Hassard Corresp 1906 - 1910

Originals in P.A.C. [illegible]
This correspondence [illegible] around articles on telescope making by Hassard & others. Clippings from English [illegible]

CORRESPONDENCE FROM A R HASSARD TO

D	Freedman	Cleveland	15 Feb 1909
			26 May 1909
Leo	Holcomb	Decatur	Mar 1909 ?
			27 Mar 1909
			20 May 1909
			4 Jun 1909
J E	Mellish	Cottage Grove	25 Feb 1909
Mellish/Prahl			20 Mar 1909
A	Prahl	Milwaukee	2 Apr 1909
			7 Apr 1909
			12 May 1909
			27 May 1909
J	Slater	Leigh, Lancs	12 Mar 1909

CORRESPONDENCE TO A R HASSARD FROM

I P	Church	Cornell U	21 Dec 1910	telescope making
D	Freedman	Cleveland	22 Dec 1908	telescope making
			5 Jan 1909	
			18 Jan 1909 ?	
			21 Jan 1909 ?	
			8 Feb 1909 ?	
			12 Feb 1909	
			23 May 1909 ?	
Leo	Holcomb	Decatur	19 Mar 1909	telescope making
			15 Apr 1909	
			7 May 1909	
			13 May 1909	
			2 Jun 1909	
F C	Leonard	Chicago	20 Jan 1912	S. P. A.
H M	Lethert	St Paul, Minn	10 Mar 1909	telescope making
J E	Mellish	Cottage Grove	22 Apr 1908	visit Barnard
			28 Apr 1908	telescope making
			4 May 1908	telescope making
			7 Jun 1908	observing
			17 Jun 1908	telescope making
			22 Jun 1908	
			30 Jun 1908	
			11 Jul 1908	
			19 Jul 1908	
			28 Jul 1908	
			17 Aug 1908	
			25 Aug 1908	
			30 Aug 1908	
			9 Sep 1908	
			15 Sep 1908	
			28 Sep 1908	
			3 Oct 1908	
			2 Nov 1908	postcard
			9 Nov 1908	
			13 Nov 1908	
			14 Nov 1908	

		20 Nov 1908		
		26 Nov 1908		
		6 Dec 1908		
		11 Nov 1908	?	postcard
		20 Dec 1908		
		4 Jan 1909		
		27 Jan 1909		observing
		20 Feb 1909		
		1 Mar 1909		
		11 Apr 1909		
		12 May 1909		
		25 May 1909		
A Prahl	Milwaukee	19 Jun 1908		telescope making
		27 Jun 1908		
		19 Oct 1908		
		8 Nov 1908		
		19 Nov 1908		
		4 Dec 1908		
		10 Dec 1908		
		14 Dec 1908		
		22 Dec 1908		
		3 Jan 1909		
		22 Jan 1909		observing
		31 Jan 1909		
		11 Feb 1909	?	
		10 Feb 1909		
		17 Feb 1909		
		24 Feb 1909		
		22 Mar 1909		
		4 Apr 1909		
		11 Apr 1909		
		20 Apr 1909		
		25 Apr 1909		
		10 May 1909		
		20 May 1909		
		31 May 1909		
G W Ritchey	Mt Wilson	19 Sep 1908		telescope making
		16 Oct 1908		
H L Schall	Decatur	3 Mar 1909		
		4 Apr 1909		
J Slater	Leigh, Lancs	28 Feb 1909		telescope making
Spencer Lens Co	Buffalo	12 May 1906		purchase eyepece

FROM
IRVING P. CHURCH, C.E.
PROFESSOR OF APPLIED MECHANICS AND HYDRAULICS,
COLLEGE OF CIVIL ENGINEERING,
CORNELL UNIVERSITY.

DEC 24 1910

CORNELL UNIVERSITY.

Ithaca, N. Y., Dec. 21 1910

Mr. A.R.Hassard

Toronto, Canada

Dear Sir:-

Having read your interesting note in the Popular Astronomy journal describing your observations with a 4 1/2 inch reflector which cost only one dollar, I take the liberty of writing you to inquire how one can construct such a good instrument as yours must be at so low a cost.

Should you have time to write me a few words on the matter I should be greatly indebted.

I enclose a directed envelope, but unfortunately have no Canadian stamps to send on for return postage

Newtonian or Gregorian arrangement of eyepiece ?

Very respectfully yours

I. P. Church.

9 South Ave.

To A. R. Harvard,
Compliments of the Author.

REPRINTED FROM POPULAR ASTRONOMY NO. 187.

The Society for Practical Astronomy.—This is the title of an association of astronomical observers, which was founded by the writer early in the year 1909, but not until now well known to the general public. The organization is a society chiefly for amateurs, and made up of amateurs largely, though we are glad at any time to welcome professionals who may care to join with us. It is our hope to bind together in one strong society all of the astronomical amateurs in America and elsewhere, and in this way encourage and help to promote amateur work in general. Among other good features, this will afford an excellent opportunity for amateurs to get in touch with one another and coöperate for a mutual advantage.

The official organ of the Society is a little journal known as "The Monthly Register of the 'S. P. A.,'" which has been running for over two years, but which has not, until the March, 1911, issue been printed and given wide circulation, and only since this issue has the organization been given any publicity to speak of. This paper is at present to be published eight or nine times a year; it is contributed to by the members of the society, and published by the society. It is hoped to in time gain for "The Monthly Register" the reputation of a paper expressly for the Amateur Astronomer, and maintained almost wholly by him. Although our little periodical has had, so far, only two printed issues, it has met with the most encouraging response and enthusiasm on the part of many who have seen it, and it has been spoken of as being "a long-felt want to the Amateur Astronomer". We are anxious that all who are interested in the Society or in its magazine should see the latter, and I shall be glad to send sample copies of our next issue to as many as will send me their names and addresses.

The aim of the Society for Practical Astronomy is the advancement of, and coöperation in Practical Astronomy. We are very anxious to admit many new members into this association at present. The only requirement for entrance is that one be a fairly regular observer who is willing to contribute the results of his observations to "The Monthly Register," as often as possible, and the only charge for membership in the Society is the subscription price of the paper, which is, to members, $1.00 per year, (to non-members, $1 50)

Copies of the last two numbers of "The Monthly Register" have been sent very generally throughout the United States, in the hope of interesting our amateurs in the Society. I extend a free and hearty welcome to all of all my fellow-observers, and will be glad to hear from any who care to join the ranks of the "S. P. A."

The membership of our organization is now rather small, but it is rapidly growing. At present we have eighteen members, (most of these having been admitted since our last March issue of the paper), but we expect to have many more in the near future. The officers of the Society for Practical Astronomy are as follows: Frederick C. Leonard, President, John E. Mellish, Secretary, Horace C. Levinson, Treasurer, Ruel W. Roberts, Organizer and Lecturer.

Before closing this communication, I wish to add further that we want to make this one of the strongest and largest amateur astronomical organizations in existence, and that we invite members from all over the world to join our ranks; we can make this society what we desire to make it only through the help of the many amateurs who are so willing to do all they can to advance Practical Astronomy, therefore, let us ask them all to join this association so that their combined efforts may result in promoting this sublime science to even a still greater degree than formerly.

FREDERICK C. LEONARD.
Director, Leonard Obs'y., 1338 Madison Pk.,
Chicago, Ill., June 17.

THE SOCIETY FOR PRACTICAL ASTRONOMY,
FREDERICK C. LEONARD, President,
1338 MADISON PARK, CHICAGO, ILL.

1912, Jan. 20.

A. R. Hassard, Esq.,

Toronto, Can.

Dear Sir:--

Referring to yours of the 19th inst., I am inclosing a descriptive circular telling about the S. for P. A. Although the circular is somewhat out-of-date, yet it will give you a general idea of the nature of our work in this organization. At present, we have nearly 60 members living in all parts of the U. S., in Canada, England, Roumania, Italy, New Zealand, Australia, and the Philippine Is. A new feature in this society is the "Observing Sections" to encourage systematic observation among the members of the Society; we have eight observing sections, one for every branch of observational astronomy.

Our paper, The MONTHLY REGISTER, has been printed ever since last March; it is the only official journal of the association and is devoted entirely to the interests of the amateur astronomer. I will take pleasure in seeing that you get a sample copy of the next issue of our magazine, after it comes out.

Trusting you will care to join our society, I am,

Very truly yours,

Frederick C. Leonard

FCL-L

WHAT WE KNOW ABOUT THE SUN

BY PROFESSOR T. J. J. SEE

OF THE NAVAL OBSERVATORY, MARE ISLAND

WHAT THE MOST RECENT OBSERVATIONS AND DISCOVERIES HAVE REVEALED AS TO THE NATURE OF THE GREAT CELESTIAL BODY ON WHOSE LIGHT AND HEAT LIFE ON OUR EARTH DEPENDS—HOW LONG WILL THE SUN LAST?

IT probably does not occur to a child, or even to the average man or woman, that every star which we behold in the firmament on a clear night is a flaming globe of the same order of size and mass as our sun. Yet this extraordinary result has been established by astronomical measurement, and is proved beyond doubt by several independent lines of investigation, all of which are based on exact methods.

To know the intrinsic brightness or light-giving power of a star, we have to measure its parallax, which gives the number of times its distance exceeds that of our sun. The great German astronomer, Bessel, of Königsberg, first measured the parallax of a star in the year 1838, choosing for this purpose the double star known as 61 Cygni, one of our nearest neighbors in the sidereal universe.

The intensity of light varies inversely as the square of the distance. Accordingly, when the distance of a star is known it is easy to compare its light with that of our sun, if the relative amounts of light given by the sun and star have been found by exact photometric measurement. So far as our knowledge goes at present, the nearest of the fixed stars is Alpha Centauri, a double body in the southern hemisphere, with two equal deep-yellow components, each of about the same brightness and mass as our own sun. The distance of Alpha Centauri is two hundred and seventy-five thousand times the sun's distance, and its mass has been calculated from the time of revolution of the companion, which moves in an orbit larger than that of the planet Uranus, and completes a revolution in eighty-one years.

OUR STUDY OF THE DOUBLE STARS

It is only in the case of binary systems that we know the mass of any star. When the parallax is known, and we can find the dimensions of the orbit compared with those of our planets, the time of revolution, according to Kepler's law, gives the attraction exerted by one body on the other, and hence the mass of the system compared with that of the sun and earth.

Another neighboring star of great interest is Sirius, the great dog-star, which the Greeks and Romans described as red in ancient times, but which has since changed its color to a brilliant white. It is half a million times farther away than our sun, and gives about sixty times as much light. This star is also a binary system, the principal component having twice the mass of our sun. The companion is extraordinarily dark, being half as large as the chief star, but giving only one-ten-thousandth part as much light.

The star of greatest intrinsic brightness yet known is the great southern star, Canopus, which is estimated to outshine a thousand suns as bright as ours. It is just visible in our Southern States.

THE LORD OF THE SOLAR SYSTEM

From these illustrations it will be seen that our sun is not a conspicuous

star in the Milky Way; yet it is of respectable mass and brightness, perhaps about an average of all the stars so far investigated. For us, however, the sun is the all-important body, the center of the solar system, which it lights and dominates with more than autocratic sway. It has seven hundred and forty-six times the mass of all the planets combined, and three hundred and thirty thousand times the mass of the earth.

The distance of the sun is about ninety-two million miles—as much as a rapid train, traveling day and night, could traverse in about two hundred and fifty years. Its diameter is about eight hundred and sixty thousand miles, so that the train might run a whole year without traversing the distance from the sun's surface to its center. These figures give us some idea of the great luminary's amazing size, and yet it is so far away that it appears small when we behold it in the sky.

Since the sun is so immense, and all heat, light, life, and motion upon the earth depend upon its radiation, is it any wonder that many nations of antiquity worshiped the glorious orb of day as a god?

Though our sun is the center of the planetary system, it is not fixed, but moves like other stars, the path of the entire system being directed toward the constellation Hercules. This motion of the solar system was discovered by Sir William Herschel, more than a century ago, and has since been confirmed by a number of astronomers working by various methods. At present, Professor Campbell, of the Lick Observatory, is reinvestigating the solar motion by means of spectroscopic observations of stars taken in both hemispheres. A branch observatory at Santiago, Chile, is generously maintained for this purpose by D. O. Mills, of New York. The work promises to be of great importance to astronomical science.

THE CAUSE OF THE SUN'S HEAT

The ancients considered the universe to be made up of four elements—water, air, fire, and earth; and the sun was regarded as a globe of fire. It was not till the year 1854 that the theory of the sun's heat was established on a correct basis. At that date Helmholtz showed that the energy radiated away must be derived mainly from the potential energy given up by particles in falling toward the sun's center under the force of gravity. The sun's attraction is twenty-eight times that of terrestrial gravity, and this powerful force acts upon a mass three hundred and thirty thousand times that of the earth. The result is the development of correspondingly enormous mechanical power in the condensing mass of the sun.

On the earth, one pound of water has to fall through seven hundred and seventy-two feet in order to produce enough heat to raise the temperature one degree Fahrenheit. On the sun, the same heat would be developed by a fall through only about twenty-eight feet. The cause of the development of so much heat in the sun is therefore obvious.

HELMHOLTZ AND HIS SUCCESSORS

Helmholtz showed that if the sun be of uniform density throughout, the condensation under gravity would produce enough heat to raise the temperature of an equal mass of water about twenty-seven million degrees centigrade. As it was shown by Pouillet's experiments on the sun's radiation that enough heat is lost in a year to cool an equivalent aqueous globe one and one-quarter degrees centigrade, it follows that all the heat produced in the condensation of the sun would only last some twenty million years if the radiation continued at the present rate throughout that period.

Helmholtz's theory of the sun has since been materially extended by Lane, Ritter, Lord Kelvin, Perry, and the writer, all of whom treat the sun's body as entirely gaseous. Lane first suggested that the intense heat operating in this flaming globe might split up the solar molecules into single atoms; and the resulting monatomic theory has recently been extended by the writer. The present state of our knowledge of the subject may be summed up as follows:

On the basis of known laws and exact mathematical methods, it is proved that the density at the sun's center is exactly six times the mean density, which is one and two-fifths times that of water, ma-

king the central density about eight and a half—slightly exceeding that of iron. In the outer part of the sun's mass the density is so slight as to be almost imperceptible. At the surface of the photosphere the gas is much rarer than atmospheric air, so that the radiation from below is driven bodily through the overlying layers with no more loss than the sun's rays suffer in passing through the earth's atmosphere on a clear day. Even at a depth of one-tenth of the distance to the center, the sun's density is only one hundred and fifty times that of atmospheric air, and the intense heat and dazzling glare of light would pass through such a medium almost unobstructed. Hence, we see that the heat is supplied by direct radiation, like the sunlight in passing through our own atmosphere, and not by "convection currents," as was formerly stated in numerous text-books.

THE THEORY OF CONVECTION CURRENTS

In the older theory of convection currents, it was supposed that a current made up of gases which had been chilled by exposure to the cold of space sank down into the sun's globe, while hot currents came up side by side to bring forth the new supply of heat required to maintain the dazzling brilliancy of that body's surface. This would imply that the sun's mass is everywhere divided into a system of double tubes, as it were, with hot matter ascending in one and cold matter descending in the other. But the pressure throughout the sun is enormous, and the friction of these supposed antagonistic currents would be so great that we now believe no such artificial convective system to be possible. Direct radiation does away with all this complicated machinery.

I have calculated by rigorous processes the average rigidity of all the layers of the sun, and have shown that the mean rigidity exceeds that of nickel-steel more than two thousand times. The interior of the sun, it may be inferred, is undisturbed by the explosions of its outer layers. The immense tongues and sheets of flame which astronomers see rising above the sun's surface are carried upward, partly by explosive forces, and partly by the repulsion of the sun's light acting on the small particles of which these prominences, as they are called, are composed.

The repulsion of small particles by waves of light was predicted by Clerk Maxwell from mathematical considerations about 1873, but it was not till a few years ago that the prediction could be actually verified by laboratory experiments with a radiometer. The effect of this light repulsion is seen in the rays of the corona during a total eclipse; and the same cause is always powerfully active at the sun's surface, where much fine matter is suspended, as it were, the repulsion of the sun's light just balancing the enormous force of gravity tending to draw the particles back into the flaming globe beneath. These effects have been especially studied by the famous Swedish physicist, Arrhenius, whose work ought to be of great value to us in the future study of the sun.

WILL THE SUN DIE OUT?

Returning now to Helmholtz's theory of the sun's heat, we may remark that it has recently been shown that the increasing density toward the center of the body increases the total production of heat throughout all past ages by forty-three per cent above the figure calculated for the simple case of uniform density. This would raise an equal mass of water to forty million degrees centigrade, instead of twenty-seven million, as estimated by Helmholtz in 1854.

Moreover, extending a theorem first derived by Ritter, I have proved that more than half of the sun's heat from the beginning is still stored up in its flaming globe, and thus made available for radiation through future ages. This accumulated heat, in connection with that yet to be produced by future contraction, assures us a future supply of energy three times as great as that required for the whole past activity of the sun. So far from approaching extinction, therefore, our sun is still in its youth, with the zenith of its glory far in the future. We need have no fear that it will soon die out and leave our world cold and wrapped in the darkness of everlasting night.

From the known rate of the sun's ra-

diation, as measured by Langley, we seem absolutely assured of a future duration of at least thirty million years; and if the radiation be at a smaller rate, it may amount to no less than three hundred million years. In any case, the sun's future is to be estimated only in periods representing immeasurable ages, and we may confidently conclude that the end of the progress of mundane development is not in sight.

THE VAST OUTFLOW OF LIGHT AND HEAT

Assuming that the sun is made up of single atoms, I have calculated that the annual shrinkage of the radius is seventy-one meters, or two hundred and sixteen feet; at this rate, the alteration in the sun's diameter would just become sensible to the naked eye in a million years. This small descent of the sun's matter toward the center keeps up all the enormous outflow of light and heat which warms the earth and other members of the planetary system. It would melt a layer of solid ice all over the sun's globe about fifty feet thick per minute.

The energy given out each minute by each square meter of the sun's surface would be capable, upon our earth, of lifting a ton to a height of about three hundred and thirty miles; which affords us an idea of the enormous work done by the sun each day that he illuminates the earth. And such are the wonderful laws of the sun's activity that his glorious light will shine throughout the coming millions of years with undiminished splendor, and with the steadiness and uniformity required for the preservation of life upon our planet. An interruption of the sun's radiation for a few days would give the earth an arctic aspect; in a few weeks our lakes and rivers would freeze over, and before many years had elapsed even the oceans would have frozen solid, and all life upon our globe would be at an end.

THE RADIUM HYPOTHESIS

Since the discovery of radium, many physicists have supposed that it might exist in the sun and stars, and might add greatly to the radiative vitality of these luminous masses. But this now seems more than doubtful. Radium is not yet understood, though it appears to be a temporary form of matter, decaying in some twenty thousand years. In a recent letter to the London *Times,* Lord Kelvin reiterated his belief in the gravitational theory of solar energy. A similar conclusion had been previously reached by the writer. So far as we can now see, there is no evidence that radium is an important cosmical agency. It is proved to exist in the earth's crust in large quantities, yet it does not produce eruptions of volcanoes, nor any similar phenomena, and seems generally to be in a dormant state. We must, therefore, explain the light and heat of the stars by the force of gravitation acting upon gaseous matter reduced by intense heat to the state of single atoms.

It is the storage of heat in the sun and stars that gives them their intense brilliancy. If there were not a secular process of accumulation the temperature of the heavenly bodies would not rise, and the unspeakable glory of the starlit firmament on a clear night would be replaced by the monotony of impenetrable blackness.

THE PHENOMENA OF SUN-SPOTS

Let us now consider the sun's surface. The spots that are so prominent a feature of it were first discovered by Galileo, in the year 1610, soon after the invention of the telescope. They have been diligently studied by many astronomers of the past three centuries, but are not yet fully understood. Galileo noticed that they appear to revolve in about twenty-eight days, and correctly inferred that the sun rotates on its axis in that period. Others have since studied their movement much more in detail, and have found that the equatorial region of the sun's surface rotates more rapidly than the regions about the poles. The swifter motion of the equatorial zones gives rise to whirlpools, or vortices, in higher solar latitudes, and no doubt the spots depend in some way on these differences in velocity of rotation.

