I remain

Sincerely yours,

J.C. Hostetter
Director, Development & Research

JCH:FRF

cc- Messrs. A.L. Day
Max Mason
O.A. Gage
G.V. McCauley

MAY 10 1933

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CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA

ASTROPHYSICAL OBSERVATORY

April 5, 1933

Dr. Max Mason
President Rockefeller Foundation
61 Broadway
New York.

Dear Mason:

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WWS		MB	

The Observatory Council met yesterday to consider the enclosed letter from Dr. Hostetter. You have doubtless received Dr. Day's letter on this very desirable new glass and a copy of my reply, so I need not emphasize the great advantages offered by this material for the large discs.

In view of these advantages and of the fact that we can arrange to keep within our approved budget for 1933, and probably to make savings sufficient to balance such possible increase of expense as Dr. Hostetter mentions, I have requested him to use the new glass in place of Pyrex.

Feeling sure that you will agree with this decision, which was unanimously approved by Dr. Adams, Dr. Anderson and all members of the Observatory Council, and with best regards,

Yours very sincerely,

GEH:G

G. E. Hale

MAY 10 1933

7103.1

COPY

CORNING GLASS WORKS
Corning, New York

March 25, 1933

Dr. George E. Hale
Astrophysical Observatory
California Institute of Technology
Pasadena, Calif.

Dear Dr. Hale:

Referring to your recent request for a revised estimate of the cost of the telescope disc, we have now had an opportunity to go into this subject thoroughly, and in this review we have also had the benefit of Dr. Day's advice and counsel. As you know he is intensely interested in this development project and his advice has been of great benefit to us.

To melt a special glass of an expansion lower than Pyrex will add somewhat to the cost of the project, because it will be necessary to bring in a melting furnace for this specific job. Furthermore, the melting conditions will be somewhat different and more costly. These factors will tend to increase the cost of the discs, but, on the other hand, there is a partially ~~xx~~ compensating advantage with the use of the lower expansion glass in that the time of annealing will be cut down by a good margin. After weighing the various factors involved, we have revised the estimate as given to you in our letter of November 29, 1932, as follows:

there

As presented we estimated an expenditure for the year 1932 of approximately \$114,500. As of March 1 we have billed approximately \$108,000, indicating that we are approximately two months behind our schedule, as indeed is the case because of the delay in receiving the large hoisting equipment. We believe that the billing for March and April will include the last major expenses for equipment. From then on operating charges such as casting and annealing, will represent the main expenditures.

Referring again to our letter of November 29, and also our telegram of September 29, 1932, we gave you estimated maximum costs of \$190,000 and \$220,000 respectively. With the extra expense due to the development of a new glass for this purpose, we believe that the latter figure of \$220,000 should be increased by approximately \$10,000 to \$15,000. There is, however, still the possibility of meeting the first figure of \$190,000. If we have no unusual "grief" we are inclined to believe that the figure of \$190,000 may cover the cost of the entire project, but for the purposes of revising your budget, I would suggest at this time the maximum of \$235,000 as a probable upper limit.

Thanking you for your cooperation, and with kind personal regards,
I remain

Sincerely yours,
(Signed) J. C. Hostetter
Director, Development & Research

JCH:FRF

cc- Messrs. A.L. Day
Max Mason
O.A. Gage
G.V. McCauley

MAY 10 1933

TBA

1103.1

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April 24, 1933.

Dear Hale:

Thank you for your letter of April 5th with the enclosed copy of Hostetter's letter regarding the new glass and the expansions. We, of course, are very happy that the dead time which the Corning people had because of the delay in the hoisting crane resulted in such a pronounced improvement. The extra expense is certainly not great.

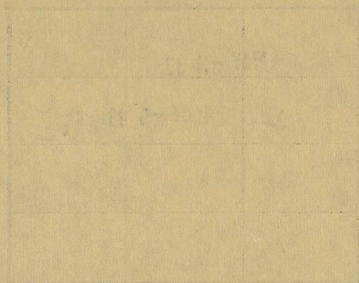
I know that you appreciate to the full the difficulty of the present financial situation on all the activities of the Foundation and the General Education Board, and that we can count upon the cooperation of the Observatory Council for every possible economy. Even with the background of 1928, the allocation of such large funds was looked upon as a highly venturesome procedure by many of the Trustees. There is not the faintest thought in anyone's mind of withdrawing from the enterprise, but in order that we may maintain this understanding and fine spirit of the Trustees, we must be able to report to them that in view of the extremely difficult financial situation unusual effort is being made by the Observatory Council to decrease the cost necessary for the completion of the telescope and auxiliary facilities.

With cordial greetings, I am

Sincerely yours,

Dr. George E. Hale,
California Institute of Technology,
Pasadena, California.

MAX MASON



HYDEMAN
BOYD
HAWTHORNE

6

MAY 7 1933

1103.1

CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA

ASTROPHYSICAL OBSERVATORY

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May 1, 1933		

President Max Mason
Rockefeller Foundation
61 Broadway
New York.

Dear Mason:

I am very glad to receive your letter of April 24 and assure you that we are making the most strenuous efforts to reduce the cost of the 200-inch telescope project.

Apart from the telescope mirrors, regarding which you are fully informed, the largest outstanding items are for the telescope mounting and dome and the mountain site and road to the summit. The model of the new type of mounting, which is so designed as to permit us to make mechanical tests to check the computations of our engineers on the deflections of the full-scale mounting in all positions under load, will soon be completed in our shop. If we decide to adopt it, as we greatly hope to do, the saving on mounting and dome should aggregate several hundred thousand dollars.

At the mountain site we hope to get the land free or at a very low figure, and to induce the county authorities to build a road to the summit without expense to us. Instead of putting up separate buildings for power-house and laboratory at this site, as we did at Mount Wilson, we expect to include facilities for all such local needs on the ground floor of the building carrying the dome for the 200-inch telescope, excepting a small pumping plant and some wooden cottages for the observers and care-takers. This should effect another large saving.

We have completed at low cost a very efficient optical shop, which is now in use for figuring the smaller mirrors and lenses. Our arrangements with the Carnegie Institution have given us the services of experienced men at low salaries. My own time has cost nothing to the 200-inch project. In general, except for our experience at Lynn, which everyone favored at the time, I doubt if we could have made better use of the funds allotted to us.

You may count on us to keep an eye to windward and to take advantage of any possibility of effecting further savings, especially as we appreciate so heartily the friendly attitude of yourself and your associates.

Yours very sincerely,

Guy E. Hale

GEH:G

MAY 11 1933

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May 8, 1933.

Dear Hale:

Thank you very much for your letter of May 1st which corresponds with the attitude we were sure you had, and which is very reassuring in regard to specific possibilities of savings. The tests on the new mounting will be very interesting.

I hope the reorganization of the National Research Council will prove as efficient and successful as it seems to promise now. I had an interesting talk with Bowman the other day, and judge that he is going to accept the position which has been offered to him.

Cordially yours,

MAX MASON

Dr. George E. Hale,
California Institute of
Technology,
Pasadena, California.

MM:AEB

MAY 16 1933

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May 9, 1933

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WWD		MM

Dr. George E. Hale
 Astrophysical Observatory
 California Institute of Technology
 Pasadena

Dear Dr. Hale,

I have been holding your courteous letter of April 6 authorizing the use of the new glass for your disc until we had a more definite schedule developed for the actual casting of the 120-inch disc. In the meantime we have continued our investigations of the new glass and have also been working on a somewhat different system of annealing, which should enable us to give you delivery of the 120-inch disc even though the actual casting will have been delayed somewhat beyond our original estimates.

We believe that our new glass is a very distinct advance for use in telescope discs. However, this has been very well described in Dr. Day's communication to you on this general subject. The higher melting temperatures have already caused us a little grief, and the last item of delay has been caused by the excessive temperatures necessitating a change in refractories after the tank furnace had been brought up to temperature. At the moment, therefore, this tank is undergoing reblocking with a different type of refractory, which we believe will stand the service under the high temperatures of operation.

To enable you to visualize a little more completely the type of equipment to be used for the casting and annealing of the 120-inch, and also the 200-inch discs, I am transmitting some photographs illustrating the equipment. You will see that the engineering on this project is quite the major portion of the job. The details have been developed practically in their entirety by Dr. McCauley. The annealer is a veritable maze of heating elements, thermocouples, and their connections. All the circuits have been thoroughly tested out and we anticipate no difficulty whatever from this part of the operation.

Now as to the method of saving some time during annealing, which I have mentioned above, you will recall that one of the advantages of the rib structure, mentioned in our initial discussions, was the probability of a reduced annealing time. This would obviously be the case if the rib structure as such were put through an annealing cycle calculated for the thickness of the ribs and top.

Dr. George E. Hale, Page 2, May 9, 1933

However, as we carried out the annealing process for the 60-inch disc, the characteristics of the ceramic mold were such that the total effect was essentially the same as annealing a solid disc. In the case of the 120-inch disc we are now making some laboratory tests to determine whether we cannot cast the disc in the ceramic mold already constructed, cool rather rapidly, remove the ceramic mold when the disc has reached room temperature, and then carry the disc through an annealing cycle based on its actual glass thickness. Dr. McCauley's calculations indicate that this will save considerable time, and, of course, we can assure you that the degree of annealing will be equal to that obtained by the other process. Furthermore, the lower expansion of the new glass will be an additional safety factor in the first cooling stage, which I have characterized as "rapid", but which, of course, will be carried out under carefully controlled conditions in the annealing kiln. At the present time we are checking the calculations, making some additional laboratory tests to indicate whether this is entirely feasible. If so it will maintain our delivery schedules, and probably even more important will enable us to determine in advance whether the disc is suitable for the job. In other words, if our inspection on the first cooling should indicate any defects, we will then be in a position to immediately cast another rather than wait for the longer period of annealing originally contemplated. On the same basis likewise the annealing time of the 200-inch disc will be curtailed considerably.

I have in mind to advise you at the earliest moment a definite time of casting the 120-inch disc. We are desirous of having Dr. Mason and Dr. Weaver here during the casting operations, and naturally, if you or any of your colleagues can be here, we would be grateful indeed for their presence.

Again thanking you for your continued cooperation, and with kind personal regards, I remain

Yours very truly,

J.C. Hostetter
Director, Development & Research

JCH:FRF

cc- Messrs. M. Mason ✓
A.L. Day
O.A. Gage
C.V. McCauley

JAN 24 1935

JUN 12 1933

mm - RLB ad 5/26

1103.1

May 24, 1933

Dr. George E. Hale
Astrophysical Observatory
California Institute of Technology
Pasadena, Calif.

Dear Dr. Hale,

Referring to your letters of May 9 and 15, I have just had an opportunity to discuss these in detail with our group, including Dr. Day, who happens to be in Corning this week.

Our records indicate that, including our invoice of April 19, you have been billed a total of approximately \$121,000. Recently you have been billed an additional sum of \$8,804.28. There will be construction expense throughout May, and there will be the expense of casting the 120-inch disc in June.

For the last six months of the year, however, the expense will be mainly for annealing, although we still have hope that, with our new plan for annealing, which takes advantage of the thin sections of the rib structure, we can complete the 120-inch disc and also cast the 200-inch before the end of the year. Summarizing the situation as we see it today, your budget allowance of \$45,000 should carry us through 1933, with the possibility of a slight deficit if the 200-inch disc is cast this year.

From the start we have realized the necessity for economy in this project, and will naturally continue the same policy. We have endeavored to use the material at West Lynn but the processes are so different that we were able to salvage but a small percentage of the total available.

We hesitate to state a definite day for casting the 120-inch disc, although as matters now stand this will take place on the weekend of June 23 to 26. However, this date may be changed by a week either way, and as soon as this has been determined, I will communicate with you and Dr. Mason.

Copy sent mm (com)

Dr. George E. Hale, Page 2, May 24, 1933

I wish to thank you very kindly for the references to the works of Couder. We will make an effort to obtain copies and I assure you that they will be studied with much interest.

Again thanking you for your fine cooperation, and with kind personal regards, I remain

Sincerely yours,

J.C. Hostetter
Director, Development & Research

JCH:FRF

cc- Messrs. A.L. Day
Max Mason ✓
G.V. McCauley
O.A. Gage

JUN 12 1933

1103.1

JAN 24 1935

W W	JUN -9 33	noted for W W
TA	JUN -9 33	J.A.
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May 26, 1935.

My dear Dr. Hostetter:

This will acknowledge and thank you in Mr. Mason's behalf for the copy of your letter of May 24th to Dr. Hale.

I notice you state that the casting of the 120-inch disc will probably take place on the week-end of June 23-26. In this connection I expect you will be interested to know that both Mr. Mason and Mr. Weaver are in Europe. Mr. Weaver expects to return about the first of July, and Mr. Mason later on in the month, probably around the 20th.

Yours very truly,

Secretary to the President.

Dr. J. C. Hostetter,
Corning Glass Works,
Corning, New York.

SEP 27 1933

Copy sent to TA 7/6
1103.1CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA

ASTROPHYSICAL OBSERVATORY

Mr. Trevor Arnett
President General Education Board
61 Broadway
New York.

Dear Mr. Arnett:

June 26, 1933
Ack RDE 7/11

a	T. A.	5 1933	Ja	7/25
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	WWS			
	DHS	JUL 26 33		

The casting of the 120-inch disc at Corning was witnessed by Dr. Theodore Dunham, Jr., one of the ablest members of our staff. The following extract from his letter will interest you:

"The casting of the 120-inch disc this morning (June 24) was a magnificent spectacle. Everything went exactly according to schedule, and when I left there was every indication that the disc would be satisfactory. Of course it was too soon to say, since the glass was still at 1250° inside the bee-hive furnace, but examination through three doors indicated that nearly all the bubbles had risen to the surface and that in two hours more the last significant bubble would be out of the way. Dr. Hostetter expected to remove the furnace at about 3 P.M., to let the disc cool to a dull red heat for 10 or 12 hours, and then to transfer it to the annealing oven tonight. The pouring began at 5 A.M., so that the entire process will probably occupy less than 24 hours.

"Everyone at Corning is very enthusiastic about the special glass used in this disc. As you must know, it has about the same amount of silica as laboratory Pyrex, but has more boric acid and less alkali, the result being to reduce the coefficient of expansion from 32 to 26, and to reduce noticeably the tendency to devitrification. They have not yet decided finally how long to allow for annealing. They are experimenting with a small model which will be tested for stress, and then an estimate of the necessary time for the 120-inch will be made, assuming that the required times will be proportional to the squares of the dimensions. They think it entirely possible that a month will suffice! This seems to me most surprising. I think they will try to push it as fast as possible. It almost makes one wonder whether to do so would be taking something of a chance. Of course I am in no position to have any opinion. I suppose their decision will be passed on by Dr. Day and others who can be relied upon. The present plan provides for only one cooling process, not a quick cooling followed by an annealing process such as you described to me recently. They hope to ship the disc by October at the latest.

"The Toronto disc (about 75 inches, I think) was cast on Thursday with a 7-inch hole, and appears to be very satisfactory so far. Being solid, it will require nearly three months for annealing. They hope to pour the 200-inch some time this summer (annealing it perhaps only three months), as soon as they remove the 120-inch from the annealing oven. All that is necessary is to build the larger mould and bee-hive furnace. Part of the present melt of glass will be used, but more will have to be added, and the furnace will have to be started three weeks before pouring the disc.

"I am much impressed with the steel table which holds the disc and its mould. The table is supported from below by four large screws operated by worm-gears which insure precision in raising and lowering. The table will be lowered

Mr. Trevor Arnett

-2-

June 26, 1933

away from the furnace tonight, run about 30 feet sideways and then raised to place the disc in the annealing oven. Dr. Hostetter does not trust a crane for such delicate work and thinks his experience with this table might be useful in designing equipment for the optical shop.

"Dr. Hostetter is anxious to cast all the secondary mirrors at the same time with the 200-inch, if possible, in order to avoid the great expense of heating the furnace a second time with another melt of this special glass. He would be glad to know how many discs will be required, by the end of July if possible. He may be able to do the Texas and Harvard discs at the same time".

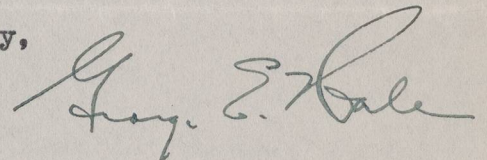
Dr. Day will be here tomorrow to discuss all questions regarding the glass, annealing time, etc.