Dr. W. E. Wilson, in Ireland, seems to have proved that the spots are hotter than the average of the solar surface. As seen against the bright background of the photosphere, they look dark, and they were formerly supposed to be

cooler than their surroundings, but this view is now abandoned.

We often hear prophecies of the baleful influences exerted by great sun-spots, which are supposed to portend all sorts of disasters, from the failure of crops to the production of earthquakes. Of course, there is not the slightest foundation for any such alarms. The regions about the spots are proved by the researches of Mr. Maunder, of the Royal Observatory at Greenwich, to disturb the magnetism of the earth, as if some electric charge was being driven from certain regions of the sun to our globe; but beyond slight tremors of the magnetic needle, no ill effects can be ascribed to sun-spots. The disturbance of the earth's magnetism is probably due to electrically charged streams of fine particles of matter expelled from the sun through which the earth passes at certain times.

About 1840, the spots were found, by Schwabe, of Dessau, to be periodic, and their period has since been fixed at about eleven years. At one time they become so numerous that there is a maximum, at another they fall off till there is a minimum; but the cause of their changes remains unknown. Nor have we yet been able to trace to these variations any climatic disturbances of measurable magnitude.

THE WATCHERS OF THE SUN

The greatest mechanical aid in studying the surface of the sun is photography, which enables the investigator to record solar phenomena with accuracy and rapidity. The sun is now photographed on every clear day at many observatories—Greenwich, South Kensington, Potsdam, Meudon, Washington, the Yerkes Observatory, Mount Wilson (California), Madras, and other places. Some of the pictures are six inches in diameter, so that all the spots and other irregularities on the solar surface are clearly shown.

From the foregoing brief account it will be seen that steady progress has been made in the study of the sun, and that the discoveries of our time compare with those of any former age. Yet much more remains to be done, and it is gratifying to find that many earnest investigators are devoting their energies to those solar phenomena which are so intimately connected with the conditions required by the life of men, animals, and plants upon our globe.

THE LIGHT BEYOND

Sweetheart, good night!
The day's long hours are past,
And twilight shades, at last
Closing around us fast,
Shut out the light.

Sweetheart, good night!
The winds of autumn sigh,
And from her throne on high
Through cloud-rifts in the sky
The moon shines bright.

Sweetheart, good-by!
The summer days are dead,
The trees their foliage shed,
And where our footsteps tread
The red leaves lie.

Good-by awhile!
The light will dawn at last
On hearts in love bound fast,
And o'er the buried past
Heaven yet may smile!

Eugene C. Dolson

RAT

BY HARVEY WICKHAM

ILLUSTRATED BY GEORGE WRIGHT

SEEING the reward of his tireless patience, Gidman gave a grunt of satisfaction. Long, bristling hairs that had trembled at the mouth of unguessed labyrinths in the corner were being followed by a sensitive nose and a pair of beady eyes as a drab shadow stole across the floor.

"Come here, Rat!" he called.

His voice, stiff from disuse, was gruff, and even the hollow response of the cell seemed lethargic and unwilling. It was at least a year since man had spoken there.

The rat, exhausting its last atom of courage in a dash for the outstretched palm, was gone before the echo. The unwonted sound had startled it like a closing trap, but even fright could not snatch the bit of cheese it lugged valiantly away.

Left alone, Gidman finished his morning's platter of food—a quarter-loaf of bread, some curd, and a tin of tepid coffee—eating with surly haste. Yet, as he thought of the tiny thief that had risked its neck for a titbit, a smile struggled with his heavy lips. Such greed and enterprise insured a return.

Breakfast over, he began to watch the sun-disks which the window-bars multiplied in vague symmetry upon the wall. What ailed the man? Years ago he had learned to turn his back to the light when brooding upon his plans. Now, it was an hour before the brain took up the thread, to weave and unravel and weave again its terrible web.

Gidman's musings were interrupted when he became aware of something forgotten. Shuffling to the wall, he carefully counted a series of short upright lines that had been scratched upon the moldy planks. Then he counted a much longer series of crosses, extending to the left and half-way round the cell. There could be no mistake. He had neglected the first duty of the day—which was to convert one of the straight lines into a cross. This work hastily performed with an uncut thumb-nail, thirty uncrossed lines remained. They were his calendar, marking the approach of coming release.

When new to the cell, he had found absorbing occupation in making this measurer of his punishment. He had counted and recounted, so as to preclude error. Eight times he drew three hundred and sixty-five straight lines upon the planks, and though he could not multiply, he was certain of the result. In the friendless darkness he had determined what would happen when the final cross was drawn. First would come the long walk to Chilquias, taking his first day of liberty. There he would make inquiries—would find Rosenthal. And then——?

For twenty years—from the day his mother had turned him from the hovel where he had caught his first unblessed glimpse of the light to the time that a misguided judge had saddled him with another's crime—the material had been gathering for the answer. In the loneliness of a Mexican frontier prison the answer had been articulated.

Crossing out the line which Rat had so nearly led him to forget, Gidman resumed his routine. He caught hold of the grating of the narrow window and crept time after time up the side of the cell, his bare feet clinging to the planks, giving him the semblance of a monstrous spider, his biceps knotting, his hands—

TAIL OF COMET WILL BRUSH EARTH

Prof. Burkholter Predicts Dazzling Display of Fireworks For Pacific Coast.

ASTRONOMERS TO GATHER

Preparing to Witness Phenomenon Which Will Occur Next May—Decline to Discuss Results.

"Mail & Press" Jan 5/10.

Oakland, Cal., Jan. 4.—Halley's comet will give the Pacific coast a close brush this year on May 18, between the hours of 4 and 10 o'clock p.m., and the "brush" will be something spectacular, says Professor Charles Burckhalter, of the Chabot observatory, because the earth will pass through the last third of the 20,000,000 mile tail of the celestial visitor, and the result ought to be as dazzling a piece of heavenly fireworks as this generation ever witnessed.

The news that Halley's comet will be seen only on the Pacific coast has not hitherto been given out, although the fact has been known for some time to the astronomers of the world, many of whom will journey to California to be on the scene when the great phenomenon takes place.

In discussing the comet the Oakland astronomer says: "Astronomers Cromelin and Cowell, of the royal observatory at Greenwich, have probably made the most exhaustive researches into the history of the comet. They have worked from a mathematical standpoint in order to calculate its periods—a period being the time it takes for a comet to travel from the point nearest the sun to complete its orbit and to return to its original starting point.

Good Observations Possible.

"The comet is very near the calculated position at the present time, and there is no reason for believing that the work of Cowell and Cromelin will need much, if any, revision. It is unfortunate that the sun will be rather low, but it will still be of sufficient altitude to make good observations possible. Should the transit take place as predicted, it will last about an hour, and should the comet cross the sun's disc centrally it will give the visiting astronomers a splendid opportunity to study a comet under the most favorable conditions.

"Another feature of the visit lies in the fact of the nearness of the comet to the earth, a distance of 14,000,000 miles. As the tail of the comet should be about 20,000,000 miles long, and pointing directly away from the sun, it will doubtless be encountered by the earth, but on that point I have nothing to say."

The astronomer insists that he has "nothing to say" about so dramatic a situation, fraught not only with awe-inspiring possibilities to the dwellers of the globe, but fraught as well with possibilities of tragic moment. Whether or not the earth's dive through the comet's tail will mean anything more than a dazzling starry spectacle Professor Burckhalter will not predict. He only says: "Wait and see."

LUNATICS CUT LOOSE

aberration = $\frac{R^2}{2F}$

~~8"~~ mirror of 84"
9½" focus — aber = 1/7" cavity = $\frac{R^2}{4F}$

M 5.13.22.17.
·20 ~~to finish~~ rad. 6.5 in mirror of 66" focal length,
aberration = $\frac{3\frac{1}{4} \times 3\frac{1}{4}}{66 \times 2}$

J. E. Wellish's 16" & 98" focal length. aberr" is .34" (shorter in centre than at edge.) used 24 carb. 1¾ lbs. + 5 grades of washings. hrs in coarse — hrs in fine grinding — polished in 5 hrs.

$\frac{8 \times 8}{2 \times 98} = \frac{16}{49} = .326$"

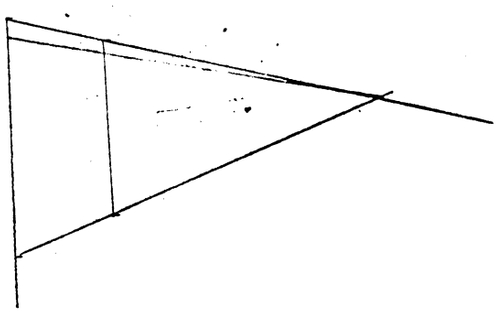
mirror 6¾" ~~focal~~ diameter + 62½" focal length
aberration = $\frac{3\frac{3}{8} \times 3\frac{3}{8}}{62\frac{1}{2} \times 2}$ = about $\frac{1}{11}$"

mirror 9¾" diameter — 87½ in. focal length.
aberration = $\frac{4\frac{7}{8} \times 4\frac{7}{8}}{87\frac{1}{2} \times 2}$ = about 1/8"

100"

20"

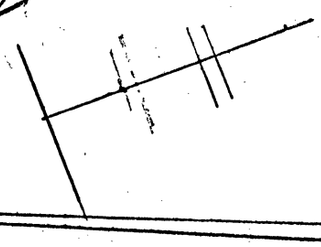
10"

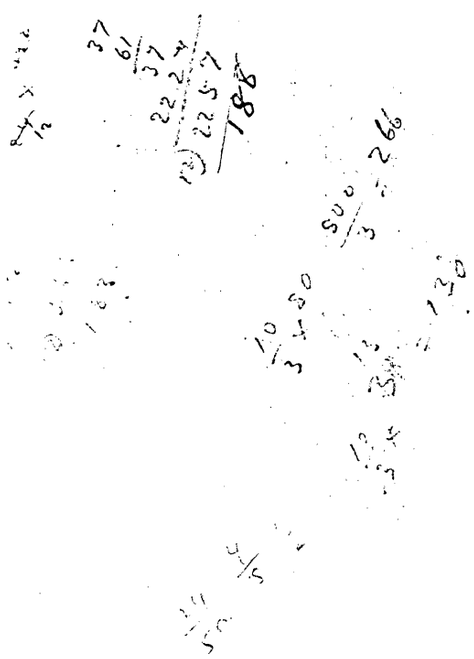


15 of acc 120"

$$\text{Cavity} = \frac{R^2}{4F} = \frac{7 \times 8}{4 \times 30} = \frac{1"}{9}$$

$$\text{above} = \frac{R^2}{2F} = \frac{7 \times 8}{2 \times 30} = \frac{1"}{5}$$





Powers of Eyepieces on different apertures.

aperture. Focal Length. 2 in. = 24 in	aperture. focal Length. 4 in. = 36 in.	aperture. focal Length. 6 in. = 50 in.	aperture. focal Length. 9½ in. = 82 in.	aperture. Focal Length. 15 in. = 120 in.
30 power.	45 power.	63 power.	100 power	150 power.
60 "	90 "	125 "	205 "	300 "
80 "	135 "	185 "	305 "	450 "
123 "	183 "	254 "	415 "	620 "
		12" of 108"		100
		135		200
		270		320
		360		480
		560.		

120" = 15"

60 power on 2" = 125
60 power = 300
80 " = 400
123 " = 615 2/10 1/5

8 16/19

19) 164
152
16/19

8 9/14

14) 121
112
9/14

"Handle" on moon

1901 May 19 - 1 - 42 min (new)
" 29 - 9 — observed "handle"

10 days 7 hrs 18 min old.

$= \frac{14\frac{1}{2}}{100} = \frac{29}{200} = \frac{3}{20} \pm = \frac{1}{6} - = \frac{1}{7} +$

512) 750 (.146
512
2380
2048
3320
3072
248

7 in mirror of 66" focus = hollow.

$\frac{7 \times 7}{16 \times 66} = \frac{49}{1056} \cdot \frac{7}{151} \cdot \frac{1}{21}$"

16 × 66 = 396, 66 × 16 = 1056

$\frac{3\frac{1}{2} \times 3\frac{1}{2}}{4 \times 66} = \frac{1}{22}$"

9 = Excavations.

Focal length of mirror be 1:8

aberration at centre of curvature of 15 in mirror of 96 in focus is:— $\frac{R^2}{2F} = \frac{7.5 \times 7.5}{2 \times 96} = \frac{56.25}{192} = .341$" = over $\frac{1}{3}$"

$\frac{R^2}{2F} = \frac{(7\frac{1}{2})^2}{96 \times 2} = \frac{56\frac{1}{4}}{192} = \frac{225}{768}$ .291"

225 / 768 = 2250 − 1536 = 7140 − 7012 = 1280 or about $\frac{3}{10}$"

aberration of 15 in mirror of 96 in focus = .291"
= $\frac{3}{10}$"

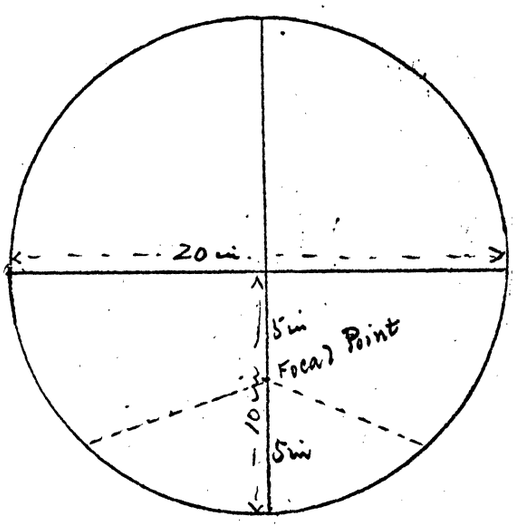
" " " " " 98 " "

$= \frac{56\frac{1}{4}}{196} = \frac{225}{784} = .287$ = about $\frac{1}{4}$"

1 = 8
14 of 112"
$\frac{14 \times 1}{16 + 112}$

$\frac{1}{36}$
$\frac{48}{448} = \frac{1}{11}$"

for 15" glass of 96" focus = $\frac{15^2}{16 \times 96} = \frac{15 \times 15}{16 \times 96} = \frac{75}{512}$.



Excavation necessary for making a spherical curve.

$\frac{D^2}{16F}$ or $\frac{R^2}{4F}$

$\frac{20 \times 20}{16 \times 5} = 5$ in.

$\frac{10 \times 10}{4 \times 5} = 5$ in.

for 15 inch glass of 120 in. focus =

$\frac{15^2}{16 \times 120} = \frac{15 \times 15}{16 \times 120} = \frac{15}{128}$ about $\frac{1}{9}$"

---

area of circle = $3\frac{1}{7} \times R^2 = \pi R^2$

15 in. " = $3\frac{1}{7} \times 7\frac{1}{2} \times 7\frac{1}{2} = 176\frac{11}{14}$ sq. inches

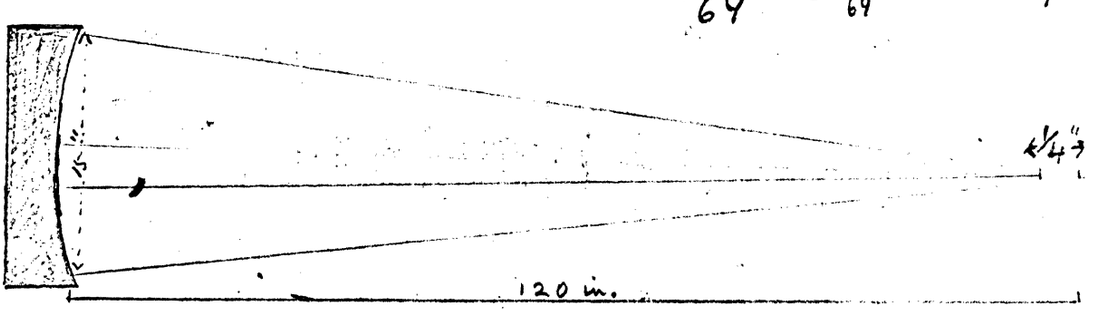
$9\frac{1}{2}$ " " = $3\frac{1}{7} \times \left(\frac{9\frac{1}{2}}{2}\right)^2$ = about 71 sq. in.

12 " " " = $\frac{22}{7} \times 6 \times 6$ = $113\frac{1}{7}$ sq. in.

$\frac{D^2}{2R}$ Aberration for parabola. $\frac{R^2}{2F}$

15 in of 120 in focus = $\frac{7\frac{1}{2} \times 7\frac{1}{2}}{120 \times 2} = \frac{56\frac{1}{4}}{240} = \frac{225}{960} = \frac{15}{64}$ = about $\frac{3}{13}$ = about $\frac{1}{4}$"

$\frac{192}{64} = \frac{1}{64}$ less than $\frac{1}{4}$"



Copper rubbed on Sal ammoniac becomes tinned. See this for soldering.

John E. Mellish
R. F. D. 1-7
COTTAGE GROVE, WIS.

MAY - 1 1908

(!)

COTTAGE GROVE WIS
APR 29 1908 6PM

Albert R. J. T. Hassard,

Toronto,

Canada.

In Earnest & Howard

Albert R. J. F. Hassard.
Toronto, Canada.

Dear Sir I read with great interest your article in Popular Astronomy for May,
How did you learn to make a reflecting telescope
Did you see my article in Popular Mechanics the October number, 1907 about reflecting telescopes
That article has started 15 amateurs at constructing their own telescopes, I suppose you are a subscriber to the English Mechanic and that that is where you learnt how to make a telescope
I first used a 2 in refractor then I thought a larger telescope would be better but could not buy such a one as I wanted so started to make one first a 6 in. in 1905, I used the 6 in until this winter then made an 8½ in 94 in focal length also an 8½ in, 40 in focal length, which I use when looking for comets
I also made an 8½ in, 75 in focus for a Professor of Astronomy in Mexico City. Mexico, it was a fine one, I made it for $55. which was cheap.,
I am sending you a photograph of it, it looks the same as mine, It does me good to see people making their own telescopes, Did you get a perfect curve to your speculum,
I did not use the same shaped polisher all the time when nearly done I made a special shape by cutting the edges of the facets away where the least abrasion was wanted in that way I get a perfect curve,
My telescopes are equatorialy mounted but the one in the photograph is for the latitude of + 19° for, Mexico City.
What is the focal length of your 9½ in,
If I can be of any service to you I will be very glad
I am, Dear Sir Very truly Yours
John E Mellish

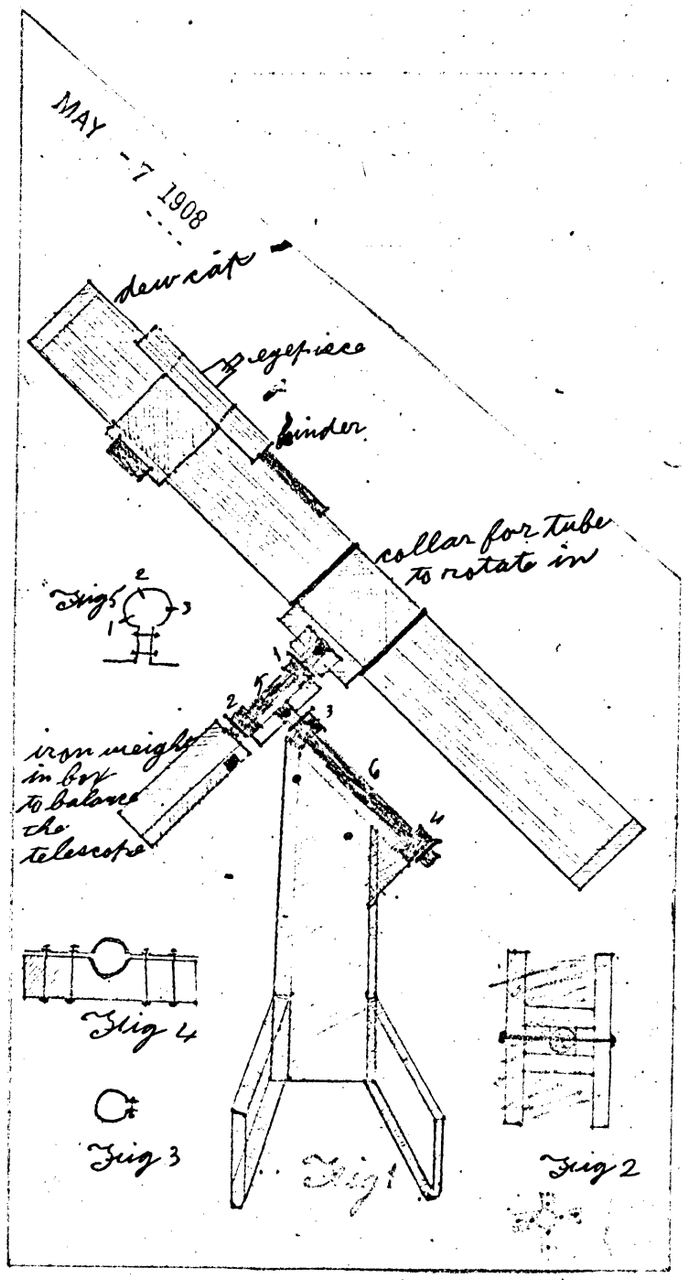

MAY -7 1908
dew cap
eyepiece
finder
collar for tube to rotate in
iron weight in box to balance the telescope
Fig 5
Fig 4
Fig 3
Fig 1
Fig 2

Fig 6

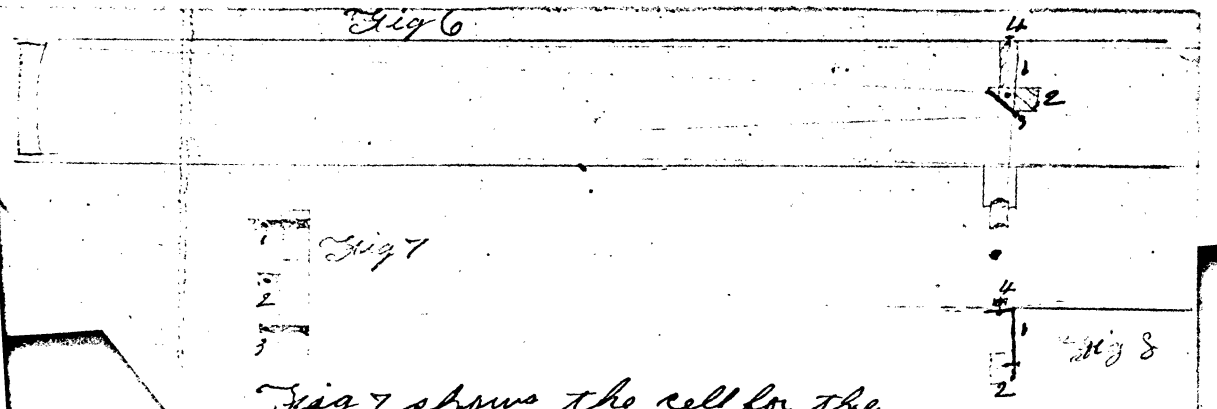


Fig 7

Fig 8

Fig 7 shows the cell for the speculum made of tin with three strips with a hole in each for a bolt the tube must have three slits 3 in long for adjusting the speculum. the speculum is held in the tube with three short stone bolts (1.2.3) Fig 7

May 4th 1908.