It is a satisfaction to us to know that the appropriation by the General Education Board for the 200-inch telescope is proving so widely useful to astronomy. The development at Corning of the new low expansion glass, accomplished during the past winter, is of the greatest importance, because of its remarkable properties. It will be used, not only for the 200-inch reflector, but also for the 75-inch Toronto telescope, and for the large Harvard and University of Texas reflectors. In the same way all of our new accessory apparatus, which has already multiplied the efficiency of the 100-inch Mount Wilson reflector several fold, will do as much for these other instruments. Thus your generous gift, instead of advancing science merely through a single institution, will have a much broader range.

As I understand that Dr. Mason and Dr. Weaver have gone abroad, perhaps you may wish to send a copy of this letter to them for their information.

With kindest regards,

Yours very sincerely,



GEH:G

JUL - 7 1933

1103.1

ASB — PWB

July 6, 1933

My dear Dr. Hostetter:

I have just returned from Europe, and have been going over recent correspondence concerning the telescope project. I note in your letter of May 24 to Dr. Hale that you indicated the casting of the 120" disc would probably take place late in June or early in July.

It happens that I am planning to leave New York, driving west with my family, on Tuesday morning, July 11. The plans for our route are not definite, but I could probably stop at Corning for a few hours if the work was likely to be at an interesting stage at that time. I would greatly appreciate it if you would drop me a note letting me know how things stand at present.

According to most recent information, Mr. Mason sails from Europe on the Statendam on July 12 and is due to arrive here July 20.

Yours sincerely,

WARREN WEAVER

Dr. J. C. Hostetter, Director
Development and Research
Corning Glass Works
Corning, New York

WW:PH

July 25, 1933

Dear Dr. Hale-:

Your most interesting letter of June 26th has been sent to me here at Grand Beach, Michigan where I am spending the summer.

I am delighted with the apparently successful operation of casting the 120-inch disc and the enthusiastic reaction it produced from those seeing the spectacle. I am also pleased to learn of the many advantages which have resulted from the improvements in the accessory apparatus which have been designed in connection with this entire enterprise. My associates and I are eagerly looking forward to the complete success of the whole undertaking and it gives us much satisfaction that the Boards cooperated with you and your associates in helping to make it possible.

You have probably already heard from Dr. Mason and Dr. Weaver to whom copies of this communication of June 26th were sent.

With kindest personal regards, I am

Sincerely yours,

Dr. George E. Hale

California Institute of Technology

Pasadena, Calif.

TREVOR ARNETT

1103.1

CORNING GLASS WORKS

CORNING, NEW YORK



DEVELOPMENT
AND
RESEARCH
DEPARTMENT

July 7, 1933

EXECUTIVE COMMITTEE
ALANSON B. HOUGHTON
ALEXANDER D. FALCK
GEORGE B. HOLLISTER

Dr. Warren Weaver
General Education Board
61 Broadway
New York City

WW	7-7	WW	7-7
mm	SEP 25 33	mm	
TA		ga	

Dear Dr. Weaver,

Referring to your kind letter of July 6, let me assure you that we will look forward with pleasure to having you visit us on July 11 or 12 on your way west. The 120-inch disc was cast on June 24 and is now reposing safely in the annealing oven. However, we believe that the set-up is sufficiently interesting to warrant your visit here and would consider it a great favor if you would stop over and visit us.

We regret indeed that you were Abroad when the large disc was cast. However, Dr. Dunham, of Pasadena, was here, arriving in time to see the last ladle cast. As far as we can now tell the disc is successful and should turn out quite satisfactorily. //

Looking forward with pleasure to your visit here, and with kind personal regards, I remain

Yours very truly,

J.C. Hostetter
Director, Development & Research

JCH:FRF
cc- OAG
GVM

1103.1

mm	JUL 10 33	mm
TA	JUL 12 33	

July 10, 1933

Dear Dr. Hostetter:

Thank you for your prompt reply to my note.

I expect to spend Tuesday night, July 11, in Ithaca, and will come to Corning reasonably early Wednesday morning, July 12. We are planning to take the boat at Buffalo Wednesday evening, which requires our being there by five o'clock in the afternoon. I suppose, therefore, that we ought to plan to leave Corning by 12 o'clock, and I will accordingly plan to arrive at Corning between 9 and 9:30. I judge it is about an hour's drive from Ithaca.

I shall probably drive directly to Dr. Gage's home, where I shall leave my family. Dr. Gage and I can then come back to the Works together.

Very cordially,

Dr. J.C. Hostetter, Director
Development & Research
Corning Glass Works
Corning, N.Y.

WARREN WEAVER

WW:PH

OCT - 5 1933

1103.1

July 21, 1933

Dr. George E. Hale
Astrophysical Observatory
California Institute of Technology
Pasadena, Calif.

Dear Dr. Hale,

Just a few words to apprise you of the fact that no billing will be made to the California Institute of Technology for June. As you can well realize, there are certain accounting matters that come up for consideration both in July and in January that result in adjustments of various kinds, and because of this fact we prefer to combine June billing with that of July. However, the costs on your project for June are definitely in line with the information contained in my telegram of July 6. The balance of your budget should carry the project safely through the remaining months of 1933.

The automatic regulation of the annealing schedule on the large disc is running smoothly and there is really nothing more to report than that all is going well. We are awaiting details from your department in regard to the design of the 200-inch disc, and also the sizes and characteristics of any smaller discs which you may need. As soon as details for the 200-inch disc have been approved, we would like to start making the ceramic parts for the mold. I presume that Dr. Day may have some information on these points, and inasmuch as I believe he will return to Washington next week, we will probably soon have an opportunity to review the situation with him.

With kind regards and best wishes, I remain

Yours very truly,

J.C. Hostetter
Director, Development & Research

JCH:FRF

cc- Messrs. Mason, Day, Gage, McCauley, Hilbert

MM JUL 24 33
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Copy for Dr. Mason
sent by G.E. Hale

1103.1

mm	SEP 25 '33	mm
ww	OCT -9 '33	PH
FBH	OCT 13 '33	FBH
WW	OCT 14 '33	WW

BRITISH SCIENTIFIC INSTRUMENT RESEARCH ASSOCIATION

Director of Research

Sir Herbert Jackson, K.B.E., F.R.S., F.I.C.

Secretary,

J. W. Williamson, B.Sc.

26, Russell Square,
London, W.C.1.

July 25th, 1933

Professor G. E. Hale, For.Memb.R.S.,
Mount Wilson Observatory
Pasadena, Ca.

My dear Hale,

I am glad to be able to report that Mr. Bracey has completed the exploratory and fundamental analysis which was necessary for him to make certain that he could produce the design of a homogeneous immersion lens for use as an Astrospectrographic object-glass. Three types of design which appeared to be promising were in his mind. He investigated these analytically and found that one type appeared to offer a practicable solution to the problem. As you will readily understand, it has been a lengthy business to carry out all the calculations involved.

The detailed investigation of lenses of this design was then entered into and Mr. Bracey has now calculated a system which brings light of wavelength 4341 A.U. centrally on the photographic plate, which gives a flat field for light between the limits 4000 A.U. and 5500 A.U., which is practically free from coma, spherical aberration and chromatic aberration both for axial rays and also for rays at a considerable obliquity from the axis, and which has an aperture such that the lens should be over $2 \frac{1}{4}$ times as rapid as the 32 mm. focus Rayton lens.

I am enclosing some notes on the design of the lens. You will gather from the notes that if the constants of the prisms to be used with the lens are not the same as those which Mr. Bracey has deduced from the publication No.400 of the Mount Wilson Observatory, some slight adjustment will have to be made, but this will not mean any lengthy work. Some slight adjustment of the lens will be required also if it is desired to use light other than of wavelength 4341 A.U. passing axially through the lens, otherwise the plate will have to be used in a slightly tilted position. We have earmarked certain glasses which will be suitable for the production of the lens and we have the full constants of those glasses.

The practical question, assuming after consideration of the notes that you wish to have the lens made, is where it should be made? My own feeling is somewhat strongly in favour of having it made in this country so that Mr. Bracey may be in a position to look after its construction and to test it when it is a completed object-glass. Wherever it is made, it would be as well, before proceeding with the making of the lens, to let him have details of the optical properties and dimensions of the prisms, and the positions in which they are to be used, the object being that Mr. Bracey can be quite sure that his deductions with regard to the properties of the prisms are correct, and that if not, he can make the adjustment which will

July 25th, 1933

enable the lens properly ~~xxx~~ to fulfil its purpose.