A. R. Hassard. Dear Sir, I was very glad to get your letters, have you a pair of small scales that will weigh down to one grain you need it as the chemicals must be weighed very accurately, pure distilled water must be used; the method of silvering in Popular Mechanics is the best way known, I never made a speculum without some scratches, but they do no harm,

The focal length of your 9½ in glass is to short for use with high power, I can only use 20 diameters on my 8½ in of 40 in focus, the curve does not show up on a short focus glass, with my 8½ in of 94 in focus I use 300 diameters not more as it is to hard to keep a star in the field with 450 or 500, My glasses are polished to the most absolute perfection not counting some scratches,

~~My 6 inch glass shows 5 satelites of saturn, the 8½ in shows 6 satelites~~ I use 200 on saturn with 6 in and 300 on 8½ in I work my glasses by hand a perfect curve can not be got with a machine, I use carborundum for the grinding it cuts six times as fast as emery, I do the coarse grinding of an 8½ in of 40 in focus in 2 hours, and the fine grinding in 4 or 5 hours then the polishing takes 5 hours, I do not test my glasses now until they are polished then I use a polisher of a special shape. the testing and figuring takes from 0 to 30 hours,

I have powers of 50 field of view 1 degree, 100 field of view just the moon or 30', 300 field of view 9', on 8½ in of 94 in focus I only use power of 20 field of view 2¼ degrees, on 8½ of 40 in focus the 8½ in of 40 in focus is only for hunting comets.,

My 8½ in glasses are 1⅓ in thick

The nearest of the 15 amateurs to you is, Attica, N.Y., the most of them have very hard work of it only three or four are done, Yes I like the observational part of astronomy I have spent as many as 12 hours steady at the telescope, last November, and December.,

I live 12 miles from Washburn Observatory I go there often and spend a day in the library.,

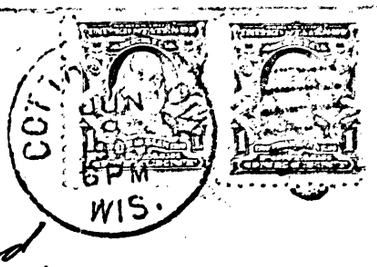
I spent two days at Yerkes Observatory last Sept, and stayed with Professor Barnard. He showed me Saturn, Uranus and some, star clusters, and nebulae with the 40 in glass

It was a very bad night. it was cloudy part of the time
I will go there again this spring or summer.
Yerkes Observatory is a most wonderfull place, it has
a 12 inch refractor, 40 inch refractor, 6 inch transit, 3 in transit
a 24 in reflector used only for photography its focus is 8 feet
Yerkes also has a 5 in refractor for comet seeking, and a
10 in refractor for photography, and 6 in and several smaller
lenses for photography all on one mounting with a 5 in
guiding telescope, I saw a great stack or several of
them, of photographs of the sun, moon planets and
all the sky, with lenses from 40 in down to 1 in
May & ½ in of 94 in focus divides double stars down to ".5
ε. Bootes is a splendid double.
Ask all the questions you want to I make it my
business to help all amateurs. I have written 300 or 400
letters this winter I have got from one to six
letters a day all winter, all those I answer in full
of course it takes time but I like it.
I must have left the picture of the telescope out of
the letter to you, I have none now but will get to work
and print some more in a few days,
I am sending a description of my telescope and stand
Fig 1. (1.2.3.4) are boring of band iron for the axles (5.6) to turn
in, the axles must be at least of 1¾ in gas pipe, 2 in is better
Fig 4. shows end view of axle and boring,
Fig 2 shows end view of axles split down 2 inches and
two ¼ in holes in each end for bolts
Fig 5 shows the irons to hold the finder (1.2.3) are set screws
to adjust the finder, the finder is a 1½ in spy glass with
the two field glasses taken out of the eyepiece,
Fig 6 shows the tube with glasses in it, the small flat mirror (3)
is fastened to a small block of wood (2) with brass strips of tin
screwed to (2) and the other end bent over the flat mirror, the
bar that holds the mirror in the center of the tube is iron 1½ in
wide 1/16 in thick with (2) screwed to one end and the other end bent
and a bolt through it and the tube at (4)., I have been up nearly
all night the last two nights so must go to bed and get some sleep to night
it is ten thirty now (Very truly Yours John E Abelliek

John E. Mellish
R. F. D. 1-7
COTTAGE GROVE, WIS.

JUN 1[illegible] 1908

(3)



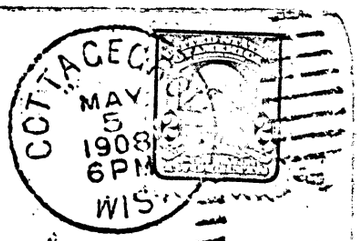
A R Hassard.
Confederation Life Bldg,
Toronto
Canada

John E. Mellish
R. F. D. 1-7
COTTAGE GROVE, WIS.

MAY 7 1908

MAY 7 1908

(2)



A. R. Hassard.
Confederation Life Bldg,
Toronto,
Canada.

June 7 1908,

JUN 11 1908

A R Hassard

Dear Sir,

I waited very long about answering your letter. I have been so very busy that time goes very fast.
Since I wrote last I polished my long focus 8½ in. to perfection and have the right curve to it my glass has some fine scratches on it but they do not hurt,
I have not taken any photographs yet but will do so soon. thank you for the little book you sent me, I think it is a great deal better to help others than not to, I have written to several prominent astronomers at different times for a little information they would write about a dozen lines and hope that I would find the desired information in some library, I am not much of a writer but I have written about 300 letters of from 200 to 1000 words this winter, I would get a lot of them printed but can not answer the questions of all in that way,
I have a power of 300 for my 8½ in but hardley ever use it, only about three times the last month,
I have a splendid eyepiece which gives a power of 100 and shows about ⅞ the diameter of the Moon this eyepiece is just grand on the nebulae, and star clusters
I have the village black-smith do all my drilling, sawing, and threading in iron.

I have no trouble at all in silvering my glasses, when the $\frac{1}{10}$ of the silver solution is added drop by drop the bath will change from clear to a yellow tint but its transparency must not be destroyed or the silver will not come up right,

(I am very sorry that your letter was not answered when I first got it, but if you have trouble in the silvering write by return mail and I will send a complete instructions as near as I can about it,

1 I used to see the companion of Aldebaran with my 2 in glass power 160,

2 The companion of eta Cassiopea is very easy with my 6 in

3 I never looked for the companions to Pollux with my 6 in

4 I expect to be able to see the companion of Gamma^2 Andromeda with 300 on $8\frac{1}{2}$ in, as soon as it gets up from the sun,

5 Loaf sugar is the common squares of white sugar,

6 I never saw the companion to Andares for certain with 6 in, will look at it soon with $8\frac{1}{2}$ in

7 The great cluster in Hercules was full of stars with 6 in and very fine with $8\frac{1}{2}$ in

8 The ring nebula in Lyra is a splendid object with $8\frac{1}{2}$ in, last Sept I saw it with the great 40 in Yerkes telescope the small star in the center of it was plain, it was one of the most wonderfull sights I have ever seen

My 2 in power 60 always doubled ϵ, Lyrae the double-double, but it was very hard work to do it

ϵ, Bootes a fine double with telescopes over 3 in

I am sending you some photos of an amateur in Milwaukee with his telescopes he is very interested in celestial photography, please send the pictures back as I would like to keep them,

His address is, 463 10th Ave. Milwaukee,

name, Arthur Prahl,

your 9½ in reflector will give splendid views of the nebulae my 8½ in shows some of them as rifts of light in the sky very queer sights,

The 9½ in will show a lot of occultations of small stars by the moon,

2½ in pipe is just the thing for the cables for 9½ in I had 1½ in pipe for the 6 in and am using it with the 8½ in but will change to 2 in pipe or 2½ in so it will be very steady

Have you ever seen the clefts or cracks on the moon the 4 in will shew a few of them, I saw over 50 with my 6 in and the 8½ in will show over 200 of them I think they are very queer sights, about ½ mile or one mile wide and some thousands of feet deep and hundreds of miles long, in some case

Saturn will be a splendid object this Summer,

In December 1906 I saw venus as a complete ring at inferior conjuction Venus never gets to faint to be seen with a good telescope, it grows brighter "at inferior conjuction" when it comes with in 2° of the sun,

The 9½ in glass, silvered, will throw a light spot on the clouds when a bright electric lamp is used I have thrown a light a distance of one mile with 8½ in and oil lamp, very truly yours, John E Ellis

July 11, 1908.

A R Hasson

Dear Sir,

My glasses did not get thinner at the edges, the speculum I mean the other glass did not wear in the centre but a trifle. Six inches ~~longer~~ shorter focus than is wanted is a plenty the focus lengthens a little in the fine grinding, Use a high power eyepiece as well as the knife in testing, the image of the artificial star must be the same on each side of the focus, a bad curve will make it bright on one side of the focus and dark in the center on the other side,

The iron must be heat to bend it and two holes must be bored in each end like this  that makes it very solid, use ¼ in rivets

My polar axis is an old wind-mill the axis is only ⅞ in shafting but it works splendidly,

I have Webbs fifth edition of celestial objects it does not have many of the rills on the map but it tells where they are, I also use Neison and the Moon it has hundreds of the clefts or rills, on its maps,

I can see a common fly and can just see its legs at a distance of 3000 feet its legs are only $\frac{1}{75}$ of an inch in diameter this corresponds to about 1000 feet on the Moon I can plainly see rills ½ mile wide but they are from 100 to several hundreds of miles in length, and several thousand feet deep You can see several of them with your 4 in they show just like a black thread spread along on the Moon,

I never use over 300 on 8½ in of 94 in focus, that power shows it clear cut and plain, I never like to look through a telescope unless it is of the very best quality

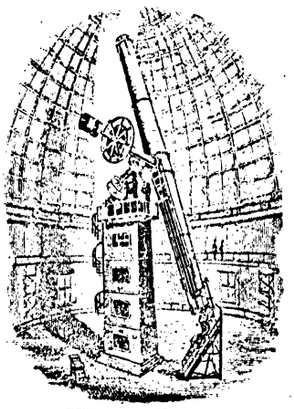
Write again soon.

Very truly yours

John E Mellish

Dover

I have four letters to write by this Mail and am nearly out of paper so will write off both sides
There is a man in belding Mich that is always out of paper and he has written about eight time
I only used one grade of emery or Carborundum and then sifted that through water and graded it in five grades of, 3 seconds, 30 seconds, 2 minutes, 6, 20, and 60 minutes,
When grinding with the three finest grades do not press a bit on the glass, pressure in the last stages of fine grinding or polishing will cause flexure which is the most discouraging thing as it can not be got out,
Carborundum is six times as good as emery for the fine grinding it takes the pits out in great shape.



36 INCH LICK TELESCOPE

John E. Mellish
R. F. D. 1-7
COTTAGE GROVE, WIS.

JUN 20 1908

COTTAGE GROVE JUN 18 1908 6PM WIS.

A. R. Hassard
Confederation life building
Toronto
Canada

John E. Mellish
R. F. D. 1-7
COTTAGE GROVE, WIS.

JUL 15 1908

COTTAGE GROVE JUL 13 1908 PM WIS.

A. R. Hassard
Confederation life building
Toronto
Canada.

June 17 1908.

A R Hassard

Dear Sir, I was very glad to hear from you again,
I do not have as much writing to do now, only 3 or 4 letters a week,
I have the American Nautical almanac it is a splendid book, I would not be with out it.
Do you take the english Mechanic, I think it is the best paper published for observers,
I do not like Popular Astronomy any more it is almost all mathematics now, I have written several articles for it but not one has been published, & P. Astronomy for November last has a part of one my letters about a meteors trail, I wrote about the transit of Mercury I saw it very plainly here,
I wrote a long article last Jan. about making a reflecting telescope and sent photographs and drawings, they wrote that they examine it very soon and report, but have not done so yet Professor Payne has said several times that they had over 100 foreign Observatorys on their list, and had to give them some strong meat to keep their appetites good, P. of P. May 1905, page 280
I do not care, only they ought to change the name to Astronomy and mathematics,
Next time I write I will send all kinds of pictures,
I buy my eyepieces of W. & D. Mogey, Bayonne New Jersey they sell lenses for eyepieces also, send for their catalogue it is interesting, also send for Brashears catalogue it is a splendid book

JUN 20 1908

I get all the catalogues I can find, one gets a lot of hints from them,

Make the draw tube for your 9½ in, 2 in, in diameter then make an eyepiece with the field lens at least 1½ in in diameter, then you will have a field of 1½° this will show the large clusters and large faint nebula finely,

Make an eyepiece like the one I gave an account of in the E. M. of Jan 3rd, it is a splendid eyepiece,

Get some band iron ⅛ in thick and 1½ in wide and make some bands for the tube with rivets every four inches

After you get the finder and all the small parts on put a band on where it will set on the cradle and bend it like this ◯ to make handles to turn it with the tube ought to have a band about a foot from the end also

Do the city lights bother you much, if they do the nebulae will not show like they do here

Have you ever seen any of the clefts or rills on the moon with your 4 in it will show ten or twelve of the larger, I think they are very interesting with the 8½ in. which will show over a hundred,

Did you look at Mars much last summer I made several drawings in the spring, but after the first of July I hardly looked at it in 1909 we will have fine views of it,

This is the first winter since I have had a telescope that I have not drawn Jupiter every good night, the last opposition I only drew it once, Saturn will be interesting again this fall, I will soon get out some drawings of Jupiter made in 1906-07 they are better than the ones I sent you made in 1905-06,

Very truly Yours, John E Evelith

Milwaukee Wisc, June 19, '08.

Mr. A. R. Hassard,

JUN 2 2 1908

Dear Sir:

Yours of the 15th on hand and was very glad to receive your missive. The instruments you saw on Mr. Mellish's photo are, a 2 inch Bardow objective of 24 in. focus, the tube, eyepiece, and tripod I made myself. The other is a 6 inch reflector of 70 inches focal length. Its definition is not of the best. I worked about 3 months on it, then my patience gave out. I am beginning to refigure it again. It is very hard to get a perfect curve. I also refigured my 2 inch, which used to show all objects as through a fog. Now it is as perfect as can be. I can divide the double star ε Lyræ with a power of 48. I also have a 3 inch refractor, which I use for photography. I am sending you a few prints. I find celestial photography most interesting, although I spoil about eleven plates out of a dozen.

The equatorial carrying my reflector is made of

John E. Mellish
R. F. D. 1-7
COTTAGE GROVE, WIS.

JUN 25 1908

COTTAGE GROVE
JUN
23
1908
2 PM
WIS.

A. R Hassard Esq
Confederation. life building
Toronto
Canada.

two-inch gaspipe in bronze bearings; the declination axis is of very hard steel, 1.25 inch diameter and 28 in. long. The entire mounting (of) weighs about 75 pounds. I made it last summer, and since then it has been outside, sun or rain, uncared for, and it works satisfactorily still. I grind all my eyepiece lenses and do all the other work of mounting, etc. Am also making a 2 inch and a 4 inch refractor.

I didnt have any trouble silvering my mirrors. I kept to the instructions exactly; but I had some trouble getting a good flat plane mirror.

Is the mirror you are working on your first? If so, dont expect to get it perfect the first time. I reground mine 4 times and it is not good yet. Even if your mirror is perfect it will not perform right unless the plane is perfectly flat. I rejected about 6 before I got a good one. Please let me hear from you again. I remain

Sincerely yours

Arthur Pirahl.

463 10th. Ave.
Milwaukee. Wisc.

A. Prahl,
Milwaukee, Wisc.

MILWAUKEE. WIS.
JUN 20
3 PM
1908
Sta. A.

JUN 2[illegible] 1908

Sarngey and Hassard
Confederation Life Bldg.
Toronto, Canada.

20

2½
5
30
39½ hrs.

JUN 25 1908

June 22 1908.

A R Hassard

Dear Sir.

My silvered glasses are not opague there is no need of that, also the silver is not very hard but it will stand polishing, I always take the glass out of the silvering bath as soon as it becomes muddy,

The silvering bath should be stirred very fast to dissolve the black deposit from solution B. I was bothered the same way at first.

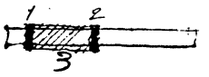
No I still grind glass by walking, it does not take long and I do not mind it at all.

I was only 2 hours grinding 8½ in, 2½ hours, fine grinding, and 5 hours polishing, and 30 almost getting the right curve,

I have no rack & monement for my eyepieces, I focus it by twisting the draw tube which is very easy

Yes I have a rotating tube, it is the only thing

The weight for my 8½ in of 94 inch focus is about 20 lbs

For the draw tube, I took brass tubes like this 

the short tube (3) is 1/16 in larger in diameter than the draw tube than I glued two strips of cloth (1.2 on the in side of it this makes the draw work snugly and easy I got that trick from the "Bardou rifle range telesc

We have had some of the finest electric storms the last two days that I ever saw, I tried to take some photographs of it but did not get a good one,

I will take a day off to morrow and get a lot of photographs, Very truly yours

John E Mellish

Milwaukee, June 27, 1908.

Mr. D. R. Hazzard,

Dear Sir.

Am very glad to hear from you again. I had intended writing immediately, but have not much spare time.