It may seem rather a long time since it was decided to take up the question of this lens, but this feeling disappears when one realizes the very large amount of work which has been involved in the analytical investigation of the various types of design considered, since, in order to produce a lens of such unusual corrections, it was necessary to take into account, and to control, aberrations of the higher orders which are negligible in the designing of ordinary lenses. The calculation of the lens system, after the principles of a suitable design had been worked out, though lengthy and involved, does not, in my opinion, represent the most valuable part of the work which Mr. Bracey has done. I consider that the most praiseworthy part of the whole investigation has been the skill and ingenuity which he has shown in solving problems arising from the embarrassing departure of rays from the path which in any ordinary lens one would have been right in expecting them to follow.

I hope you have been keeping well and that there may be a chance of your coming to London before very long. After July 31st I am handing over the directorship of the British Scientific Instrument Research Association to Dr. Harry Moore, whom you met here. I have had the compliment of being asked to continue in a consultative capacity, so that I shall still have the pleasure of hearing of the progress and activities of the Research Association.

With affectionate greetings and every kind wish,

Ever yours sincerely,

(Signed) Herbert Jackson

NOTES ON THE DESIGN OF AN ASTROSPECTROGRAPHIC OBJECT-GLASS

OF N.A. 1.43 (EQUIVALENT TO $f/0.35$).

The design of this system has been worked out on the plan which was briefly outlined in the notes sent to Professor Hale on December 23rd, 1932. As a guide in the designing of the lens system an analysis was made of the conditions which must be satisfied, by the prism and lens combined, in order that the images of the collimator slit formed by light of various wavelengths should lie in one plane.

It has been assumed that the lens would be used with the prism system described in the publication "Contribution from the Mount Wilson Observatory No. 400". The directions at which light of various wavelengths would travel after emerging from the prism have been calculated as accurately as could be done from the information given in that publication.

The lens system has been designed on the assumption that light of wavelength 4341 Å.U. passes axially through the lens system.

In the preliminary consideration of the design an analysis was made of the properties required in the lens system to achieve the results outlined above. This analysis has proved a very useful guide in working out the design in detail.

In the design of a lens of the type under consideration, three properties of the lens and its associated prism system are of particular importance: these are

(1) Variation of position of axial focal plane with change of wavelength of the transmitted beam:

(2) Curvature of the field of the lens and, in particular, curvature of the tangential astigmatic field.

(3) Variation of the direction of the beam emerging from the prism system with change of wavelength, and the corresponding variation of obliquity with wavelength of the rays passing through the lens system.

Expressions have been developed by which each of these relations can be expressed as functions of wavelength. Examination of the expressions obtained shows that it is possible to balance these properties against each other in such a way that the system can be compensated so as to bring the images of the collimator slit formed by the lens for light of wavelength ranging from 4000 Å.U. to 5500 Å.U. all into one plane within very small limits.

It was considered sufficient to flatten the field to such an extent that the images would lie in one plane to within ± 0.005 mm. It was assumed that this could be taken as the effective thickness of the photographic ~~film~~ film. If it should be desired to flatten the field a little more, this could be done by modifying the lens to some extent, such as by using a Flint glass of a higher refractive index for the front lens.

The system has been compensated in such a way that with a beam of light of wavelength 4341 Å.U. passing axially through the lens, the photographic plate would lie at right angles to the axis of the lens. If it is desired to transmit light of some wavelength other than 4341 Å.U. axially through the lens, the photographic plate must be tilted so as to lie not precisely at right angles to the axis of the lens.

The system has also been calculated on the assumptions described above relating to the magnitude of the dispersion given by the prisms. If the angular dispersion of the prism system is greater than that assumed, the focal surface of the lens will be concave towards the lens, and vice versa.

If it is desired to use the lens with light other than wavelength 4341 Å.U. passing axially through it, but to keep the photographic plate at right angles to the axis, or if the angular dispersion of the prism system is other than that for which the lens has been computed, the design can be modified if the requirements are precisely stated, provided the conditions under which it is desired that the lens should be used are not greatly different from those assumed in making the calculation.

The type of correction which has been achieved is indicated diagrammatically in the attached sketch.

It is anticipated that this lens on account of its increased aperture will have a rapidity 2.35 times as great as the 32 mm. focus Rayton lens after allowing for the additional losses due to internal reflection and the additional absorption due to the increased number of components.

With regard to the lens itself one or two points call for comment.

The photographic plate with its glass side towards the lens is to be brought into optical contact with the front lens by means of a fluid (a suitable mixture of Xylene and Monobromnaphthalene is given in the specification). The photographic plate, front lens and fluid are to form an optically homogeneous system, i.e. the refractive index of the photographic plate is to be about 1.624 for λ 4341 Å.U.; the dispersion of the glass of the photographic plate should not have any appreciable effect. If the plate is made somewhat thinner than the thickness specified a fluid-filled space would be left between it and the front lens; this might be useful if the plate is to be tilted so as not to be perpendicular to the optical axis of the lens.

The design of the lens has been carried out so as to remove coma, spherical aberration and chromatic aberration as completely as possible along the axis of the lens and also at a considerable obliquity from the axis.

The remaining point of interest is the front lens. Light proceeding along the axis of the object-glass enters the surface of the front lens normally at all points, and if the centre of curvature of the curved surface of the front lens be maintained at a fixed point (the focal point) then varying the radius of the front lens has no effect whatever on the axial corrections of the lens. This variation will however profoundly modify the curvature of field of the complete object-glass and indeed affords the only means of controlling it satisfactorily.

The full specification of the lens is given in the following table. In the table the values are given as calculated to give full correction; it is not suggested that accuracy of the order indicated could be obtained in manufacture.

SPECIFICATION OF AN ASTROSPECTROGRAPHIC OBJECTIVE

Numerical Aperture 1.43.

f/0.35.

<u>No. of Lens.</u>	<u>Radius of Curvature of 1st surface</u>	<u>Radius of Curvature of 2nd surface</u>	<u>Thickness of Lens.</u>	<u>Distance to follow - ing lens</u>	<u>Radius of Aperture required at 1st surface</u>	<u>Particulars of glass to be used</u>
1	+3.22	+2.688	1.12	0.00	0.98	No. 1.
2.	-2.688		0.35	0.112		No. 2.
3.	+3.22	+2.688	1.12	0.00	0.84393	No. 1.
4.	-2.688		0.35	0.014		No. 2.
5.	+1.54		0.9120923	0.0162581	0.62892	No. 1.
6.	+0.392	-0.5236	0.1291493	0.0028010	0.33466	No. 1.
7.	+0.20804	-0.2086	0.1378234	0.1106		No. 1.
8.	+0.098		0.0728			No. 3.

Thickness of Photographic Plate 0.0252
Equivalent Focus 0.687 i.e. 17.45 mms.

All dimensions are given in inches unless otherwise specified.

A positive sign indicates a convex curve.

A negative sign indicates a concave curve.

Lenses (1) and (2) are cemented together.

Lenses (3) and (4) are cemented together.

Glass No. 1. is a Fluor Crown, No. 2 is an Extra Dense Flint and No. 3. is a Dense Barium Crown.

OPTICAL CONSTANTS OF GLASSES

<u>Glass No.</u>	$\lambda =$	<u>5461 A.U.</u>	<u>4861 A.U.</u>	<u>4341 A.U.</u>	<u>4047 A.U.</u>
1		1.49602	1.49932	1.50336	1.50641
2		1.65571	1.66480	1.67664	1.68610
3		1.61339	1.61808	1.62391	1.62831

Fluid for making contact between Front Lens and Glass side of Negative

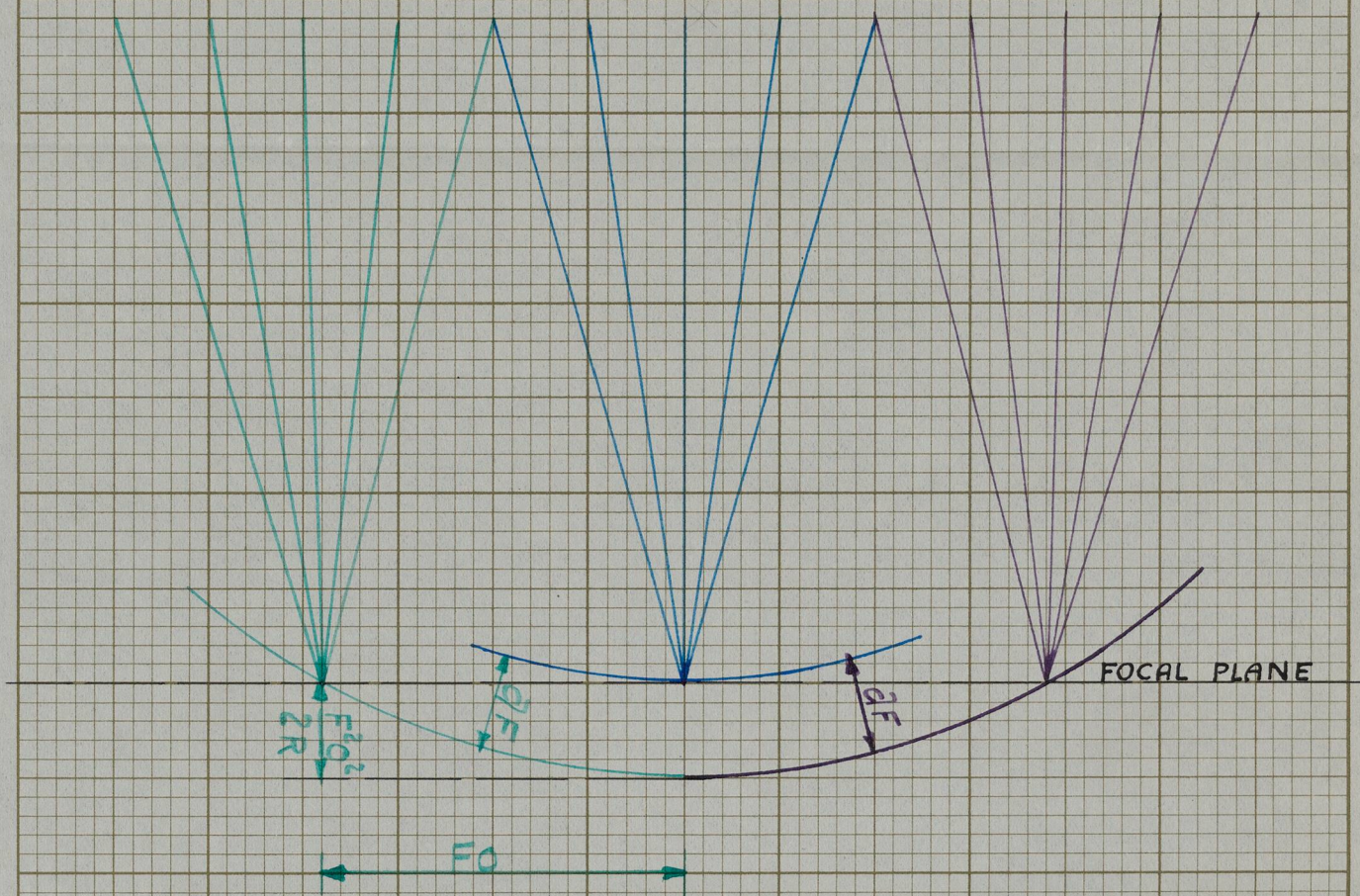
A mixture of Xylene and Monobromonaphthalene

31 percent by weight of Xylene
69 percent " " " Monobromonaphthalene

The refractive index of the glass which forms the photographic plate

should approximate fairly closely to the refractive index of the front lens, i.e. lens No. 8.

Diagrammatic Sketch showing the quantities involved and
methods of correction mentioned in the previous pages.



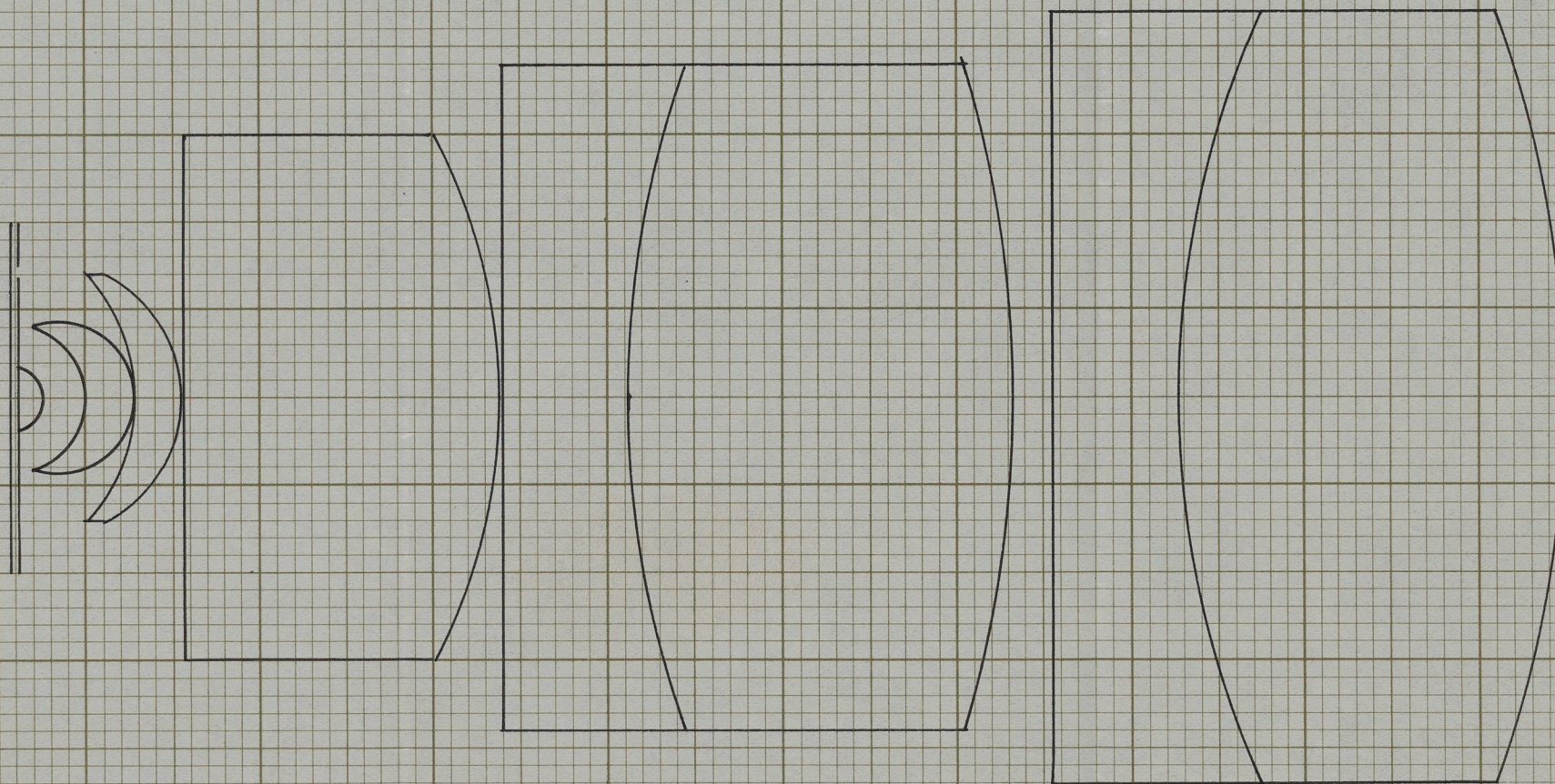
The arcs of circles are the tangential astigmatic focal
surfaces, the surface for blue light being nearest the lens
and the surfaces for green and violet exterior to the blue.