My three-inch telescope is not run by clock-work. I am sending a picture of it, as it looks with an eye-piece. As you will see, it is mounted on a simple equatorial, a very convenient mounting for such work. I carefully focus the group on the ground glass, then point the guiding telescope on the brightest star in the vicinity, and bring it on the cross-wire, put it out of focus a little, thus: ⊕, and then try to keep it there by means of the handle, which controls both axes. The time passes very slow during exposure, and in summer the position is rather trying on account of the mosquitoes. I generally make my exposures as long as a cigar will last.

The reason I do all my own work is that I have not the money to buy them. I've had about five years practical machine-shop experience. Now I am with a wholesale optical concern.

The only way to test your mirror is by a star or artificial point of light. I use a small electric bulb. Get the star in focus, then note the appearance of the image about half an inch on both sides of the focus. If the images are similar, your mirror is perfect. If the image half an inch out of focus, has a bright border, your mirror needs polishing by short elliptical strokes. If the centre is brightest, use long strokes.

I proceeded with my silvering thus: I first put all articles, viz. mirror, chemicals and dishes, etc., in one room for 24 hours, to equalize temperature. This is important. I then carefully cleaned everything with nitric acid, rinsing with distilled water. I then proceeded as you did, but tried to get rid of all deposit. The ½ silver solution is put in before the reducing solution. After the mirror was immersed, I watched until the fluid began to get brown, then I lifted the mirror out. If left in too long, you will have a foggy film.

Several days later I polished with a cotton pad. This brightened the film, and filled it with small scratches. Anything damp will remove the film. The insensible perspiration always present in the finger tips is sufficient to do this. I got my distilled water at a druggist. It must be "perfectly clean," or the silver will not rise.

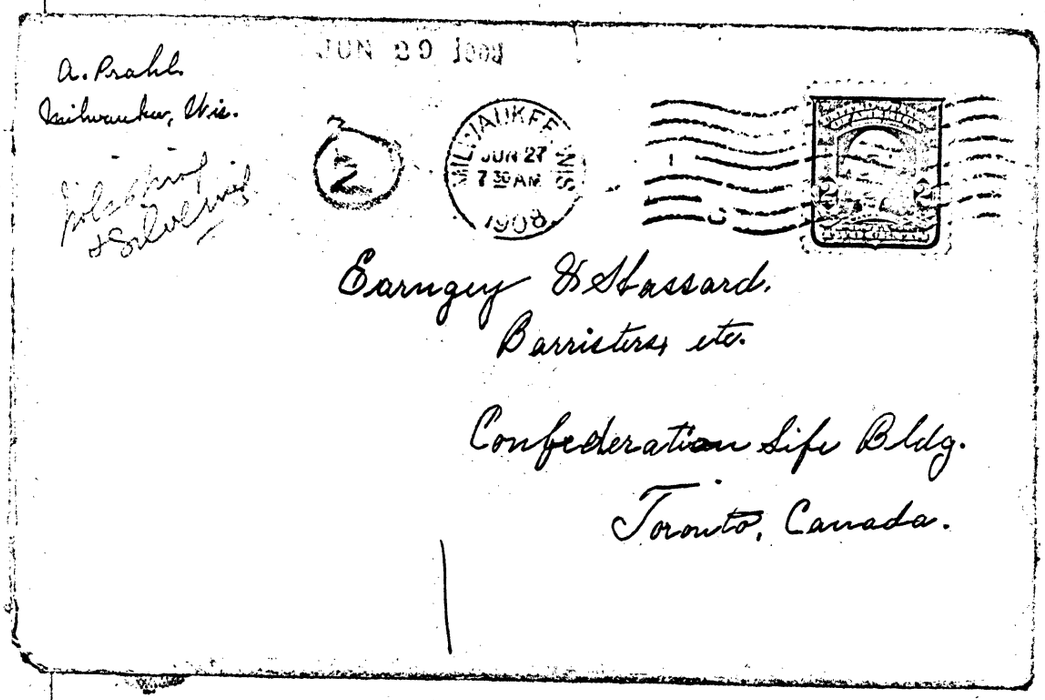
I have a good screw-cutting lathe, on which I do all my work. It is of 9 inches swing, taking 26 in. between centres. I even made a rack and pinion with it, also several slow-motion gears. I grind my lenses on cast-iron disks, turned to the proper curve. The disk is then screwed on a rapidly revolving spindle, the glass cemented to a little handle, and then finished about the same as a mirror. I ground my 6 in. mirror on such a disk. Grinding took 2 hours, polished in 1 hour. The figuring of the curve took about 20 hours. - Well, I must close now. I remain,

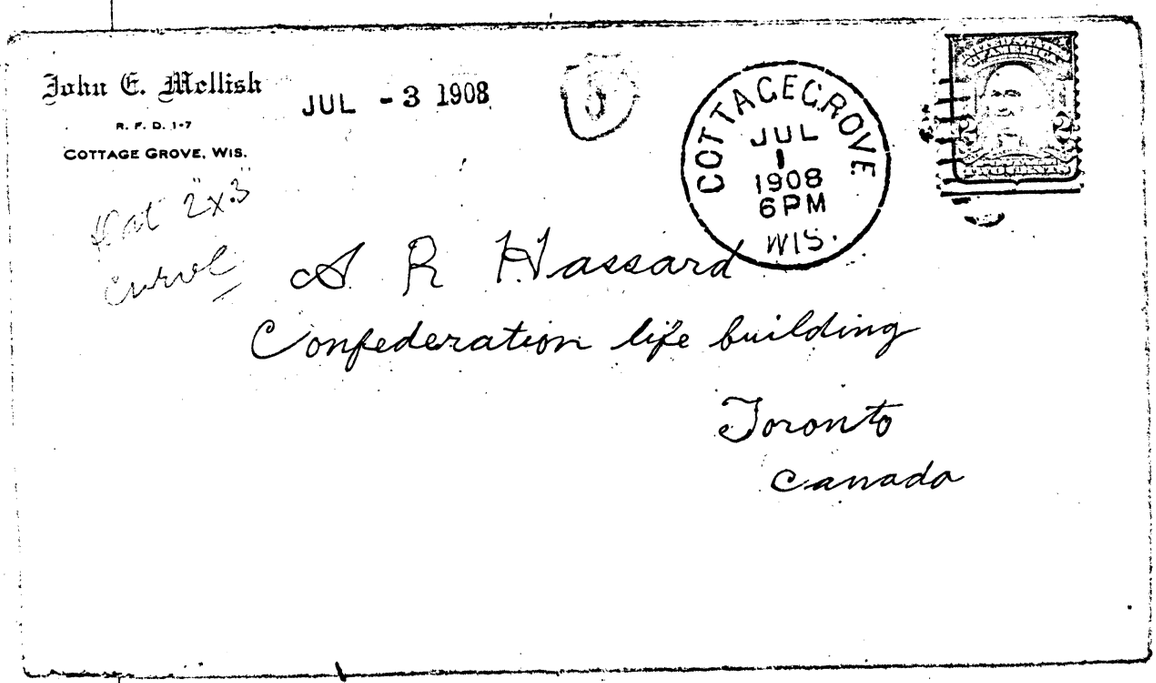
Sincerely yours,

Arthur Brahl.

463-10-Ave. Milwaukee, Wisc.

To find North true bearing by watch
4 pm; bisect angle between hour hand
& 12 — that bisecting line runs N.S.





June 30, 1908.

A. R. Hassard

Dear Sir.

I got your letter yesterday and wanted to answer it by return mail but could not, It is the short focus, a focus of 8 inches is better and I think it is impossible to get a perfect curve on a very short focus, I know my 8½ inch of 41 in focus did not show anything only the parabolic curve but it will not bear more than 40 diameters

For the coarse grinding use No 24 carborundum sift the ground carborundum through water and use it instead of emery, I did it and it worked splendidly

1 inch thick is very thin for 9½ in the telescope makers say they should be ⅙ of the diameter, or there is almost sure to be flexure, but there is not much danger if the glass is not pressed hard any time in working or in testing it.

Get a piece of plate glass for the flat, ⅓ inch thick, oval shaped 2 X 3 inch, and make an eyepiece with the field lens 2 inches in diameter and 4 inch focus, and eye lens 1 inch diameter and 2¼ inch focus, distance between lenses 2 in this will be a splendid eyepiece giving a large field of view, 1° on 8 inch focus, I use that size on 8½ in.

Take one oz of jewlers rouge and mix it with one quart of water let it stand a little until the coarse stuff has settled, than turn it off and let it settle again, this is almost sure to be clean, if it is not free of grit sift it again,

I have not had time to finish my pictures yet but will do so soon, will send one of my self and the six inch the way it was mounted this winter

I am a naturalist and I just took a photo of a Blue Jay sitting on its nest it is splendid

For lengthening the focus of 9½ in use the tool to work with instead of the speculum, and fasten the speculum to the bench, in the place of the tool use short circular strokes for fifteen minutes steady work this will flatten the speculum a little then change them, and work the ~~flat~~ old way with circular strokes not more than 2 inch when the right curve is reached use a few short straight strokes, then go at the fine grinding,

I ground my 8½ in of 94 in focus on a 7½ inch glass that is something unheard of, but I have not got a turned down edge or a turned up edge, only a turned down edge of 1/16 inch from the edge, it is impossible to do better than that,

By changing them, I mean put the tool under and work the speculum, over it.

When polishing I do not test the glass at all I use long straight strokes until polish is complete then I test the glass and use short straight strokes, not more than ¼ the diameter of the glass that will bring a pretty good curve if the facets are in the right position, when the curve is nearly perfect, the hard job comes into play, when the speculum is very good under test it may not be so very good with the eyepiece, Take a very high power eyepiece and examine the image of the needle hole in the screen, on each side of the focus the image must be the same on each side, that will tell whether the parabolic curve is to strong or not,

The parabolic curve is so small that I can hardly tell it from a flat test

I also take a sharp knife and trim the edges of a few facets where they wear to much, that is the only way I can get a perfect curve. I have my polisher ¼ inch less diameter than the speculum then the edge will not turn down.

Very truly Yours John C Mackie

July 17 1908

A. R. Hassard

Dear Sir

In what number of the E.M. did you read about having the focus 6 or 7 feet longer than at the end,' I do not remember of reading about it

When polishing if I got the—Oblate Spheroid, I took a sharp knife and trimed a little strip from the edge of the facets where the least wear is wanted then used short straight strokes, that always took the ridge away, If I got the Hyperbola, I did the same, If there was several rings I always tried a shorter and shorter stroke until I got down to one inch stroke then if the rings stayed there was no use but to make the polisher over as the facets did not have the right position with the center of the tool

If the edge of the speculum turned up I warmed the facets a little and pressed it, so the polisher would be a little larger, The edge almost always turned down for about ¼ inch, I left it that way till it was nearly done then cut a slice from the edge around the tool of about ½ in on one third of the facets and ¼ in on One half of the facets the edge of my 8½ in of 96 inch focus turns down for about 1/16 of an inch but that is not enough to do any harm, Make the artificial star as small as possible, also be sure to use as high a power as 300, examine the immage on each side of the focus, it must be exactly the same on each side, The glass is not good unless the needle hole shows entirely free from any stray light, When testing place a piece of paper of the size of the small flat mirror, on the center of the speculum,

I always polish the glass complete before testing, and when testing I always use less than 2 inch strokes generaly one inch, some of the amateurs insist on using long strokes Mr Prahl wrote that short stroke did not work good but he used less than one inch strokes before he was done,

When I first started I used long strokes but had to give

[illegible] nearly done I had to rest up for [illegible]
only five minutes as that would make a great change

Do not try to get the parabolic curve it is better to make it test flat I never got a good ~~[illegible]~~ glass with the parabolic curve, I think the reason of it is, the parabolic curve, and the flat ~~[illegible]~~ in the test is very nearly the same so near in fact that it is almost impossible to tell them apart,

I just got two more medals for discovering comets they are bronze and very large

Good for you a camera is one of the best things to have, I think you have, glass ~~[illegible]~~ working by heat and by abrasion, if not get it from { The book supply Co Chicago

Price 35¢ postage 5¢

It is the best book that I have ever read on that subject it is very short but that is the best,

We have had lots of splendid nights this summer so for, I spend a good share of the moonless nights now looking for comets it is queer that there is no comets around

What kind of camera have you, What did you pay for it, What is the focus, and diameter of lens

My camera is only a small box, which I bought just to learn photography with I am thinking of getting a stereoscopic camera,

I got up and went picking berries this morning before it was light and did not come back until 2 o'clock this afternoon, I got so interested in the new country that I did not want to come back then

Very truly Yours

John E. Mellish
R. F. D. 1-7
COTTAGE GROVE, WIS.

JUL 22 1908
and Same Day

COTTAGE GROVE
JUL 20 1908 6PM
WIS.

A. R. Hassard Esq
Confederation Life Bldg.
Toronto
Canada

July 28 1908

JUL 31 1908

Mr. A. R. Hassard,

Dear Sir I am sending you the book glass working, your 9½ inch short focus is just the thing to use for comets, use an eyepiece with a field of 1°, I only look near the Sun, I start just as soon as the sky is dark and go over the sky that is inside of 90° from the Sun I take a part of the sky and move the telescope across it then move it back and move it up half of the diameter of the field of view then move it down again I only have a star map of my own make, and Webbs celestial objects fifth edition, from Longmans Green and Co N.Y. $3.50 in two vols. You will find a note about my first comet in Popular Astronomy for May 1907 and Nov 1907.,
There are lots of nebulae in the sky and some of them look like a comet, when you find a nebula mark the stars around it, set them down on paper and then look at it in an hour and if it has not moved it is not likely to be a comet but look at it the next night to make sure, I do not need to mark them down now as I ~~not~~ know all the nebulae in the sky, I mean the bright ones such as are visible in a short focus 8½ in, Glass working tells the difference Between the Oblate Spheroid and the hyperbola,
with a good glass a star in focus shows like this ◎ hold this out at arms length to look at it,
The small paper on the center of the speculum is for the eye-piece test, the image out of focus will then look like this ◎ on both sides of the focus with a perfect glass, but with a poor one like this on one side ◎, and like this ◎ on the other side,
I mount my eyepiece on a small stand like this  a pointed stick on a block and the eyepiece in a loop at the top,
I am going to Chadwick soon and will look up the best star atlas for comet work and give the name to you
I would have answered this last letter sooner but I lost it for four days, and just found it in the bottom of a box of trash
when polishing I make 200 strokes a minute and keep it up for fifteen minutes when I have to rest that speed takes about four hours to polish it then comes testing, When you are through with drapers work will you send it to me to read I intended to send for it, but will not if I can read yours, Very truly yours

John A Mellish

JUL 31 1908

(9)

COTTAGE GROVE JUL 29 1908 6 PM WIS.

A. R. Hassard Esq
Confederation Life Building
Toronto
Canada

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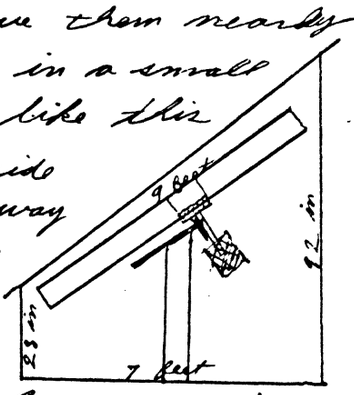
AUG 24 1908 August 17 1908

A D Hassard

Dear Sir I have been fixing my telescopes for some days now and have them nearly done I will beet my 8½ in of 14 in focus in a small house out in the yard the house will be like this the house is only one foot wide that is inside then I have handles and take the sides away when I want to use it the stand is a 4 in sauare and 4½ feet in the ground,



The sides are 2 in yes like I wrote you a while ago that they were 1½ in that was inside measure, Yes I have also seen "Work" Glass Working Page 133 Fig 28 The upper arrow is right when the knife is inside the focus the shadow comes on from the same side as knife, when outside shadow moves on from opposite side

The needle hole must be very small in order to show the curves on the glass if they are not very large or plain it is hard to see them on a short focus glass,

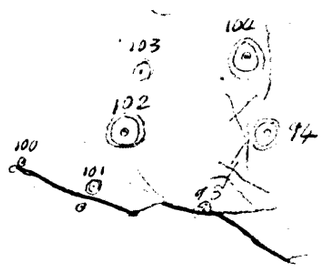
You have the exact focus for the 9½ in, by Brashear it will be just the best size and length, my 8½ in of 94 in focus is a little unhandy it is so long I am afraid of falling and breaking my neck, in 1905 I was up several nights and one night I got sleepy while looking at some stars in the Zenith I was standing in a chair and droped to sleep at once and fell against the telescope both went to the ground with a whack I did not know a thing till I struck after that I could not go to sleep if I had to the rest of the night. I now have a large black paper in front of my eyes so as not to shut one of them when observing I do not get sleepy then, long strokes are almost sure to bring the curve to a Hyperbola, even with a graduated polisher if longer strokes are used than half the diameter of the speculum, but there is not much danger in strokes of 4 in so the star is not as good a test as the artificial star because the glass in the tube will shake, while the glass on the floor is solid and the knife should be on a separate table from the lamp unless the table is solid the tin tube around the lamp should have a copper so

the room will be very dark, the north star is not bright enough to test a glass on, the artificial star is about as bright as venus or about 240 times as bright as the north star, a small electric light is a great deal better than an oil lamp from its superior brightness
I am now enjoying the nebulae, clusters, and doubles I shall start on the moon now in earnest and map all the clefts I can see with 8½ in I have seen 51 and possibly 13 more with the 6 in, Have you ever seen Webbs celestial objects fifth edition they are a splendid set of books two of them, the first has a map of the moon one foot in diameter, it has the largest rings and mountain chains on but not the clefts I mark them in when I see them. they are only visible when very near the terminator, I shall spend some time on Saturn soon I am going to draw Jupiter after the first of October every good morning for the rest of the year.
I also spend a lot of time looking for comets,
ug 18 Are you going to look for comets you may find one in a few weeks and it may be a year or two, the one five new ones on an average found every year last year there were five new ones, this year there has been not one so far, I will try hard now while the moon does not rise till late, to find the next comet, the best time to find a new one is just after the moon has passed the full, as the full moon has [illegible] been keeping the sky light for a few days so no one could see a comet if it came around, I will be glad if you take to comet seeking, Professor Leon, whom I sold the telescope to will hunt for comets, and I do not know of anny other person doing it now so we three stand a good chance we would not have a speck of show if Professor Lewis Swift and Mr Brooks were as busy as they were a few years ago. I am giving a sketch of the rills around Triesnecker with 6 in I have not had a chance of examining it with 8½ in on a good night yet the rills can only be seen near the terminator

Over

Very truly Yours - John E Meitzler

93 Hygin
94 Tricen
102 Agrip
103 Godin
104 R hac



AUG 24 1908

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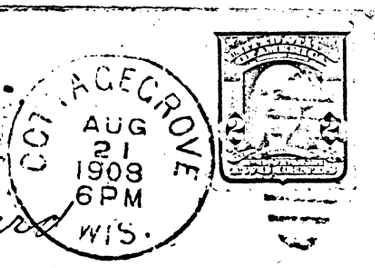

A. R. Hassard
Confederation Life Bldg
Toronto
Canada

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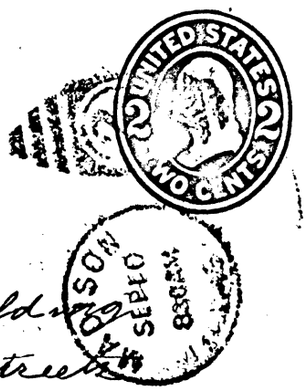
After 5 days, return to SEP 11 1908

John E. Mallish 13
COTTAGE GROVE, WIS.



A. R. Hassard Esq
Confederation Life Building
Yonge & Richmond Streets
Toronto
Canada

After 5 days, return to AUG 28 1908

John E. Mallish 11
COTTAGE GROVE, WIS.