$f/0.35$

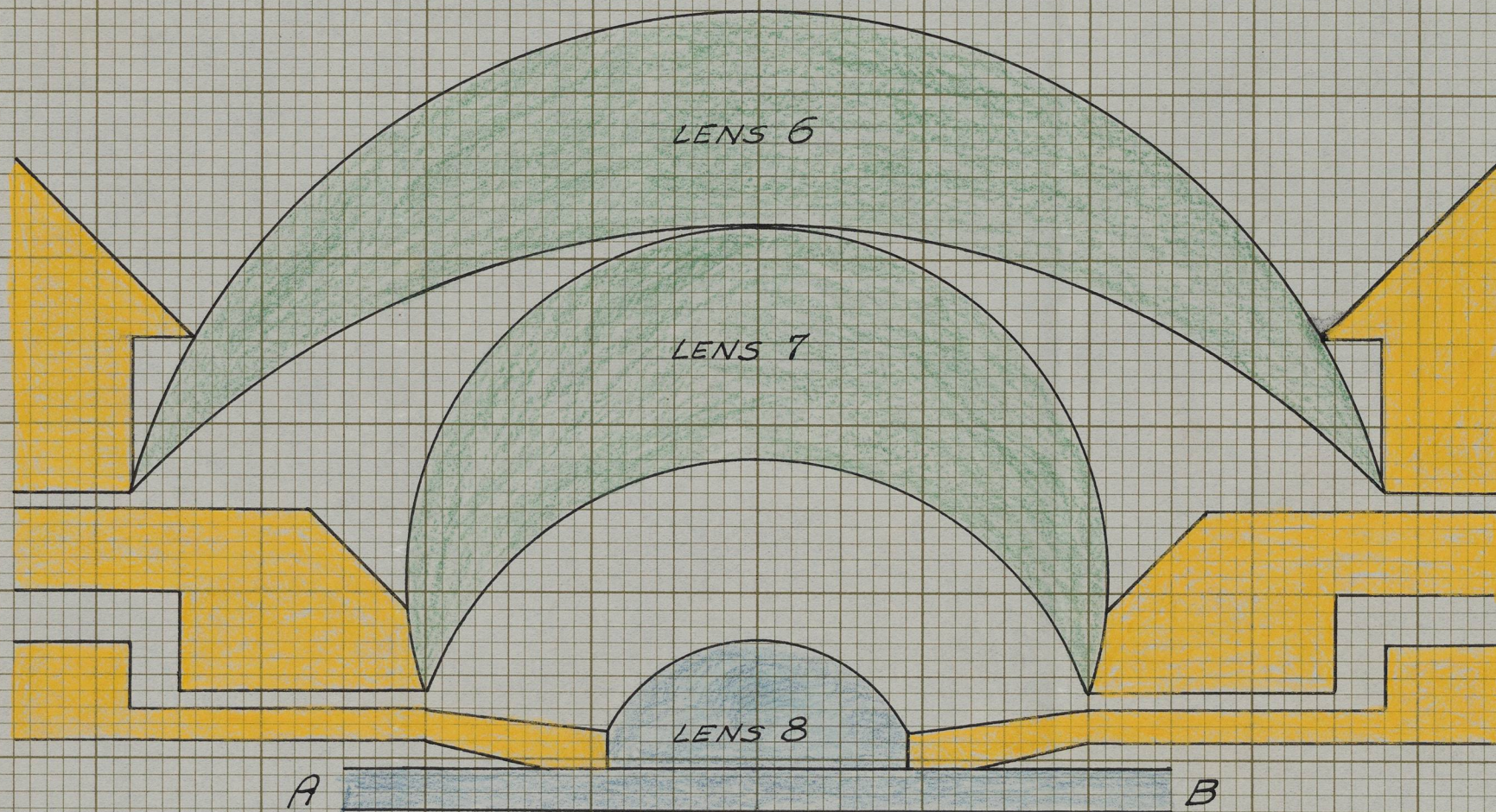
OBJECT GLASS

GENERAL ARRANGEMENT

SCALE 2/1



f 0.35 OBJECT GLASS - ARRANGEMENTS FOR MOUNTING SMALL LENSES - SCALE $10\times$



AB IS THE PHOTOGRAPHIC PLATE - FILM SIDE OUTWARDS

1103.1

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ww - PH
FBH - FBH
ww

July 31, 1933

Dr. George E. Hale
California Institute of Technology
Pasadena, Calif.

Dear Dr. Hale,

Referring to your kind letter of July 25, I now realize that I should have mentioned in my last letter that Dr. McCauley's experiments to determine whether it would be best to cool the 120-inch disc rapidly, remove from the ceramic mold and then reanneal, indicated that no great amount of time would be gained by this method. Consequently we are annealing this disc in the conventional manner according to a schedule based on our laboratory studies of the annealing characteristics of this particular glass. On this basis something like three and one-half months will be required for the completion of the schedule. The disc was cast on June 24 so that we will be unable to inspect the disc until October.

For this reason we would like to use the intervening period in working up the mold design and building the ceramic parts for the 200-inch disc. If we can have the design of the 200-inch disc during the annealing period of the 120-inch disc, it will obviously save some time in preparing for the casting of the latter disc.

I assume that the original plan to cast the small accessory mirrors after the completion of the 200-inch disc still holds. Under this condition we could no doubt cast several of them at the same time and use the 200-inch disc annealing equipment. I believe that this would result in the greatest saving of time and money.

I believe that Dr. Day has returned to the East and am looking forward with pleasure to his next visit to Corning at which time we can discuss details which undoubtedly developed in his conferences with you.

Sincerely yours,

J.C. Hostetter
Director, Development & Research

JCH:EMC

cc- OAG, McCauley, A.L. Day, E.C. Sullivan, Max Mason.

OCT - 5 1933

1103.1

ackd. 8/9

CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA

ASTROPHYSICAL OBSERVATORY

Dr. Max Mason
President Rockefeller Foundation
61 Broadway, New York.

MM	August 1, 1933	MM	(initial for MM)
TA	AUG - 7 23	SA	
WW		WW	
WWB		WWB	

Dear Mason:

As I understand that you are to return from Europe about this time, I am sending you the enclosed report of our Advisory Committee, which unanimously approved the provisional decision of the Observatory Council to adopt a new and greatly improved form of mounting for the 200-inch telescope. I think I wrote you that a model of this new type was under construction in our shop. This model, which embodies all the features enumerated in the enclosed report, was carefully studied from every angle by the best engineers of the California Institute as well as by the Observatory Council and the Advisory Committee. We all agree that it represents a material advance in design, and that it will render the telescope much more efficient in operation than any other type of mounting. Moreover, it calls for a much smaller dome than that needed for the best mounting previously available, thus reducing the amount of this large building item.

Mr. Arnett writes that he has sent you and Dr. Weaver copies of my letter regarding the apparently successful casting of the 120-inch mirror disc, which at last reports was steadily passing through its annealing schedule. If, as we hope, it turns out well, the 200-inch disc will probably be cast in December.

As the design of the mounting has now been agreed upon, the task of making the working drawings will be undertaken immediately. Reports of progress will be made frequently to a committee consisting of Adams, Hubble, Martel, Anderson and myself, and occasionally to the Observatory Council and the whole Advisory Committee.

The new photoelectric amplifier of Stebbins and Whitford is giving remarkable results in conjunction with the 100-inch telescope. It is now certain that the development of this auxiliary for the 200-inch telescope will enormously increase its range and efficiency. All other work is going satisfactorily and we are keeping well within our budget for 1933.

I may be able to go to Europe soon for a short trip, sailing from Quebec on September 2. If so, I hope to see you in New York on my return about October 12 or 13.

With best regards,

Yours very cordially,

George E. Hale

GEH:G

OCT - 5 1933

1103.1

Sent to M M by
G E Hale 8/1/33

A meeting of the Advisory Committee for the 200-inch telescope was held in Dr. Hale's office in ^{the} Solar Laboratory on the afternoon of July 13, 1933. There were present. Dr. Adams, chairman, Bowen, Epstein, Hubble, Martel, Seares and Tolman.

As a result of study and discussion extending over a considerable period, the following resolutions were adopted as representing the consensus of opinion of the Advisory Committee.

A. Resolved that the following focal ratios are very desirable in the optical system of the 200-inch telescope: primary focus, 1 to 3.3±; Cassegrain focus, 1 to 16±; Coude focus, 1 to 30±.

B. Resolved that it is very desirable to incorporate the following features in the design for the 200-inch telescope mounting:

- (1) The possibility of working in the axis of the large mirror, at the principal focus.
- (2) The possibility of working in the principal focus of the telescope (as above) or at any of the secondary foci (except the Newtonian) without changing mirror cages.
- (3) The possibility of observing from the north pole to Dec. -53° .
- (4) The possibility of attaching a Newtonian cage, if it should prove necessary in the future. (This would involve a slight shortening of the upper half of the square tube of the new model).

(5) The importance of keeping the diameter of the dome as small as may be possible, and therefore of avoiding the use of a large observing platform.

(6) The provision of a second Cassegrain mirror, giving a ratio of about $f:30$, for use with a fixed spectrograph in a south constant temperature room. (The south face of the telescope tube to be designed with this purpose in view).

(7) The use of an exceptionally stiff telescope tube, so designed as to permit the observer to be carried by it, either in a cylindrical observing chamber covering the principal focus or on a railed platform forming the upper extremity of the square tube.

(8) The use of two lateral suspended observing chambers, one of them to be of sufficient diameter to contain a long-focus two-lens plane grating spectrograph.

(9) The provision of a small elevator on the south face of the square telescope tube, to carry the observer from the base of the tube to the top.

(10) The provision of any necessary additional observing platforms, to be attached to the mounting.

(11) The provision of a narrow platform, extensible in length and free to turn in azimuth, which can be run by motor up one side of the shutter opening in the dome.

C. Resolved that the desirable features enumerated in Resolution B are now, or can readily be, incorporated in the Brass Model with square double tube and structural fork, exhibited to the committee during this meeting.

Edwin Hubble
Secretary

1103.1

AUG 14 1933

WM	-	MM
FBH	-	FBH
WW	-	WH

TA - 3a

WWB	-	MB
WW		WW

August 17, 1933

Dr. George E. Hale
Astrophysical Observatory
California Institute of Technology
Pasadena, Calif.

Dear Dr. Hale,

Replying to your kind letter of August 7, I have discussed the present annealing schedule for the 120-inch disc with Dr. McCauley, and it now appears that this disc will not be removed from the annealer until the latter part of October. Consequently, this will be too late for your proposed visit about October 15.

Naturally we would be delighted to have you visit Corning, and Dr. McCauley will have arrangements made so that you may be able to see the 60-inch disc in polarized light. If, however, you would like to examine both the 60 and the 120-inch it will obviously require a somewhat later date, perhaps early in November.

Inasmuch as you may wish to visit Corning around October 15 as you now plan, and because at that time I shall be abroad, I would ask that you get in touch directly with Dr. McCauley or Dr. O.A. Gage on your return to New York and they will be glad indeed to make suitable arrangements for your visit.

We have now received the proposed design for the 200-inch disc. We note particularly that this disc has been increased one inch in diameter to 201-inches, and, of more importance, because of its effect on annealing schedules, the thickness has been increased to a point where it approximates the same dimension for a solid disc. Naturally this increased thickness will increase the cost considerably, not only in the construction of the mold, but also in the annealing time. I mention these points because of their bearing on the costs of the project for 1934. We would

Dr. George E. Hale, Page 2, August 17, 1933

rather not make any estimates of costs until a final design for the 200-inch disc has been developed. I believe that Dr. McCauley will write Dr. Pease within the next week or so on this subject. Personally I am rather disappointed that the design shows such a great thickness. Are we taking full advantage of the ribbed structure in this design?

Yours sincerely,

J.C. Hostetter
Director, Development & Research

JCH:FRF

cc- Messrs. A.L. Day
M. Mason ✓
O.A. Gage
G.V. McCauley

JAN 24 1935

CORNING GLASS WORKS
CORNING, NEW YORK



1103.1

WM	10/17	mm	10/18
WW		WW	
TA		Ja	
WWB	NOV 14 1933		

DEVELOPMENT
AND
RESEARCH
DEPARTMENT

EXECUTIVE COMMITTEE
ALANSON B. HOUGHTON
ALEXANDER D. FALCK
GEORGE B. HOLLISTER

In reply refer to:
Dr. G.V. McCauley.

October 12, 1933.

NOV 15 1933

Dr. Max Mason,
The Rockefeller Foundation,
49 West 49th Street,
New York City.

Dear Dr. Mason:-

In Dr. Hostetter's absence your letter of October 11 was referred to me for reply.

We are indeed pleased to learn that you are coming to visit us at Corning, even though for only a short time. We have some things doing on Saturday, in fact the most of our production continues until midnight Saturday.

Judging from your time of leaving New York and probable arrival in Corning you should be here in time for luncheon and we, therefore, accordingly expect to have luncheon with you in Corning on October 21st. Kindly let us know if Mrs. Mason will be with you.

I have just written Dr. Hale who expects to be with you in New York from October 14th to 19th. He is somewhat doubtful as to visiting Corning. I have urged him, however, in the letter, to come and if possible arrive to be here with you.

At Dr. Hale's request I had made up an itemized statement of expenditures to date and estimates for the remainder of 1933 and the whole of 1934. A copy of this is enclosed.

We regret that the 120" disc will still be concealed in its kiln at the time of your arrival but we are very anxious to show you and Dr. Hale what we have expended your money for. We feel that it will be well worth your while to see this equipment and the means we use for making these large discs.

Very truly yours,

Geo. V. McCauley

Physical Laboratory.

D.

OCT 31 1933

1103.1

WW	OCT 25 '33	Rept WW
FBH	10-27	FBH
TA	OCT 26 '33	yu
AMJ		✓
		UST
		TBA

October 11, 1933.

Dear Dr. Hostetter:

I expect to leave New York by automobile on Friday afternoon, October 20th, and shall be passing through Corning probably in the somewhat late forenoon of Saturday. When I first planned this trip there was some leeway as to time, and I hoped I could make a real visit at Corning. This is now not possible, but I should like nevertheless to stop for an hour if the works are open. Since the time of arrival is somewhat uncertain, I should be grateful if you would let me know if things are shut down on Saturday afternoon, and if so what time they close.

I have just had a note from Hale, who arrives in New York October 14th. I do not know whether he plans a Corning visit or not. I suppose it is possible that you may be able to have a look at the 120-inch in the very near future.

Cordially yours,

MAX MASON

Dr. J. C. Hostetter,
Corning Glass Works,
Corning, New York.

MM:AEB

JAN 24 1935

OCT 25 1933

1103.1

		WST TBA

October 13, 1933.

Dear Hale:

I am glad to know that you are to be here soon. I shall be in town during next week up until Friday. On Friday I have committee meetings, and leave in the early afternoon for Toronto.

I have planned to drive with some friends and hope to stop in at Corning for an hour on Saturday, but I am afraid our trip will be too hurried for more time than that. I shall be most happy to see you at any time you name before Friday, and shall be glad to stop at the University Club if that is more convenient for you.

Needless to say, Mrs. Mason and I always hope to have Mrs. Hale and you at our home for dinner, if and when that suits your program.

Cordially yours,

MAX MASON

Dr. George E. Hale,
University Club,
1 West 54th Street,
New York, New York.

MM:AEB

JAN 24 1935

W W	OCT 24 '33	PH
T A	OCT 25 '33	Ja
W W B	OCT 26 '33	MB
B A B	OCT 27 '33	BB
F B H	OCT 31 '33	F B H

October 18, 1933.

Dear Mac:

Thank you for your letter of October 12th. I have just talked with Hale, and am disappointed to learn that he must be in Chicago by the time it will be possible for me to stop at Corning.

I am very glad to know that at least the works will not be shut down, and, without knowing the exact time, hope to be there in the late morning. I am sorry it has to be such a flying trip, but we are due in Toronto that evening and so shall have to make it very short in Corning. It would, therefore, be better not to plan for luncheon, both because of uncertainty as to time and necessity for hurry, and because we shall be quite a caravan, since Dr. and Mrs. Ruggles of Providence will be with Mrs. Mason and myself.

Cordially yours,

MAX MASON

Dr. George V. McCauley,
Physical Laboratory,
Corning Glass Works,
Corning, New York.

MM:AEB

DEC - 7 1933

1103.1

TA - J.A.
DHS B
GWB file

WW DIARY - CALIFORNIA INSTITUTE OF TECHNOLOGY - 10/23/24/25, 1933

Astrophysics:

WW spends a half day with J.A. Anderson (Executive Officer, Obs. Council) inspecting the Astrophysical Building, the machine shop and the optical shop on the CIT Campus. The site for the 200" has not been chosen as yet, but the choice has narrowed to two locations: Palomar Mountain in San Diego County, and a mountain back (north) of Mt. Wilson. A. shows and explains to WW the brass model of the proposed form for the new telescope, including the wonderfully ingenious suggestions made originally by Mr. Edger, an English railway engineer living in Los Angeles who has made a lifelong hobby of telescope design. WW also sees the aluminum mirrors, distilled in vacuo, which are being developed by Strong. This aluminum surface protects itself by forming a mono-molecular skin of aluminum oxide. It reflects the extreme ultra violet, can be washed with soap and water, and is apparently quite permanent.