A. R Hassard
Confederation Life Building
Toronto
Canada

August 25 1908

A. R. Hascom

Dear Sir,

Excuse me for speaking plain, but do not waste time testing the speculum on a star I tried it time and time again the waves in the air spoil the testing also the glass is not solid enough for the most perfect work, I always test my glass in the cellar where there is no waves of unevan temperature or if the testing must be done above ground it must be a still night, if you get a good glass testing it on a star you will beat me, at my level best

Your drawing gives a large hill in the center and edge of the glass, if they show at all on a third or fourth magnitude star which is so very faint now try the glass my way if an oil lamp is used the edge of the blaze must be to the needle hole, The in and out of focus image must be exactly the same, I was supprised what a bad star image my first glass made with a very small difference in the in and out focus, I do not have a bit of shadow on my 8½ in just the faintest kind of shade with an artificial star as bright as venus

With the lamp test the knife must be shoved on from the left side and the lamp must be on the right side of the head, if the blade is shoved on from the left side the glass will look as if you were looking at the back side, yet I do that sometimes it gives contrast

There is not a 5½ in telescope in the world that will show Neptunes satelite, a 7 in reractor will just show it on a clear dark night I think an 8 in specul um will show it 8½ in will quite easy

That 4.3 in Wray is infamous for its powers do not believe a thing it has shown, also A. S. Williams 6.5 in speculum shown all the satelites of saturn in transit I mean their shadows, that is not so, even the Lick and Yerkes hardly show them, they are nearly invisible in any telescope from some unknown

reason, I get this information from Barnard and the other best known observers, I have read that 4.3 in Wray shows the outer satelites of Uranus that was not so, & in will just show them they have been seen with a splendid 6 in Objective in a very high altitude of 10.000 feet but not a 2000 or 3000 feet

Halleys comet is about 700 000 000 miles from us now or 600 000 000 miles from the sun, a very large telescope will show it next September I think our telescopes I think will show it in March they would sooner if it was not behind the sun I made a mistake I think 8½ in telescope will show it in Dec 1909,

I just tested my 8½ in on Arcturus could not see a thing the waves in the air make a continual flashing Look at letter (NO2) Feb 7. 1908 E. ott. and you will see the bad report of a Gregorian, also letter (29) Feb the drawing shows Jupiter's third satelite behind. shadow when it was exactly North of it

letter (62) Feb 21., letter (91) Feb 28., letter (226) April letter (2) Mrs Hopkins saw a black round spot on Saturn that was some fault with the Gregorian, he also saw Delta Cygni double with his 4 in Gregorian, an other trusty observers can not do with less than 6 I saw ε Bootis double with my first speculum it was very plain, but I found out later that was a stray speck from a faulty mirror, yet it there the best part of a month

Read letter (50) Feb 21 that writter knows what is about, only he thinks Mrs Hoard saw all th

Professor Barnard told me that the 15 in refractor at Pulkowo showed a small star near some star I do not know what one it was now, they measured the position angle an different dates and sent a notice around the World but no one else could see it, they then took the objective out and cleaned it, and saw the small star no more, Why did it show the star near one large star and not near any other

Barnard says Leo Brenner was not to be trusted the European papers quit publishing his observation

Very truly yours John E Ad

After 5 days, return to SEP - 1 1908

John E. Mielisch
COTTAGE GROVE, WIS.

17

COTTAGE GROVE AUG 30 1908 7AM WIS.

TWO CENTS

A. R. Hassard
Confederation Life Building
Yonge and Richmond Sts
Toronto
Canada

~~August~~ Sept 9 1908

A R Hassard

Dear Friend

I was not here when your letter came and I am sorry of it, from the drawings you sent me the shadows are of the Hyperbola the surface of the glass is like ⌓ in the test a hollow in the centre the polisher should wear the most between the centre and edge now

I am sending your two last papers you will see that the shadows have changed sides

It is bad that I was not here when your letter came it is very late to answer it now

I know the best telescope makers test the glasses on stars but I can not get as good results as I can by the artifical star

a speculum that is un silvered will show a star like this ∴ and when it is silvered it will almost hide the small star like this ⁘

Please let me know what Mr Brashear says about my hauling some observers over the coals

I have been thinking of writing to him for a long time but have not done it yet

Please send me Mr Brashears long letter I would like to read it

I hope you will have a chance to talk with Mr Brashear, I wish I could see him

I alys imagine the shadows on the glass to be made from hills with a light at the right side, the polisher should wear the most half ways from centre to edge or a little nearest the edge can you see the hills on the glass or do you just see shadows, I hope I have made this plain

I am Dear Sir, very truly yours

SEP - 1 1908

August 30 1908

A. R. Hassard

Dear Sir

I never used the knife from the right in testing but by all means it is the same,

I never make use of any other stroke than the straight stroke, a side throw will almost always bring the surface into a Hyperbola. Strokes from two to three inches in length are good with a graduated polisher,

I think if the shadow is plain on the glass, it will do to work 30 minutes without stop, then if the shade is much better work only 15 minutes at a time, then test

I ~~have~~ think the shadow will draw to the centre, and get faint, if all goes right the speculum under test will grow flat, Fig 289 in Glass working is not a very good one the shade is too large, though not much,

I did not understand you about the screen in Fig 284 the screen appears to move the opposite way from which the knife moves, when the knife is outside the focus, I thought you meant the real knife was moving from right to left that is the way I always looked at the cut, but it must be a mistake,

I have not seen the English Mechanic earlier than October 1907 but I will go to Madison and look it up

A 4 inch refractor ought to show Tethys. Dione. Rhea. Titan. and Iapetus at West elongation,

9½ in ought to show all of saturns satelites

I can not make out the satelites from your drawing the Ephemeris gives Titan at the South side the evening of the 27. th, Can you see the shade on the glass as a hill to cast the shade I always saw the hills very plainly. we have one mail train sunday and I want it to take this letter so you will get it monday. Very truly Yours John E Mellish

Thursday
SEP 17 1908

Sept 15
Tuesday

A. R. Hassard

I went to the post office saturday night thinking I might get a letter from you, that was at 6 o'clock and I did not wait for the last train at 8 o'clock your letter came on it I was away Sunday and Monday so did not see it until last night,

When the knife is moved from the left to right it gives a true shadow, be the lamp on left or right either it will be the same,

When the knife is moved from right to left it gives the shadow that the surface would if turned back side in front, with lamp on right or left

Like this. "Hyperbola" lamp on right or left either and knife moving from left to right Hyperbola

If the lamp is on right or left either, and knife moving from right to left the Hyperbola is like this

When testing always move the knife from left to right

Yes you have the Hyperbola but with the graduated polisher you can change it back to the parabola easily I think the cut of the polisher ~~you have~~ your sent will be just right, work at least half an hour between testing now and when the curve is better you will have learnt from experience about how long to work at a time. It is almost impossible for one to ~~do~~ tell some one else how to finish it, without trouble; I think 3 or 4 hours ought to bring the curve nearly right, use 3 in strokes now. Never give a glass up, because it can be made right no matter how bad the curve is if a graduated polisher is used,

SEP 17 1908

I think Mr Brashear is afraid you will get discouraged if you try hard. he is one of the most particular persons, about having his own work just right, I am sick of using a glass as soon as I find that it is not as good as I can possibly make it,

I was several days even weeks on my first glass before it was polished and brought to a good curve but now it takes about 20 to 30 hours testing and polishing after the glass is polished to transparency to have it done, but that is very hard work When a glass is done there will not be a trace of a shadow untill the glass is dark all over and no then, you will soon get it done now that first shadow test you sent I thought was good but it was tested with the knife on the wrong side, so the shadow test was the opposite to what it should have been, so I made you a lot of work by telling you to have the squares longest in centre and on the edge,

After 2 or 3 hours work the glass may show signs of some small rings that will be all right just use shorter strokes and they will come out or if not longer strokes will without fail, but with longer strokes it will not do its work over fifteen minutes at a time as the shadows will change very quick at the end

do not make the largest squares more than twice the size of the smallest ones or it will act too quick thank you for the photographs you sent and the notice about the comet which I think was a hoax, because Professor Comstock knew nothing about it except that a message was received at Yerkes Observatory from some place out west, did you see any aurora on Friday evening last it was splendid here the bands you saw August 3rd was cast from

some thunder heads about 300 miles west of
casting their shadows on the high haze and
it was raining that night in the northern por
this state and over lake Michigan,
We nearly die here now I have been nearly sick
for several days from smoke, the sun hardly sho
through it sometimes yet the nearest fire is a
a hundred miles from here.

Very truly yours

John C Mil

After 5 days, return to

SEP 17 1908

John E. Mallett

COTTAGE GROVE, WIS.

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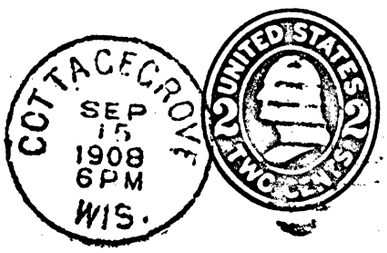


A. R. Hassard
Confederation Life Building
Toronto
Canada

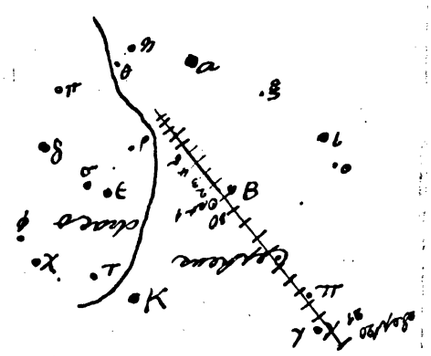
I am not used to drawing comets orbits and I may not have this one just right We will soon see it in the suns rays but next spring it will be in sight in the morning,

I certainly made a mess of the drawing below When looking for the comet if you have an eyepiece giving a field of one degree just look along the line and the comet will show at once, of course after the moon has set,

The comet in on the Meridian at 9o'clock the 20th

P. S. My speculum that showed the little star near ε Bootes was good except the edge which was not round but rough like this and one of the points had a different radius My flat is plate glass then I made a polisher of the same size and work with very short circular strokes for fifteen minutes then I test it.

Comets path through Cepheus



38

After 5 days, return to

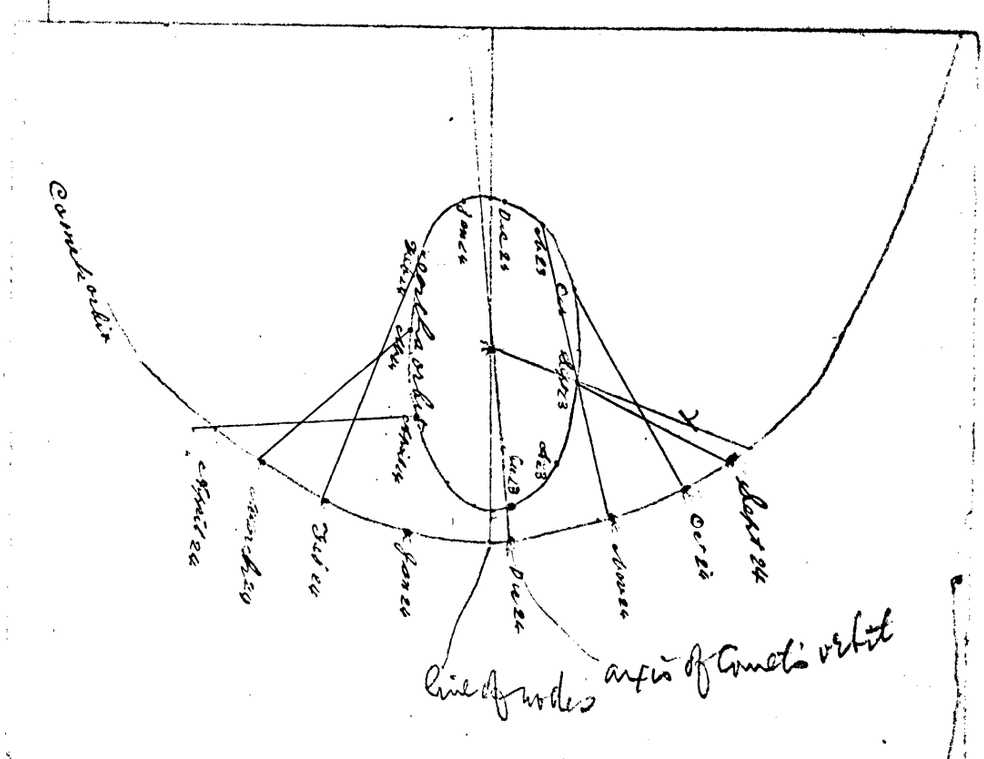
.....John....E....Mallish....
COTTAGE GROVE, WIS.

17

COTTAGE GR
OCT
3
1908
8PM
WIS.

UNITED STATES POSTAGE TWO CENTS

A. R. Hassard
Confederation Life Bldg
Toronto
Canada



After 5 days, return to

OCT - 1 1908

John...E....Mallish.....
COTTAGE GROVE, WIS.

16

COTTAGE GR
SEP
29
1908
6PM
WIS.

UNITED STATES POSTAGE TWO CENTS

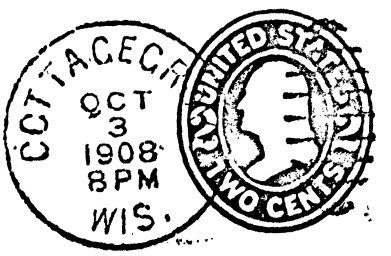
A. R. Hassard,
Confederation Life Bldg.
Toronto,
Canada.

55

After 5 days, return to

John E. McElliott
COTTAGE GROVE, WIS.

17



A. R. Hassard
Confederation Life Bldg
Toronto
Canada

After 5 days, return to

OCT - 1 1908

John E. McElliott
COTTAGE GROVE, WIS.

16

A. R. Hassard,
Confederation Life Bldg,
Toronto,
Canada.

OCT - 1 1908 Sept 28 1908

A. R. Hassard

Dear Sir,

I do not see how a letter is so long in going from you to me, your letter of the 25th just came to day, one of your letters came the day after you wrote, A speculum as small as 9 in does not need to be set in its cell just so, my 8½ in only touches at the edge, it was different with the old speculum metal speculums For testing I have a tin tube of the same size as the glass chimney Then I have four ~~tooles~~ holes of different sizes, the smallest hole is as small as just the point of the smallest needle made, then the blaze is set edgeways to the needle hole to get the brightest light possible,
I have the handle cemented to the speculum with some soft wax, and then take it off when I test it,

I never polished a glass with the polisher on test,

I soften my pitch with oil of turpentine when it is to hard, then it will not scratch to ammount to anything,

I was grately disapointed when I went to look for the E. M. it is not in the four libraryz in Madison,

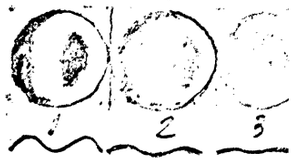
I saw the sun spots nearly every day since the last of August, through the smoke when the sun was low, this was with the unaided eye

I used to go and sit for hours at a time and listen to a law case, but do not have much time now days, but will have more time this winter,

Nearly every glass I have made, had the Hyperbola to start with but I only make a graduated polisher to suit, and go ahead full speed 200 strokes a minute, which is very warm work, but acts like a charm,

I must say that my mirror is not exactly flat in the test but very near it, all the writers give the impression that the parabola is very plain but it is hardly seen to differ from the sphere, a sphere will give quite a good view of a star, a person has got to be an expert to get a glass at just the parabola, without silvering and examining it two or three times to get it perfect
I have only made one glass which was just right the first time it was silvered, that is the reason I always say make it flat as possible

here I give the three curves as I see them, (1) the Hyperbo
(2) some writers give as the Parabola (3) Parabola.



In the true parabola the shade is very faint yet to one who has worked a long time at it the shade or tint shows up plainly, and it spreads over a large surface all at once So the mirror appears sensibly flat,

In your last letter you have a splendid curve, I mean it is the very best kind to turn into a parabola with a polisher that has facets of exactly a size and in exactly the right places, with the centre of the tool like this ⊡ on the central facet, And I think the best stroke is 2 or 3 inches, if the hills between centre and edge do not go away fast enough, or as fast as the hill on the edge it would be easy to trim a little from the facets at O and E D E but I think they will wear away all right is your pitch soft enough to dent in with a light pressure with a finger nail if not it must have a coat of wax or worm and add ½ oz of oil of turpentine to a pound of pitch and stir well the pitch must take about an hour to soften or it may have some air bubbles form in it and it would be hard to get them out, my pitch is so soft that it will get out of shape if the speculum is left on it an hour with moving,

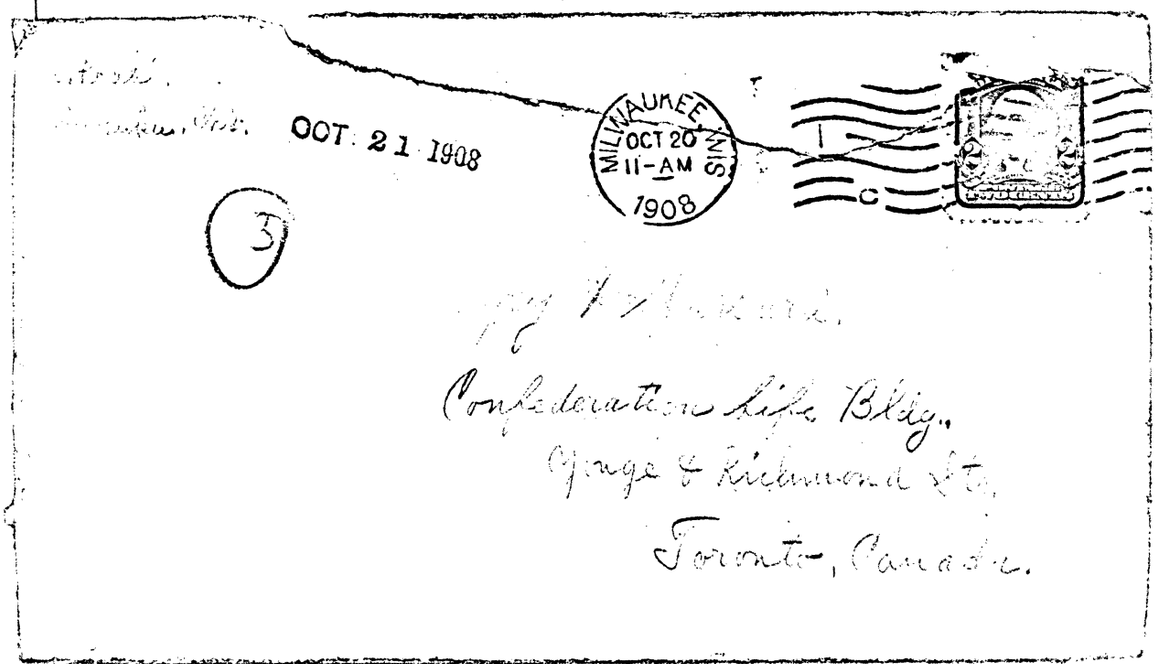
I think if a layer of wax on the facets makes it harder to push, it must be because the wax fits tighter to the glass and cuts faster, I think I will try it,

Oh I was not annoyed at the way Mr Brashear wrote I read his letter four times, thank you for it and I am sending it to you now,

Did you ever send to england "as you wrote of doing" for some eyepieces,

I want to write to Brashear soon, and find out some things

Thank you for the card about the comet it was the first word I got about it, it was a long time before an ephemeris came to Washburn Observatory, the night of the 25 was the first night I saw it, and then I saw it with naked eye, Very truly yours John E Mellish


OCT. 21 1908
MILWAUKEE WIS
OCT 20
11-AM
1908
3
Confederation Life Bldg.
Yonge & Richmond Sts.
Toronto, Canada.

40

2 4 1908

CARNEGIE INSTITUTION OF WASHINGTON

MOUNT WILSON SOLAR OBSERVATORY

PASADENA, CALIFORNIA

September 19, 1908.

Mr. A. R. Hassard,

Federation Life Bldg.,

Toronto, Canada.

My dear Sir:

I have your letter of September 10th in regard to your 9-1/2-inch mirror. Your information concerning the appearance of the eye-piece image given by a paraboloid inside and outside of the center curvature is entirely erroneous; it is only with the spherical mirror that this appearance should be the same inside and outside. My advice to you is to abandon the full sized tool cut out to give an excess of action at the center, make a full sized normal tool (that is, with equal squares of pitch or rosin all over) and bring the surface back to a perfectly spherical one. This, of course, you can test easily. Then make a tool 4 inches in diameter for parabolizing. The actual time of rubbing required to parabolize your 9-1/2 spherical mirror with such a tool should not be more than half an hour of light rubbing, although, of course, you will have difficulty in distributing the rubbing correctly in the different zones. We recently had an 8-1/2-inch mirror to parabolize here, and this was accomplished by one of our young boys (after the perfect spherical surface was obtained) in exactly 15 minutes of actual rubbing with a 3-1/2-inch diameter parabolizing tool. This rubbing was distributed over three runs of 5 minutes each, hanging the glass up and allowing it to stand for two hours in the intervals, so as to be sure that it came back to normal figure after each 5 minute's work, and then measuring the zones carefully. We took straight strokes across the center at first, then gave more and more side throw for the remaining time, so that the tool worked on long chords instead of on the diameters of the glass.

Mr. Hassard, 2.

You should understand that everything depends upon the optical tests of the successive zones, unless, indeed, you have a full sized plane mirror to test your parabola in the manner described in my Smithsonian book published in 1904. It is folly to expect to obtain a perfect parabola without one or the other of these tests. In testing the 8-1/2 inch we mada three diaphrams, one exposing a central 3-inch circle, another a zone 1/2 inch wide around the edge, and a third intermediate. You will probably have to bring your mirror back to a spherical surface several times with your full sized normal tool before obtaining a figure in which these zones will measure exactly as they should. You will find the formula for this also in my Smithsonian book.

Very truly yours,

G. W. Ritchey Supt.

P. S. Do not hesitate to write me again if I can give you any further advice.

CARNEGIE INSTITUTION OF WASHINGTON
MOUNT WILSON SOLAR OBSERVATORY
PASADENA, CALIFORNIA

SEP 24 1908

PASADENA, CAL.
SEP 19
4 30 PM
1908

Mr. A. R. Hassard,

Federation Life Bldg.,

Toronto, Canada.

42

Oct 3 1908

A. R. Hassard

Dear Friend,

I was away yesterday and did not get your letter, Fig 2 around L and M are ridges, A and B are hollows,
Fig 1 A & B are the sides of hills sloping away from the lamp, The dark places are always the sides and holows sloping away from the lamp
I meant 100 strokes from me and 100 to me
If the polisher is even all over the abrasion is greatest on the highest parts of the glass even if the difference is only the 100.000 of an inch, that is if the hills are of the complex type or different from the Hyperbola, or oblate Spheroid
If strokes of 2 or 3 inches do not work right use shorter and shorter strokes, I have used only $\frac{3}{4}$ inch strokes at the very last on $8\frac{1}{2}$ in,
This is the best I know what to say now but write and let me know how the hills come out, short straight strokes work wonders but are very slow, I am grinding an $8\frac{1}{2}$ in glass now for an amateur in Kansas,
Plate glass is polished on a woolen pad and so does not have a smooth surface enough for this work
In Fig 1 shadow B should be the slope down M in Fig 3 and the hollow B Fig 2, A in Fig 1 is A Fig 4
I would write more but will not have time to send it on the next train if I do
If you write Wensday address it in care of Ferdinand Maenicke Esq Milwaukee Wis 623 Milwaukee Street
after that I will be home to get your letter, I am going Tuesday and will come back Friday
send your letter back so you can compare notes, Very truly yours John E Mellish Esq

Oct 21 1908

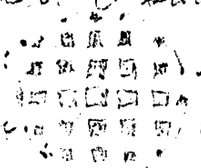
Milwaukee, Oct. 19, 1908.

Mr. A. R. Howard,

Dear Sir:

I was just thinking of writing to you again when I got your letter. The reason I did not write sooner is because I began work on a mirror, and its performance so delighted me that I've had it in use every clear night and morning. Although not absolutely perfect, it is so very near so that I let well enough alone. I will describe my method of making the mirror: I ground on an iron tool, which I turned to the proper curve on my lathe. I wanted 64 in. focus, and I got it exactly. Rough-grinding took 2 hours, and the fine emeries I used each grade for one hour. I used 1 min. 5, 15, 30 and 60 minute emeries. I got some bad scratches, but they only reduced the amount of light. When done grinding it was so fine that I could see through it. All the objects lying on the table could be seen by holding it between the table and the eyes. This with the day mirror.

I used 4 in. straight strokes during rough grinding, and for every fine emery I shortened stroke and made it more elliptical until at last I moved the glass in little circles 1½ inches in diameter. This way: From one side of the centre to the other; not much.

I finished with short straight strokes (1½ in.) 4 hours. Then I saw that the curve was slightly hyperbolic so I shaped my polisher in the following way:  the facets smallest at the edge. They were 1 in square in the middle, and about half an inch square near the edge. The spaces between the facets varied from ¼ in. to about ¾ in. I then finished with short elliptical strokes for 1 hour going from side to side over the centre, this way (O) and walking around the polisher. I got around once in about half an hour. I did not use the shadow-test. I used an artificial star, and polished until no stray light showed around the image, and until the image looked the same on both sides of the focus. On silvering, I found the mirror was very slightly hyperbolic, but I am satisfied for the time being. It shows wonderfully good on the moon, bearing high powers (up to 600 diameters) satisfactorily. I saw 9 clefts one morning, Oct. 14, 5:30 A.M., power 200. It shows the minute double star between K¹ and K² Tauri, mags. 11, 11.6, dist. 5" apart, without difficulty, and divides to about 5".8. It will not show a faint star near a bright one, however. I finished it in just 11 hours, from beginning to end. I am thinking of grinding a 15 inch mirror, only I have'nt the money to buy such a glass disk.

The tool I would turn off in my lathes. — In your

case, you must use short strokes (1½ in.) and move from one side of the centre to the other. This will prevent ringe and depressions. You have a very hard curve to get rid of, the hardest of all. The polisher I described will change the curve very fast, (test every 15 min.) and you ought to subdivide your four central facets, but not too much. This way. ⬚ ⬚ The black spot is the exact centre of the entire p⬚⬚lisher. Keep at it, and when you see the moon with it the first time, you will think it was worth all the trouble. While you polish, just imagine how the various celestial objects will look. Sir Howard Grubb said: "A good curve is gotten only by accident." And he made the 4ft Melbourne reflector. This was probably my case. But grinding on an iron tool is the fastest and best way. — I will close now, and hoping that my suggestions will be of some use to you. I remain

Very truly yours,

Arthur Pralel.

P.S. Thanks for the picture. Your instrument is very well mounted. I will send a photograph of mine soon; and let me know how you get along.

P.P.S. I sold several eyepieces during the last months. I make them, any focus, for $ 2.50 apiece.

Saturn, power 200 (poor sketch) *.

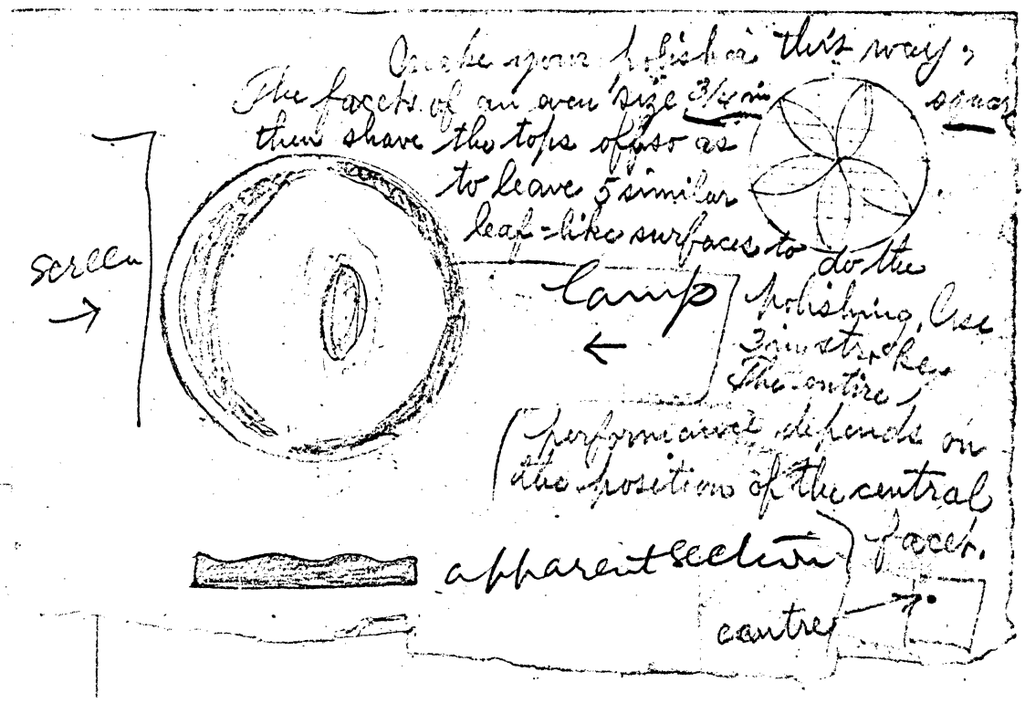
A. P.

Milwaukee, Nov. 8. 1905.

Mr. C. L. Hossard;

Dear Sir:

Yours of the 6th on hand and found me busy getting my 8 inch into shape again. In my last, I wrote that it was almost perfect, but it didn't satisfy me: so I took it in hand Saturday, Nov. 1st (Oct. 31?), and tried to make it still better. I spoiled it completely. This was a bad disappointment. Every day I spent from 6 to 8 hours, working far into the night, trying to get the curve back again, but in vain. Then, taking some hints I received, I made my polisher over, and in 4 hours I had the mirror done. Was I delighted? I performed all kinds of capers. I am sending a diagram of the polisher. My curve was the same as yours. Mr. Ritchey, of Yerkes Observatory, uses this kind of polisher, and I recommend you to use it also. I guarantee that it will perfect your glass in about 4 hours. It is only a matter of time and patience. Use 3 in. straight strokes, then gradually shorten down to 1½ in. The polisher should be exactly the size of the mirror, no larger. Make it carefully, as a well-made polisher is half the battle. Make it ¾ inch thick of soft pitch. It should not splinter while trimming to shape. Your glass should have been fine-emeried until you can read a newspaper through it, by laying the glass on the paper, ground side up. Then it would polish in 5 hours.


One lens ground & polished this way;
The facets of an even size 3/4 in
then shave the tops off so as
to leave 5 similar
leaf-like surfaces to
lamp
screen
Polishing. Use
3 in. strokes
the centre
performance depends on
the position of the central
facet.
apparent section
centre

My speculum is 1 inch thick. I could not get any heavier glass. If I know where to get a 15 in. disk, 1/2 inch thick, I would willingly pay $2 for it. My 8 in. cost this much. It is French plate-glass.

I am going to visit Dr. Bullock soon, to see his instruments, and spend a few days with him. I hope to have the pleasure of meeting you some day.

Let me know how you succeed with the kind of polisher I suggest. From experience I know that it will do the work.

Yours, in good faith,

Arthur Brahl.

I send a picture of my telescope.

NOV 10 1908

MILWAUKEE, WIS.
NOV 9
10-AM
1908

Ewing and Hassard.
Confederation Life Bldg,
Toronto, Canada.

Dear Sir, NOV - 2 1908

I got a letter from the Express agent in Detroit asking about the glasses I sent a letter by the next train so I will soon get the glasses, I have just sent the speculum to Kansas it was a splendid one and I would liked to have used it one night but did not have time I learnt a great deal in grinding and polishing it
It was a very nasty job I got the curve almost at the sphere when I worked 15 minutes at a stretch and should have worked only 5 minutes which would have left it just at the right curve, as it was I had to work about 2 hours more
I will write more about it soon John E Shellick

Nov 9 1908

Monday

A. R. Hassard

Dear Sir

I think your glass is do now with only 3 hours polishing, The first polis was even all over with squares one inch in diameter, I worked on that polisher just one hour last Friday than I did not have time to work at it again, then I had company, Prof Flint, from Washburn Observa and two students, came out to see Saturn and the Moo with my 8½ in they thought it was all right, Flint said the Moon was very sharp better than with the 15 in refractor of Washburn Observatory which was mad by Clark, I also have looked through the 15½ in ~~on~~ several times and do not like it, The 6 in telescope a refractor that Professor Bernham discovered so many double stars with is at Washburn Obs, and it is one of the most perfect telescopes in the world, and Professor Comstock will let me use it some good night and I will then give you the results,

This forenoon I started at your glass and studied about half an hour about the shape of polisher to us I thought it best to keep the same polisher, as it had had improved the glass a little in one hours wo so I just cut the top of the four central facets and four facets near the edge away so the wear was uneven an in the right place, then I put the cold speculum on the polisher, wet with rouge and water and left it one hour to press, at one o'clock I went at it savage and worked just as hard as I possibly could and in twenty minutes my clothes were all soaked through from sweating so, Friday I used three inch stroke and at the rate of 100, or a little over, a minute, this afternoon I went at the speed of 180 strokes a min

and about ¼ to ⅓ of the diameter of the speculum length
stroke, or 2½ or 3 in strokes, I worked at that speed
exactly 2 hours to the minute, then I thought it
would be the best thing to test it, I then set it in
the test room and left it for 1½ hour then I went and
tested it, and of all the humbugs I thought this
the worst one for the glass was perfect, I tested it
all kinds of ways, and used an eyepiece giving 270 diameter
the speculum was all right, I tested it at times for
hours and then gave up, as a last resort I set
the lamp with the artificial star, 50 feet from the
speculum and set the small flat mirror in the
path of the rays and threw them to one side then the
glass was exactly flat and the definition was grand
I will send you a print of the second polisher so
you can see where the facets were cut away.

The polisher was ½ of an inch smaller than the
speculum and it should have been ¼ of an inch
smaller as the edge of the speculum turns down,
I have spent just about 8 hours on this speculum
in all, so I made $5 in 8 hours, play.

If I had worked only five minutes longer than I
did the curve would have been bad again is it
not queer how I ever happened to work 2 hours so
hard and then stop on the minute, it is the first
time in my life, I expected to find the curve a
little better then it was before, and I counted on
working 6 or 8 hours to get it done

When you sent the glass to me the rays from some
parts of the glass came to a focus ¾ of an inch or
nearly that, inside of other rays, now I can not tell
the difference, except the centre which is very bad yet
but the small flat covers it. I did not press
on the glass at all with my hands while at work

After 5 days, return to NOV 12 1908

.....John E. Mallet..... 20

COTTAGE GROVE, WIS.

A. R. Hassard Esq
Confederation Life Bldg
Toronto
Canada

The pad of pitch was as thick as the tool,
When you get the speculum test it and let it set
here and hold your hand on it for a minute then
ist it and you will get a shock at the change
the surface,
I do not in the least know how you could have got
he great hole in the centre, only by the tool being
oo thin and causing flexure, I am writing this
letter in a rush so I can go at my 9½ in,
The glass you gave me is the worst by far that
I have seen yet the rays come to two focuses
ne focus is 2 inches inside the other focus, I do not
know how long it will take to correct it but I will
work very hard, for I must ship your glasses to
ou the 11th, I have not gone at my 8½ in
lasses yet, will do so as soon as your glasses are out
the house,
The surface of your 9½ in is just fine
nd you had a fine polish on it not a scratch to
mount to anything,
It is no wonder you found it hard to get the curve
ood, a 9½ in glass is several times as hard for one
o learn on as a 6 in,
Now write and let me know how the glass [illegible]
the double stars,
I will paste a paper on the surface which
you are to use for a flat mirror it is the best
f the four surfaces,
If any one has a speculum to be refigured I will
be glad to do it, I do not expect such luck
gain I forgot all about writing you that I got
he #5 order all right, I do not know what makes
he glass get this ⌒ shape, I do not understand it
t ought to get this ⌒ shape or this ⌒ shape

The glass I sent to Kansas was of this ⌒ shape when I first tested it, it was entirely polished then with 5 ½ hours work, then I made a polisher of this shape Fig 1., Then I worked 1 ¾ hours and tested, then worked 1 hour, and tested, then worked ½ hour then tested, then worked ½ hour and tested then worked 20 minutes and spoilt it, then it was like this ⌒ I should have worked only 5 minutes, Then made a polisher like Fig 2 worked 15 minutes and tested, worked 20 minutes and tested, then worked 15 minutes four times then I worked 10 minutes and tested, then 3 minutes and was done

1 3/4
1
1/2
1/3
1/4
1/6
1/10
5 hrs
40 min

First I used 2 in strokes then the last two times with polisher (1) I used 3 in strokes, then with polisher (2) I used 2 ½ in strokes

I used to work with a polisher even all over when the glass was like this ⌒ and it would take from 3 to 6 days to get the glass right first using 3 in strokes an 2 ½ in and ending with 1 in strokes,

Now I use shaped polishers and it goes with a rush using strokes nearly ⅓ the diameter of the speculum,

I am almost sorry that you will not be working at a glass now, it was very interesting to hear from you so often, I wish I could make you a visit this winter but it is out of the question,

I remain

Very truly yours

John E Mellish

Fig 1

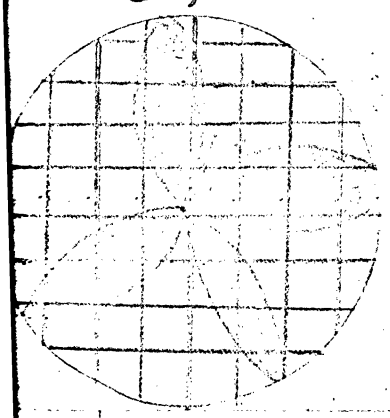
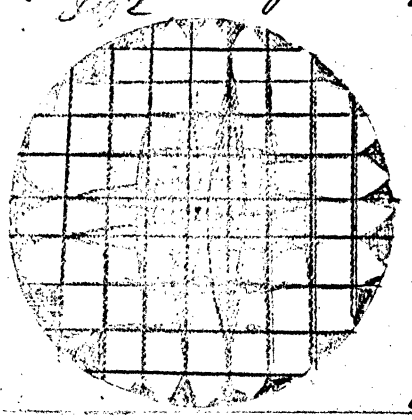
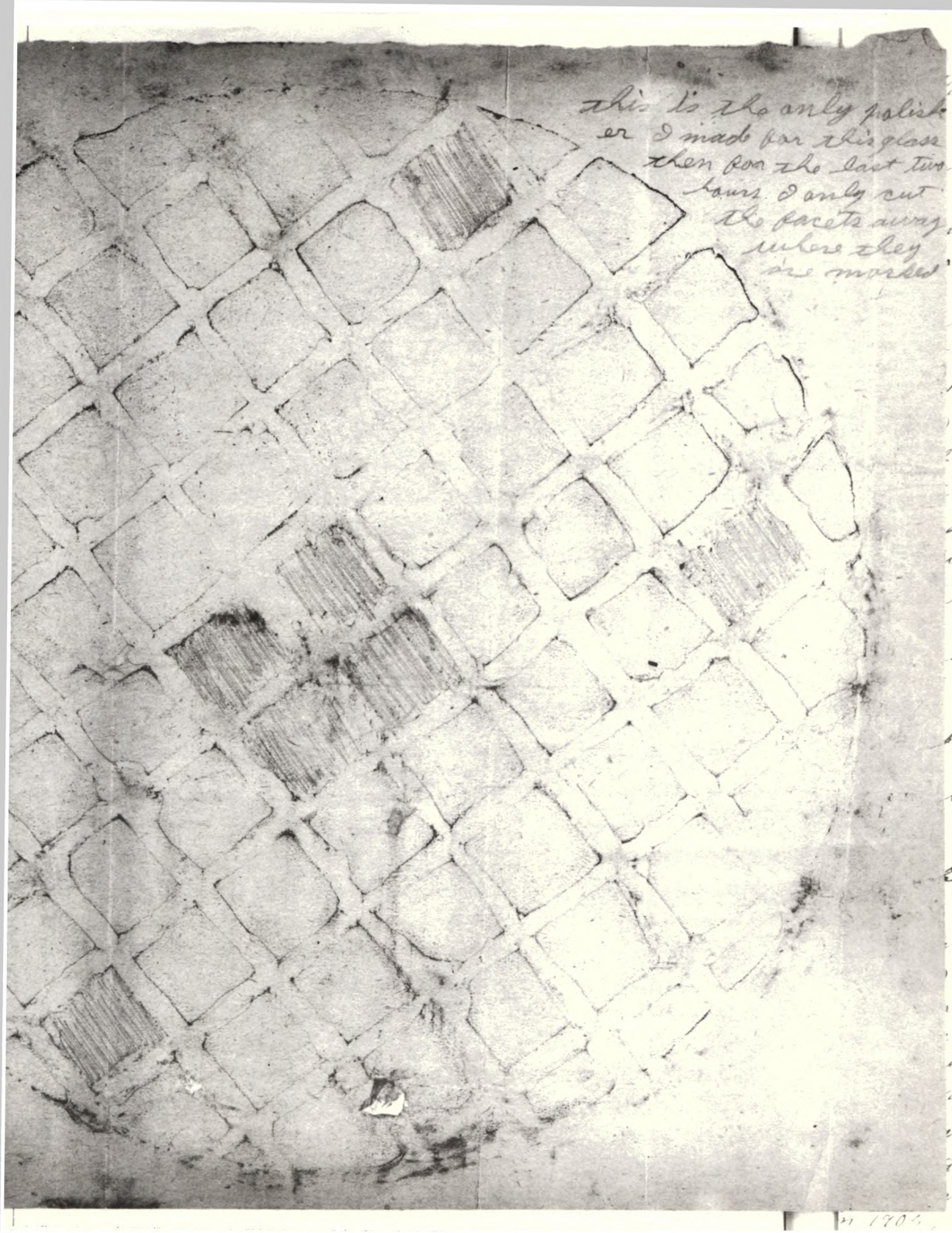


Fig 2



The glass I sent to Kansas is the first one that I ever did this with I wish I had known of it before, and it would have helped you the dark places are where the facets were cut away.


this is the only polish-
er I made for this glass
then for the last two
hours I only cut
the facets away
where they
are marked

Nov 13 1908

A. R. Hassard

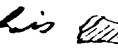
Dear Sir,

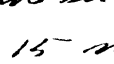
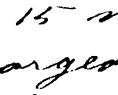
I have sent your glasses in the same box in which they came,

The glass tool was very much too thin that is why you got the speculum so very bad, yet it was not so bad as some others got who had thick tools, one a doctor in Minn got such a bad curve that it was impossible to get it right only by going through the fine grinding,

I did not press one bit on the glass when polishing and I made the pad of pitch as thick as the tool and then put some small papers under the tool to keep it from bending.