Copy EB

Copy WEB, TA, DHS, GEB files

1103.1

NOV 20 1933

CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA

ASTROPHYSICAL OBSERVATORY

November 7, 1933

Dr. Warren Weaver
Rockefeller Foundation
49 West 49th Street
New York City.

Dear Dr. Weaver:

	WW	NOV 11 33	WW	11-14
	mm	11-15	FBH	
	TFI		17.7	
			TA	
	DAS		DHS	

I was disappointed, on my arrival here, to find that you had gone. It would have been a pleasure to discuss with you the 200-inch telescope project and other matters relating to the California Institute, but I trust you obtained all the information you desired from Dr. Anderson and others.

I am enclosing three photographs of the model of the telescope mounting, two of the coelostat built in our Instrument Shop, and one of the interior of the Optical Shop. I am also sending a sketch by Mr. Porter of the exterior of the Optical Shop, which is proving very satisfactory in making difficult optical tests over long paths, impossible in our old shop of the Mount Wilson Observatory.

The design for the telescope mounting was strongly approved by all of our advisers in Europe. It strikes me as the best I have ever seen, and I hope you got a similar impression.

Our budget for 1934, which I discussed with Dr. Mason and Mr. Arnett, will follow in a few days. We have been delayed in completing it because of the illness of Mr. Barrett, Secretary in charge of the accounts of the Institute.

On my way west I visited Corning, and was very favorably impressed with our work in progress there.

With kind regards,

Yours very sincerely,

George E. Hale

GEH:G

1917

1917

1917

1917

1917

1917

The following is a list of the names of the persons who have been appointed to the various positions in the Department of Agriculture for the year 1917. The names are arranged in alphabetical order of the last name.

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1917

1917

FBH	11-15	FBH
mm	NOV 15 33	mm
TA	NOV 17 33	J. a.
DHS	NOV 17 33	DHS

QJB NOV 18 33

WWB NOV 18 33

NOV 20 1933

November 14, 1933

Dear Dr. Hale:

One of the few disappointments in my recent pleasant visit at Pasadena was not to find you there. I did, however, have a most satisfactory half day with Dr. Anderson in the Instrument Shop and the Optical Shop. I also visited the Astrophysical Building. It had been thirteen years since I had been at Pasadena, and you will understand that it was most interesting to me to see the wonderful development that has taken place.

May I thank you for the photographs which you have sent. I am sure the group here will be interested in seeing them.

Very cordially,

WARREN WEAVER

Dr. G. E. Hale
Astrophysical Observatory
California Institute of Technology
Pasadena, Calif.

WW:PH

NOV 20 1933

1103.1

CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA

ASTROPHYSICAL OBSERVATORY

November 9, 1933

Dr. Max Mason
President, Rockefeller Foundation
49 West 49th Street
New York City.

Dear Mason:

MM	NOV 13 33	17.7
WW		WW
JA		JA
WWB		WWB

I enclose copy of letter and budget just sent to Mr. Arnett, and trust you will agree, after visiting Corning, that the prospects for complete success are now excellent. The work at Corning is being done in a much more scientific manner than in the case of any other very large telescope. In fact, this is the first time a thorough knowledge of the fundamental principles of glass-making has been utilized in such a project. I am glad that the Toronto, Chicago-Texas and other large reflectors will have the benefit of the studies made for us.

Dr. Weaver's visit here was much appreciated, and I am sorry I could not get back in time to discuss with him the work and the policy of the California Institute.

With warmest regards,

Yours very cordially,

Guy E. Hale

GEH:G

NOV 29 1933 ✓

1103.1

CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA

ASTROPHYSICAL OBSERVATORY

November 9, 1933

Mr. Trevor Arnett
President, General Education Board
49 West 49th Street
New York City.

Dear Mr. Arnett:

a	T. A.	NOV 11 1933	3a	11/11
GEH	Files		✓	
	WWB		11/11	
C	KEO		11/11	
			ART	

I enclose copy of our budget for 1934, with statement regarding commitments and outstanding balance. You will see that a new allotment of \$219,667.36 is requested. This amount, added to the estimated balance of \$49,832.64, should carry us through the coming year.

I visited Corning shortly after I saw you in New York, and was greatly pleased with what I saw there. The 120-inch disc should be out of the annealing oven before the end of this month.

I am also glad to report that our work here is making satisfactory progress, as Dr. Weaver will be able to report to you.

Assuring you of our appreciation of your continued interest in the 200-inch telescope project, and with kindest regards,

Yours very sincerely,

George E. Hale

GEH:G

P.S. I regret that I have been delayed in sending you this letter, because of the illness of Mr. Barrett, Secretary of the California Institute in charge of the accounts. I trust, however, that it will reach you in time.

WW	NOV 16 '33	WW
TA	NOV 17 '33	S.A.
FBH	11-17	FBH
WNB	NOV 18 '33	///

NOV 20 1933

November 15, 1933.

Dear Hale:

Thank you for sending me a copy of the budget for next year for the astrophysical work at Pasadena.

I stopped in at Corning the day after you did, and have the same reactions to the way in which they are doing the job.

I have no doubt that in the faith for complete success of the pyrex there is little more than an academic interest in the metal alloy as a material for reflectors. These are hard times and I would be a traitor to the cause if I suggested anything resembling unnecessary expenditure, but I still have the feeling that if occasion offers some expenditures on experimentation in this line at the time when your group is so actively interested in the general problem would be justifiable.

Incidentally, I stopped off at Chicago and talked briefly with Gale, and saw some of the stainless steel disks which Pearson has been making and using for gratings. The samples which he had did not have the hard spots which characterized the one that Johnston sent you, and Gale seemed to think that proper annealing would take care of most of that

November 15, 1933.

#2

difficulty.

I hope very much that Mrs. Hale has benefitted
from the change in climate and is through with her trouble.

With cordial greetings, I am

Sincerely yours,

MAX MASON

Dr. George E. Hale,
California Institute of
Technology,
Pasadena, California.

MM:AEB

NOV 29 1933

1103.1

GJB	mail	Wm
DGP		Wm
MPT		MPT

November 18, 1933

My dear Doctor Hale:

At a meeting of the Executive Committee of the General Education Board held November 17, the officers presented your letter of November 9, submitted on behalf of the Observatory Council of the California Institute of Technology, requesting the release of funds for the Astrophysical Observatory for the period January 1 to December 31, 1934. The Committee observed that the budget for this year would require approximately \$269,500.00, which after deducting \$49,832.64, the estimated sum remaining unused at the end of 1933, leaves \$219,667.36 to be provided for.

I desire to inform you that the Committee acted favorably on your request and released to the Board of Trustees of the California Institute of Technology a further sum of \$219,667.36, or as much thereof as may be needed, for this undertaking.

The Auditor will make arrangements for payment.

A copy of this letter is being sent to Doctor Millikan for his information.

Sincerely yours,

W. W. BRIERLEY

Doctor George E. Hale
California Institute of Technology
Pasadena, California

WWB:KEO

DEC - 7 1933

1103.1

CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA

ASTROPHYSICAL OBSERVATORY

November 23, 1933

Dr. Max Mason
President, Rockefeller Foundation
49 West 49th Street
New York City.

Dear Mason:

MM	NOV 27 '33	MM
WW	NOV 23 '33	WW
TA	NOV 29 '33	TA
WWS	NOV 29 '33	WWS
FBH		FBH

Thank you for your letter of November 15. We have obtained many samples of metal alloys for mirrors, but thus far have found none that promises to be satisfactory in the large discs we require. Dr. John Johnston still has an eye on the problem, and if you see him I hope you will talk the matter over. To date this work has cost us nothing, but if a sufficiently promising lead appears I think with you that some experiments on a moderate scale would be justifiable.

I am glad to hear that our budget for 1934 has been passed by the Executive Committee and assure you we are doing everything in our power to carry out the big task effectively. I am hoping to hear soon that the 120-inch disc is safely out of the annealing oven.

I am also pleased to say that Mrs. Hale is now quite well again, though her infection was not easily overcome.

With kindest regards,

Yours very cordially,

George E. Hale

GEH:G