I have finnished the speculum you gave me and did it in $2\frac{3}{4}$ hour, I made the first polisher like Fig 1 and worked with 3 in strokes, and 180 strokes a minute for one hour. Then I made the polisher over like Fig 2 and worked one hour then tested, and worked again 30 minutes, this time I used 4 in strokes and got the curve a little out of the way so I worked again with 3 in strokes 15 minutes, and it was done

When I started on it the focus of the central part of the speculum was 2 inches shorter than the edge, and the curve was like this  , and when I had worked one it one hour with polisher Fig 1 the curve was like this  . Then I made the polisher like Fig 2 and after working one hour the curve was thus  after working 30 minutes the curve was thus 

Then I made the polisher a little different like Fig 3 and worked 15 minutes and got the curve like this  or in an enlarged scale like this  the small flat covers the central dip, and the edge turns down for 1/4 inch very much but that is not bad

I must say if the first glass I worked had been a 9½ in glass, it would have been very hard as it was I worked nearly three months on my 6 s in 1905, then in 1906 I worked it over and worked on it nearly one month day and night, sometimes 18 hours a

The first glass I ground I used sand and it took me 37 hours to grind it to the right depth, then the fine grinding took 43 hours and the polishing took 23 hours. Then getting the curve right took me nearly 80 days with six hours on the average a day,

I sent the box to W. H. Edwards as you told me to there is some very interesting reading for you to have a look, Go to J. S. Plaskett Dominion Observatory, and ask to see some papers about the testing of some telescopes with the new extra focal plates,

The Astrophysical journal for May 1908 by Philip Fox, he measured my 6 in glass and it was about the same as the 40 in yerkes telescope, Also see a paper by Hartman which Fox told me you could get at the Dom. Obs.

I will photograph my 8½ in when it is done and ask Fox if he will measure them for me, I wish I could have photographed the glass I sent you, but did not have time, It may be possible for you to do it and have the plates measured by some one you know, It is very interesting, this test will show very much more on the surface than the knife edge test will, Astrophysical Journal, 25, 1907, 195
27. 1908. 139

The small glasses you sent are good and one surface is better than the rest, and I pasted a paper on it, to keep it from getting scratched,

Here is a method of testing the flat, you may know it before, after it is silvered set it at a distance 20 feet from your 4 in telescope, only cut the aperture down to 2 inches, and look at the reflection of some distant object reflected from the flat use a very high power and do it in the evening or ~~morning~~ morning when the air is still, then if the telescope does not have to be focused to look at the same object straight the flat is all right, set them as in Fig 4

I will now write to the E, M, about the last glass I have polished, Write soon

I remain, Dear Sir. Very truly Yours
John E Wells

Fig. 4

87 hrs - Coarse finishing
43 " fine " } 6 mch
23 " polishing
480 " curve

8) 583 hrs
73 Days

After 5 days, return to

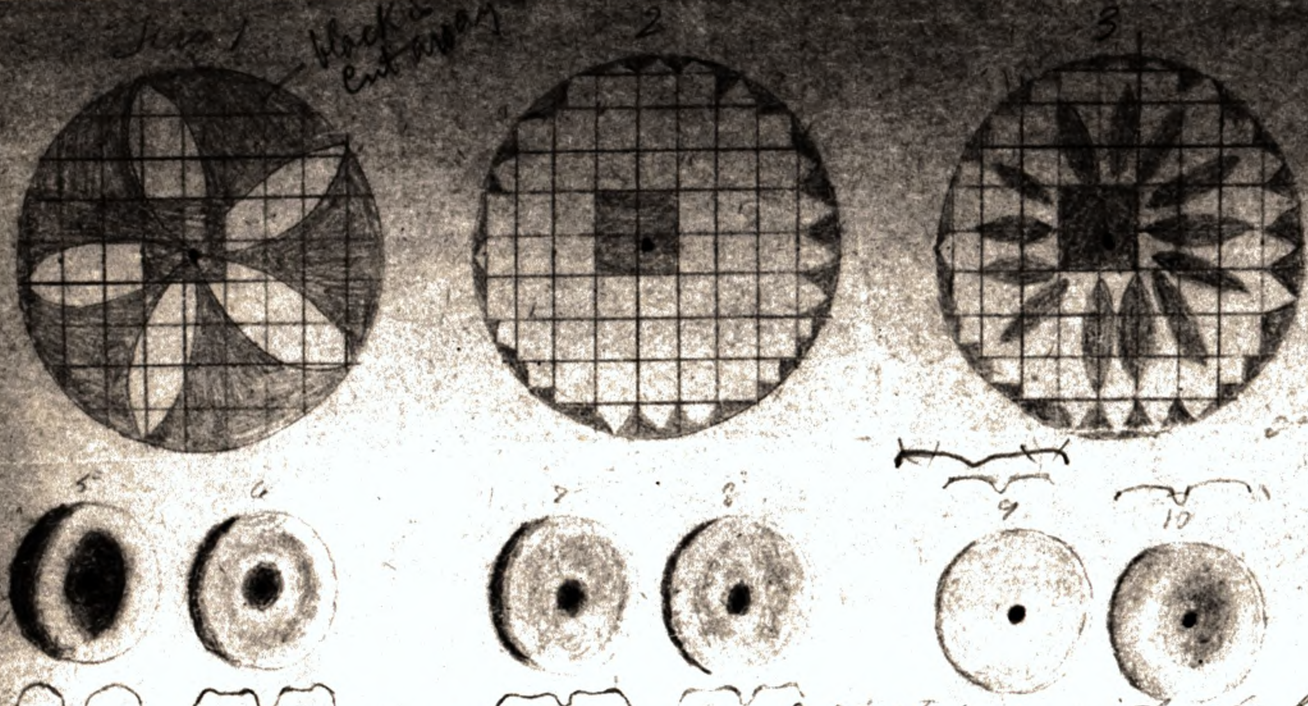
NOV 16 1908

.....John E. Mallish..... 21
COTTAGE GROVE, WIS.

MILW. & CAL. R.P.O. NOV 14 1908

UNITED STATES TWO CENTS

A. R. Hassard.
Confederation Life Building.
Toronto,
Ont.



[illegible] of the facets away [illegible] they are [illegible] down then I [illegible] the tool a little and pressed it by setting the [illegible] speculum on [illegible] 10 min

Fig 5. shows the speculum when I started it with the first polisher Fig 1. (3 in stroke)
Fig 6 was when I had worked it one hour on polisher Fig 1. (3 in stroke).
Fig 7 is after one hours work on polisher Fig 2 (3 in stroke)
Fig 8 is after working 30 minutes (4 in stroke)
Fig 9 is after working 10 minutes on polisher Fig 3. (3 in stroke)
Fig 10 is after working 5 minutes more (3 in stroke)
There is [illegible] $\frac{1}{2}$ in wide around the edge but that makes no difference
I think if you cut a circle $9\frac{5}{8}$ in out of a card and use it in [illegible]
from a $\frac{1}{8}$ in rim around your $9\frac{5}{8}$ in it will be better, The 40 in yerkes glass
would show better if there was a $1\frac{1}{2}$ in rim taken from it making it only $38\frac{1}{2}$ inches
also a 4 in spot in the centre. I tested both glasses in a tube with the artificial
star 50 feet away wich is almost like seeing a real star

besides the glass work, farm work, and correspondence studies in Algebra and Geometry, with the University
A funny thought came into my head last night, It is this, if we had money we could go to Arizona and build a large observatory, we would have you a lawyer and glass worker, Max Brahl, could turn out the mountings and eyepieces on his lathe, H. G. Fullmer, Medina. Ohio is a metal worker and could make the tubes, You and I could work on some very large glasses, and there would be a dentist from Minn, and a doctor from Maine, A carpenter from Kansas, a lumber inspector from S. C. a farmer from Indiana, and one from Call, and a piano tuner from Sask, Canada, also a merchant from Chicago Would not we make things hum?
I have a few drawings of Sun spots with powers of 20 and 144 on a 2 in refractor, which show great changes in a few hours, in 1904, Did I ever send you ~~one~~ a photograph of some drawings of jupiter with my 6 in, 1906. if not I will do so, I will soon take a photo of my Medals and send you,
It is a good thing to grind a large lens from a 9½ in glass I have thought of making an 8½ in lens just for fun, if it has a focus of three or four feet it will make a good search light with a bright light, with a 6 in speculum and bright lamp I have thrown a light on the clouds, and could read small print at a distance of 150 feet, and I think I could have done at 300 feet my 8½ in speculum of 40 in focus will set a board on fire in a few seconds with a clear Sun,
There is an old man in Madison who made a 2 in, 2¾ in and a 4 in refractor some years ago, and never got the curves right, I told him if he had made a reflector he could have had a good telescope, I heard of a man who made a 7 in refractor lately and I will write to Frost the director of Yerkes and get his name.
I am going to try my best to make my 8½ in of 40 in focus so good that it will stand a power of 120 diameters and yet give sharp definition, which is almost unexpected then I will go at the long focus 8½ in
Mr Forbenst of Yerkes has a 6½ in Brashear reflecting telescope which never gave very good definition I am going to ask him to let me test it when I go there again
I remain, Very truly Yours, John E Mellish.

NOV 16 1908

Nov 14 1908

A. R. Hassard

Dear Friend, I waited about sending my letter thinking I would get a letter this morning and it came, I think you are just right, be sure to write a good long article for the E. M. I will do my best at it this week, We must try to stir things up, Prof Flint, who has used the 15½ in refractor of Washburn Observatory, looked at some of my drawings of Jupiter and he said they were better than what he saw with the 15½ in, also he saw the moon and says my telescope gives the best view, as the blue shows with a large refractor I am sure you will think there is no finer sight than the moon at last quarter now, it is very high and a good speculum will give a sharp clear view, I think you are right about the astronomers now a days they think it is enough to look the papers over, that is the way at Madison, but the Observations at Yerkes, are not published, as they ought to be, I hope you can get up an interest in observational astronomy there, that is what I am trying to do Let us send drawings of Jupiter and other things to the E. M. also try to correct the prehistoric ways of doing things,

I do not use the very short strokes in polishing and figuring now, I find the, shaped polisher does better, I also am a conservative observer, yet I never see much that is not well seen,

I also have learnt a great deal from the ideas of the amateurs I have been corresponding with,

I now have a new idea, could not we form some kind of an amateur astronomical society and send our observations and thoughts around and so help and be helped, there are now eight of us who are very much interested and I will send a card to about twenty others and see if some of them would not be interested in it I have around 100 letters now which I think are very interesting and read them over and over,

I have had nearly 500 letters in the last year to answer

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After 5 days, return to NOV 28 1908

John Hassard
COTTAGE GROVE, WIS.

Ansd

COTTAGE GROVE
NOV
20
1908
6PM
WIS.

UNITED STATES
POSTAGE
2 CENTS

A. R. Hassard.
Confederation Life Building,
Toronto,
Canada.

Milwaukee, Nov. 19, 1908.

Mr. A. B. Howard.

Dear Sir:

Yours of the 16th on hand, and was glad to hear from you again. Many thanks for the copies of letters you wrote to Sir. Inellish. They have set me to thinking, specially in regard to forming a Society. I think reflectors are peculiarly adapted for the study of planets, on account of their being perfectly achromatic. I have studied Astronomy for almost 11 years, and always record my observations. I have made some hundreds of drawings of planets, double stars, etc. As to your mirror: Don't throw it at a cat, or any other thing. Make your Thirteen thousand, seven hundred and twenty-seven and a half the polisher, and get to work. Don't let the thing bluff you. Have two polishers, one a 5 leaf polisher, the other with even facets. Never mind the appearance of the mirror under the shadow test, and the dance with the central 2 in. Test by zones. Set your eyepiece in a sliding tube near the lamp, and then polish till the zones all focus in the same place. Then you have the sphere. Take the handle of your mirror and push it by means of the edge. The rays coming

from the edge of the mirror should focus 1/50 inch farther than the inner rays. Then you have the parabola. This is a very delicate operation. I did not obtain it. In my case, I merely glanced at the illuminated mirror to see that it was free from rings. I don't even know how the shadows look now. My mirror shows fairly well, but needs an expert to put the finishing touches on it. During summer, when working at the bin. I worked so long at it, that the outer edge became rounded and well polished, merely from the contact with my hands. I dont know how many polishers I made for it but I think it is somewhere between 35 and 36 million. I have not too much spare time, as I grind other lenses. During the past summer I ground and polished about 100 small lenses, for eyepieces, microscopes and other purposes. I get them down to absolute perfection, and only wish I could get my mirror as good. Some time I'll try my hand at a refractor. I also wish to thank you very much for the little book you sent to me. It is quite useful information and is very handy. I will close now, so as to get to work. Hoping to hear from you soon,

I remain

Very sincerely yours

Arthur Probst.

NOV 21 1908

MILWAUKEE, WIS
NOV 20
10:30 AM
1908

C

Toronto, Canada.

Nov 20 1908

A. R. Hassard,

Dear Sir,

I sent an article to the E. M. the same time you sent yours, they will create a sensation in the old country,

I sent your glass by Express I suppose you have got it by this time, or it ought to be there,

Thank you for your very interesting letter of the 16th. We will form the society right away I sent your paper as to Mr Prall, Your name for the society is just right then we will sign ourselves as members of the A. A. O. S. I think we can start in with at least 30 members, I will write to all the amateurs who have written to me, and explain things, We will do as you say, send our observations to the E. M. the editor will be glad of it, I think I have the reason, why you can not get a good curve, The speculum must warmed to blood heat before trying to polish it, else the pitch will be hardened near the edge and will not work even,

I am thinking of making a ring polisher for my 8½ in of 94 inches focus to take the rim from the edge which is ⅓ of an inch wide, I think in fact I know that strokes of ⅓ the diameter of the speculum is the only stroke to use with shaped polishers,

The speculum must be wiped dry every time it is tested I have had a speculum turn from a bad Oblate spheroid to the sphere and on to a bad Hyperbola while drying and coming to the temperature of the air, around it

A speculum should never polish at the edge before it polishes at the centre, the cause of it was the speculum or the pitch being too cold, if the glass is cold it will bump against a hard rim when using long strokes, have you noticed it I have not blackened my tubes yet but must do so soon I do not know how yet,

I was some months at my first glass and never once got the sphere

I always have a pan of warm water to put my speculum in when polishing and figuring,

Will you please send me back my letter telling how I got the curve to your glass, and if you want it again say so and I will send it soon, I want to copy it,

Very truly yours

John E Mellish A.A.O.S.

After 5 days, return to NOV 30 1908

John E. Mitchell NOV 30 1908

COTTAGE GROVE, WIS.

Ans'd 25

A. R. Hazzard Esq.
Confederation Life Bldg.
Toronto.
Ontario.

DEC 7 1908

MILWAUKEE, WIS.
DEC 5
10:30 AM
1908

Mr. W. H. [illegible], M.A.A.C.
Confederation Life Building
Toronto, Canada.

NOV 30 1908 Nov 26 1908

A. R. Hassard

Dear Friend

I am very glad you sent me that letter from Texas it was very interesting, the drawing was beautiful,

Thank you for the Journal, they did not believe you about Saturns crape ring, but it has been seen by all of the best observers with from 4 to $4\frac{1}{2}$ in glasses, I saw it in 1905 with $4\frac{1}{2}$ in, of 6 in reflector.

I have a letter from a man in Kansas City asking me to examine my glasses from time to time to see if the curve changes I have seen nothing of it yet, but an 18 in refractor had lost its curve two years ago and Brashear refigured it, and the Yerkes 40 in seems to be loosing its curve, Mr Parkhurst of Yerkes, has a $6\frac{1}{2}$ in Brashear speculum and he says he never saw what he ought to with it, and it never gave good defenition, only on one morning some years ago it gave a fine view, he thought it was the closed tube that made it, I have seen only three nights this fall when my $8\frac{1}{2}$ in did what it ought to,

I have not used my $9\frac{1}{2}$ in yet will do so in about a week

I read your very interesting letter five times last night and twice this morning it is the most intereiting letter you ever sent me, it is not practicable to make a $9\frac{1}{2}$ in of 50 feet focus. I find it very hard to get the curve of my $8\frac{1}{2}$ in 94 in focus just right I had to use one inch strokes longer ones would not take the hills out no matter what kind of shape I made the polisher, I worked about eleven hours on my $8\frac{1}{2}$ in 94 in focus, for three days now and silvered it last night, got a splendid coat on it, just as clear as any French mirror,

I told Mr Prahl where to get the glasses

I wrote to Mr Carothers last night, he is a very interesting man, you did splendid on the $9\frac{1}{2}$ in this time you will now have some very clear sky now and it ought to show what the $9\frac{1}{2}$ in is worth,

I will take your advice and write an abominably short letter to Popular Astronomy, I always sent long letters before, I wrote them careful too

I do not think there is any use in keeping the glass round they are only for the pitch pad, and any glass of the right size will do, I forgot to say that for you to see the crape ring this summer was very good the ring was so flat,

and it is only half as wide now next year it will be fine, here are the members of our society so

1 You
2 me
3 Arthur Prahl
4 Herman G Fullmer. 327 Elmwood Ave. Medina. O
5 Clinton van Pelt, Charleston. Ind. R. F. D. 2.
6 Edw J Barnes, Chanute. Kansas R. F. D. 1.
7 E. J Hutchinson. Ferguson, South Carolina.
8 W. F. 2 others,

. We will keep the numbers, and I think it will be good to have a set of cards and write the name and numbers, and adresses. we may grow into very large society soon, we will have thirty members inside of a month.
I think I will not make a long focus glass again I think Brashears focal lengths must be best, Mr Prahl will be here tomorrow to stay a week

I am very truly yours

John E Mellish

DEC 7 1908

Milwaukee, Dec. 4, 1908.

Mr. A. R. Hassard.

Dear Sir:

Recieved your double letter yesterday and greatly enjoyed reading it. I paid a visit to Mr. Mellish last Saturday and stayed 2 days. I took my 8 inch mirror along and he finished it. It now defines splendidly; all that I desire. I photographed his instrumnts and will send you some pictures later on. I inclose two of mine one showing the 8 inch after rough-grinding, the other, my home-made microscope. How does your telescope perform? The moon is a wonderful sight, powers 200 to 400. And Saturn, the division in the ring is readily visible, as well as several satellites. I am going to make a driving-clock just as soon as possible, and will provide the bearings with ball-bearings. Then I'll have an instrumnt de luxe! After that, I'll settle down and try to do some really valuable work with it. I also have several eyepieces to make. I sell them almost as fast as I make them. I have 8 in my set. Judging from the description of your eyepiece, the inner lens is of unequal refractive power, and would have to be replaced

by a new one. My lens-work is of the very best and rivals the work of any optician; just ask Mr. Mellish. Could you give some information about the man who made a 3 inch objective, how he tested it, etc? I tried to make a 4 inch last summer, and found it to be a of a job. In fact, I never finished it, and I am not sorry. The 8 inch beats any 4 inch.

If your silver won't rise, use less ammonia, and more of the reducing solution. It will then rise very fast. I lifted mine out at intervals and compared it with a looking-glass. What did you pay for the aluminum cell your mirror rests in? I am going to make one too. I have so many things to make, I hardly know where to start. I blackened the inside of my tube with printer's ink and benzine. It got so very black, that it grew dark all around, and people began lighting their lamps, while I groped my way out of the darkness. I have much more to say, but will keep some for next time.

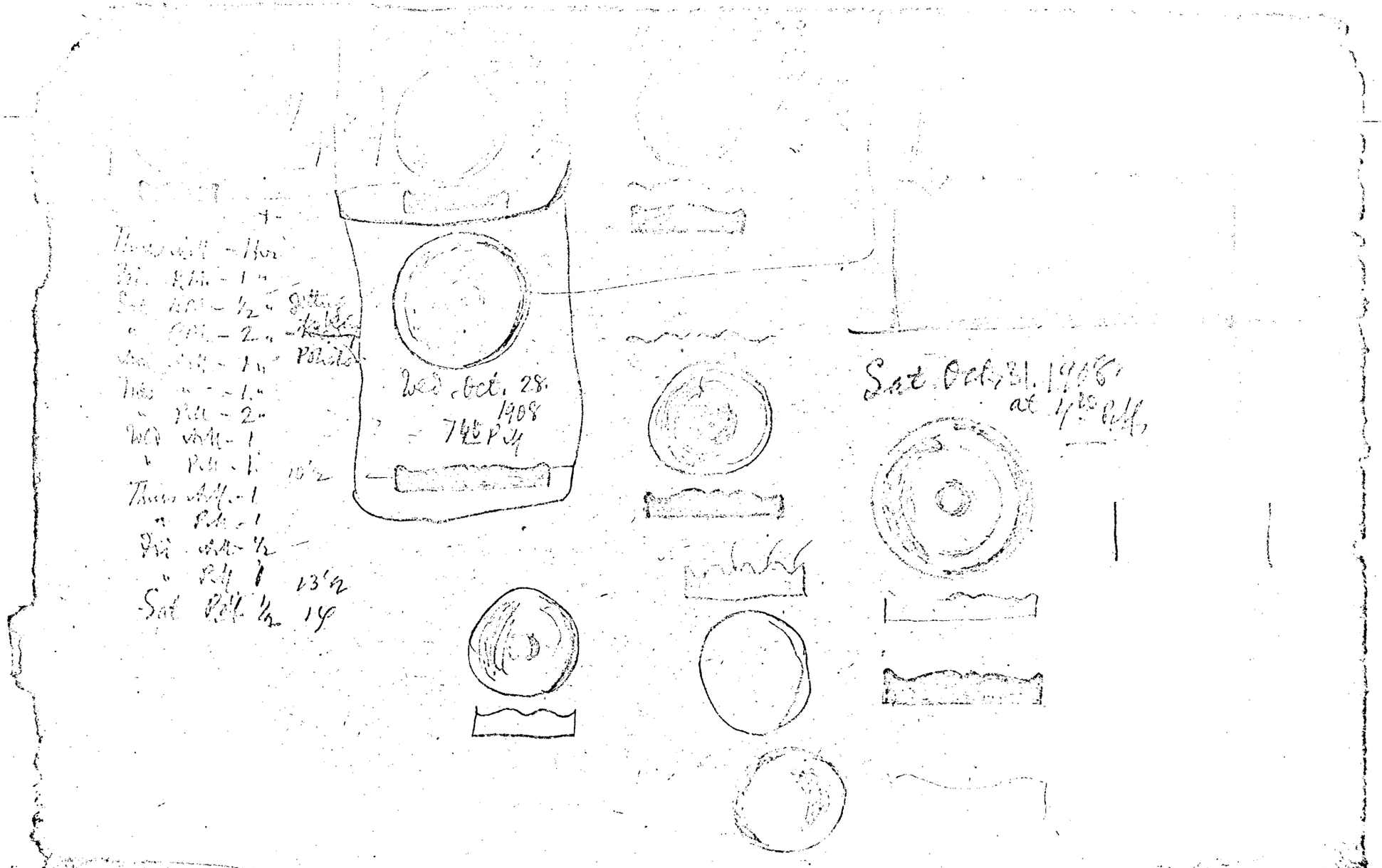
Awaiting an early reply, I remain

Astronomically yours,

Arthur Prahl, M. A. A. O. S.

P.S. Have you a picture of yourself? I would like to see who I am writing to.

A. P. member of American Astronomical Observational Society.


Wed. Oct. 28. 1908 - 745 PM
Sat. Oct. 31. 1908 at 1:15 PM

Roswell Park, M.D. Pres't. William H. Glenny, V. Pres't. Henry R. Haverland, Sec'y & Treas.

Spencer Lens Company,

MANUFACTURERS AND DEALERS IN

Optical Instruments and Laboratory Apparatus.

OFFICE AND FACTORY, 367 - 373 SEVENTH ST.

Buffalo, N.Y.,

OUR SPECIALTIES: SPENCER MICROSCOPES AND ACCESSORIES.

May 12, 1906.

Mr. A.R. Hassard,

Toronto, Ont.

Dear Sir:-

I am in receipt of your favor of the 7th inst., for which I thank you.

I will start the eyepiece at once, and hope to be able to deliver it in about ~~ten~~ 14 days. I do not think it advisable to have the focus of the eyepiece shorter than 5mm, which will give you a power of ~~130~~ 120, as an eyepiece of shorter focus increases the power at the cost of definition, so that nothing will be gained by higher power.

Yours very truly,

W.J. Bielicke

on 2 inch 24 in focus

May 7, 1906.

Mr. Bielicke,

c/o Spencer Lens Co.

367 Seventh St.,

Buffalo, N.Y.

Dear Mr. Bielicke,

I received your firm's letter this morning, for which I am very thankful. In view of the fact that the objective will not go over 200 power, - I suppose because of its short focal range) - I think I will not bother with it just now, but will keep my eyes open for one of longer range until I get it. In the meantime, please make me an eye-piece for the 2 inch objective that I now have. The focal range of my 2 inch glass is 24 inches, - which I think is just a trifle short of the regular proportion; but that is its range. I think I ought to be able to go up nearly to 150 with it - somewhere between 120 and 150 will you please make this eye piece, and I will advise you further regarding sending it. Thanking you for your courtesy, - will you kindly say when it will be ready. If you think my glass - it's a very good one & will stand 150 power then please make that power eyepiece with as you think will be safe to do

Faithfully Yours,

A.R. Hassard

Dec 6. 1908.

A. R. Hassard

I was very glad to hear of your success with the speculum, it is a very hard job to get a perfect sphere, yet I got it on my long focus 8½ in, then it took me 7 minutes to get the parabola, and it is perfect, a star looks like this * The small specks are caused by the eyepiece, The star has no real ring only four parts of what might have been a ring, these parts do not stay in the same place but move around, they are so small as to be hard to see, I got my 8½ in so good that there was not a sign of a shadow only all over all at once, I never thought it was possible to get a glass so perfect, I do not like this cold weather, it is tough to be out with the telescope, yet I can not stay in the house when it is so very clear,

I got a letter from Mr Carothers this morning he did not write much was very busy, he now has a 2⅝ in refractor by Bardou & Son, their telescopes are splendid, my 2 in was of their make, The reflector is the only telescope for me now, I saw Enceladus ~~Enceladus~~ one night with power of 300, and I think it will show climmas on a good moonless night, Your 9½ in will show seven of Saturns satelites,

I painted my tube inside from the formula you gave me and I swear it is as dark inside the tube at noon as the darkest night,

I will make a bet of 1000.00 dollars with you that I can see the debilisima in Lyra at noon with it,

I read both sides of your letter they are both very interesting only the back side was disconnected one page was 71 and the next 73. The only star map I have is one I made and a fine one it is too. There are 36 maps each map is about 8 X 10 in and two hours of R.A. and 30° of dec. all stars down to 5.7 mag and all clusters and nebulae are set down in the right place also all double stars of any interest with an 8½ in. the maps are so perfect that when a new comet comes I know its position right away, I will soon mark in all stars down to 7th mag I got the star catalogue from Harvard.

I am going to leave Popular Astronomy out of my list now it is no good, I read every thing of interest in the last number in one hour and I can go to the Observatory once a month to read it, I do not have one bit of trouble silvering my glasses now, do you mix up all your chemicals and do you distill your own water if not you can not count on a good coat of silver I have a pair of scales which weigh from ¼ grain up to 4 oz. I only use 100 grains to silver my 8½ in glass 16 59 in Sanford and get a thick perfectly even film, so dark that a lamp will hardly show through it.

I am in a great heat about the E.U. I want to see our articles and what effect our articles have on the antediluvians like H.

[illegible] many mirrors I have made, they are three 6 in. ~~[illegible]~~ 8½ in. one 8 in refigured for Mr Prahl two 9½ ins refigured, and now one 8½ in just started for Mr Fullmer. Have you ever seen any of the clefts on the moon, 4 in will show a few I saw 7 in Cassendi one night lately. I think last Friday night. I think the clefts are wonderful with my 8½ in

I sent a short article to the E & M this morning. I will try to write every week now.

Mr Carothers ~~[illegible]~~ wrote that he thought he would not have time to join our correspondence society, he must think we expect him to do a whole lot, I will write him again soon and point out that he is not expected to write so much, only when he wishes to do so. Here are two new members No 9 Dave Freedman. Cleveland. Ohio.
% Cement testing laboratory. City Hall.
No 10. James Hill. Grant City. Mo.
I am sending you Mr G's last letter I would like it back. Many of the idioms in the E & M are very queer to one who never hears the english, talk
Your 9½ in will give splendid views of the nebulae and star clusters, Mr Prahl said he used to wish he had a 6 in refractor and he would be satisfied now I tell him he has a better than a 7 in refractor
I once tried my 1⅞ in refractor with 2 in of the speculum and the refractor was ahead in light giving power, then I tried 2¼ in of the speculum and it beat the refractor

trim I tried 2½ in on the speculum and it gave just as much light as the 1⅞ in refractor, that would make my 8½ in speculum equal to a 7⅜ in refractor for light gathering power. then comes in the loss of light from the greater thickness of the 7⅜ in objective so the 8½ in speculum will beat a 7½ in refractor for light and the definition is very much better with the reflector I am glad I do not live up in Alberta it is down to 30 below zero there some of the time now, I get the government weather maps every day they are a splendid thing,

How is the 9½ in I refigured it ought to show stars as a disk with not much of a ring and a few specks around it, the air will not be very good from now on for several months or until spring the higher air is now charged with frost,

I think Arthur Grahl will soon take the E M he wrote that he was very lonesome without it

Try the debiliesima in ε Lyrae and see what is the smallest aperture you can see it with I can see it with a 4½ in of a 6 in speculum, this would be equal to a 4 in refractor or a little less,

Very truly Yours

John E Mellish

P.S. did I ever tell you that Mr Parkhurst of yonkers has a 6½ in Brashear reflecting telescope and it never did show well not even a disk to a star but there is a glare around it. I will test it next time I go there,

DEC 11 1908

MILWAUKEE, WIS. DEC 10 10:30 AM 1908

Mr. A. R. Hassard
Confederation Life Bldg.
Toronto Ont.

After 5 days, return to
John E. Mellish
COTTAGE GROVE, WIS.

DEC 10 1908

24

COTTAGE GROVE WIS. DEC 8 1908 6PM

Mr A. R. Hassard
Confederation Life Bldg.
Toronto.
Ont.

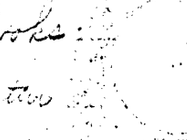
DEC 11 1908

Milwaukee, Dec. 10th, 1908.

Dear Mr. Hassard:

I have recieved your letter and the pictures; I think they are just splendid. Your telescope is a monster, and makes a very imposing appearance, and you resemble a Patagonian in size only. I suppose you are continually climbing a box while using your telescope. You have a good declination axis, but your polar axis could be heavier. Can you focus without the image dancing about? I can do this with mine; even when using 400 diameters, although the image does move then, but not much. I judge that you are using a Brownie Camera. I used one 5 years ago. Am sending you some of my best. Now I have a 4x5 camera with a quadruple lens, and it fulfills all my requirements. I generally use 3¼ x 4¼ and 5½ x 3½ plates in it. The last two pictures I sent you and the one of my 8 inch telescope were taken at 7 A. M. on dark cloudy days. You should use the smallest stop in your camera on a cloudy day, and expose 5 seconds. The result will surprise you. You did some close measuring on my mirror. It is 1 in. thick, and about 7¾ inches in diameter. It is easier to say 8 inch. I am surprised to hear that your mirror is unsatisfactory. You must remember that a reflector must equal a refractor in definition, on account of the unstable, sensitive nature of the instrument. Are your mirrors aligned? Before you test your mirror, test the atmosphere for steadiness, your eyepiece for achromatism, astigmatism, [illegible] the lens, and spherical aberration. I can easily seperate ε Lyrae with power 64,

2.

both pairs cleanly divided, and with 400 each pair is wide. This is fairly good, but nothing extra. My 2 inch, 24 in. focus, divides both pairs with power 38, using an eyepiece I made of Jena glass. With such an eyepiece the definition is wonderfully sharp. Both pairs are very easy with power 48 on the 2 in. refractor. With power 200 on the reflector I can clearly separate η Orionis, mags 5, 6, dist. 0".9. The moon is simply indescribable, it is an overpowering sight, and I think a most wonderful one. Saturn is splendid. Sometimes I see the division in the ring. But best of all is Jupiter. His moons present little disks. The last few mornings I noticed a nebulous object in the same field with Jupiter, and am wondering if it is a comet. It is very bright.  Power 64. Dec. 9, 6 A. M. My telescope is satisfactory in every respect, being entirely constructed of metal, and my eyepieces of the new glass are the best in the world. I gave Dr. Millikin one in return for finishing my mirror. The glass is so pure and transparent, it can scarcely be seen. This is how my mirror looks:  (hold this at arm's length.) The several lit. [illegible] mirror or objective [illegible] is the appearance of a star-image inside and outside the focus, equal distances. The image should expand into a disk of even brightness. In the reflector this disk will have a black spot in the centre caused by the flat mirror. There should be no stray light whatever. My 2 in. fulfills these conditions, and the reflector almost does. Mr. eyepiece of mine is in South Carolina, and the more I use the more I like it than with a Brashear eyepiece. This surprises me. I find that a power 400 brings out more detail

3

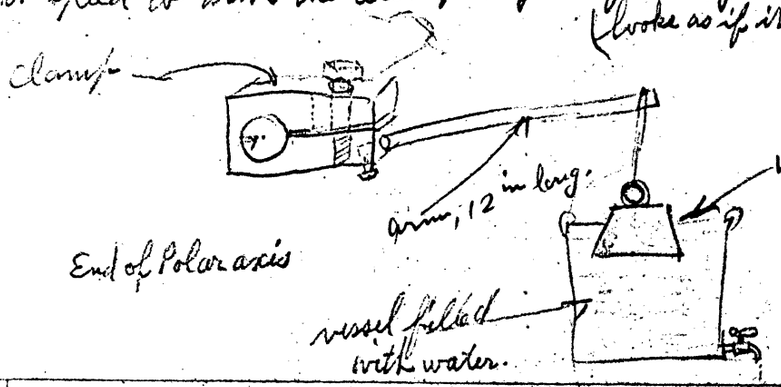
on the moon and planets than a lower power. So you see I have a fairly good mirror. Yours ought to take such a power without breaking down. I intend to start the 15 inch next year, in fall. I am now taking a little breathing spell, having worked on mirrors, etc., since January last, to say nothing of the preceding years, when I was making refractors. — You can depend on it that I watched Mr. Mellish very closely, when he finished my glass. He reduced the surfaces in size, and used 2 in. stroke. He said it would be done in 2 hours, and in exactly 2 hours it was exactly finished. He said it was the best he had ever done. I think Mr. Mellish has some subtle touch, one might almost say instinct, gotten only by experience, that enables him to control the curve so perfectly. When I got home I made a polisher, the way he did, took my old 6 in., and got a miserable curve. I never strained my silvering solutions. Black specks are usually caused by impure water. I sometimes have this trouble. It is not easy to get pure water. I don't think I'll allow myself to get robbed on my cell. I'll have one made of cast iron. This costs only 3¢ a lb, so my cell will cost about 24¢. My entire glass cost between $4 and $5. Awfully cheap, isn't it? I think I'll stop writing now, as you'll need a day off to read this, so I'll close, as ever,

Your sincere friend,

Arthur Braid.

P.S. "Ite sume".

A simple driving clock, as suggested by Prof. E.E. Barnard.
Attach an arm to the polar axis, having a heavy weight suspended from it, hanging in a vessel of water. This vessel will have a small hole in it allowing the water to escape at the right speed to drive the telescope by the force of the descending weight. (looks as if it would work.)



Nov. 11, 1908

Dear Sir your glass surprised me it was about as bad a curve as I ever saw, the centre black spot seems to be caused from the tool which it was ground on being to thin, that is the only reason I know for its being there, the curve is slowly growing better it will take me all this week, Thank you for the other glass after your glass is done I will spend a few hours on that one and try to make it good, Yours truly, John E Mellish.

DEC 15 1908

Milwaukee, Dec. 14, 1908.

Mr. A. R. Hassard,

Dear Sir:

I won't do it. That is, I won't have an iron cell made. Your suggestions on making a wooden cell are very good, and I shall make one on this order. Sooner or later, I suppose, I'll make another telescope, [illegible] I won't invest much more money on this one. I cannot remain inactive [illegible] any length of time. Already vague ideas are flitting through my mind, [illegible] from some dim corridor of my brain; the substance of these ideas is this: "Make [illegible] refractor about 6 inches aperture." I'll tell you the reason why. I've noticed [illegible] my mirrors tarnish very rapidly, especially the diagonal plane, which [illegible] in a week. I have 6 silvered flats in stock. I think the city air, laden [illegible] it is with smoke and sulphurous gases, is to blame. Mr. Ullrich says [illegible] [illegible] 2 years. It is, I think, a tremendous task to keep a reflector in order. [illegible] is subject to [illegible] of excellence and incompatibility. For instance: [illegible] evening last week it worked splendidly, dividing close doubles readily, and showing the clefts on the moon. So I let the telescope stand as it was, not [illegible] it, and the next evening when I wanted to use it, you can imagine my disgust on finding that it showed everything double and blurred, [illegible] all my mirror adjusting was of no avail. A star persisted in looking like [illegible]. Truly, an airship is more tractable than this monstrosity. Sometimes I feel like throwing the whole shooting-match into some corner and use my refractor. [illegible] fortunate in possessing a 4-inch. Whatever possessed you to make a

oc, 35; dist 1". (·) This satisfies me, I can also see the division in Saturn's ring with it. I saw Titan steadily at 4:30 P.M.

Somebody told me that there is a great difference between distilled and boiled water. I dissolved 100 grains of silver nitrate in 4 oz. of water. Caustic potash, the same. Added ammonia to the silver solution till it cleared. Then added the potash. Then ammonia till it cleared again. At this stage I always have fine black particles floating around in it. Then add a small amount of the nitrate sol. (about 1 oz.) I don't know anything about "brown Saffron color," as the books say. I wouldn't know this color if I saw it. If the suspended mirror will not reach the fluid, add distilled water until it does. Then add 2 oz. reducing solution, stir gently, and immerse your mirror. Do not leave it in too long. When mine is silvered, I can read a newspaper through it. If you don't succeed, swear at it and try, try, etc. You ought to have heard me when I had my solution already, and dropped the mirror in it, broke the dish, and stained everything in my vicinity, including myself. Damages, $1.25. Mold your mirror over, try your patience to the limit? And an achromatic objective glass has its surfaces to work. Think of what is in store for me! I think I'll stop now, shovel a few bushel-baskets full of pencil chips away, and go to bed.

Very truly yours

Arthur Crahl, A.M., O.S.

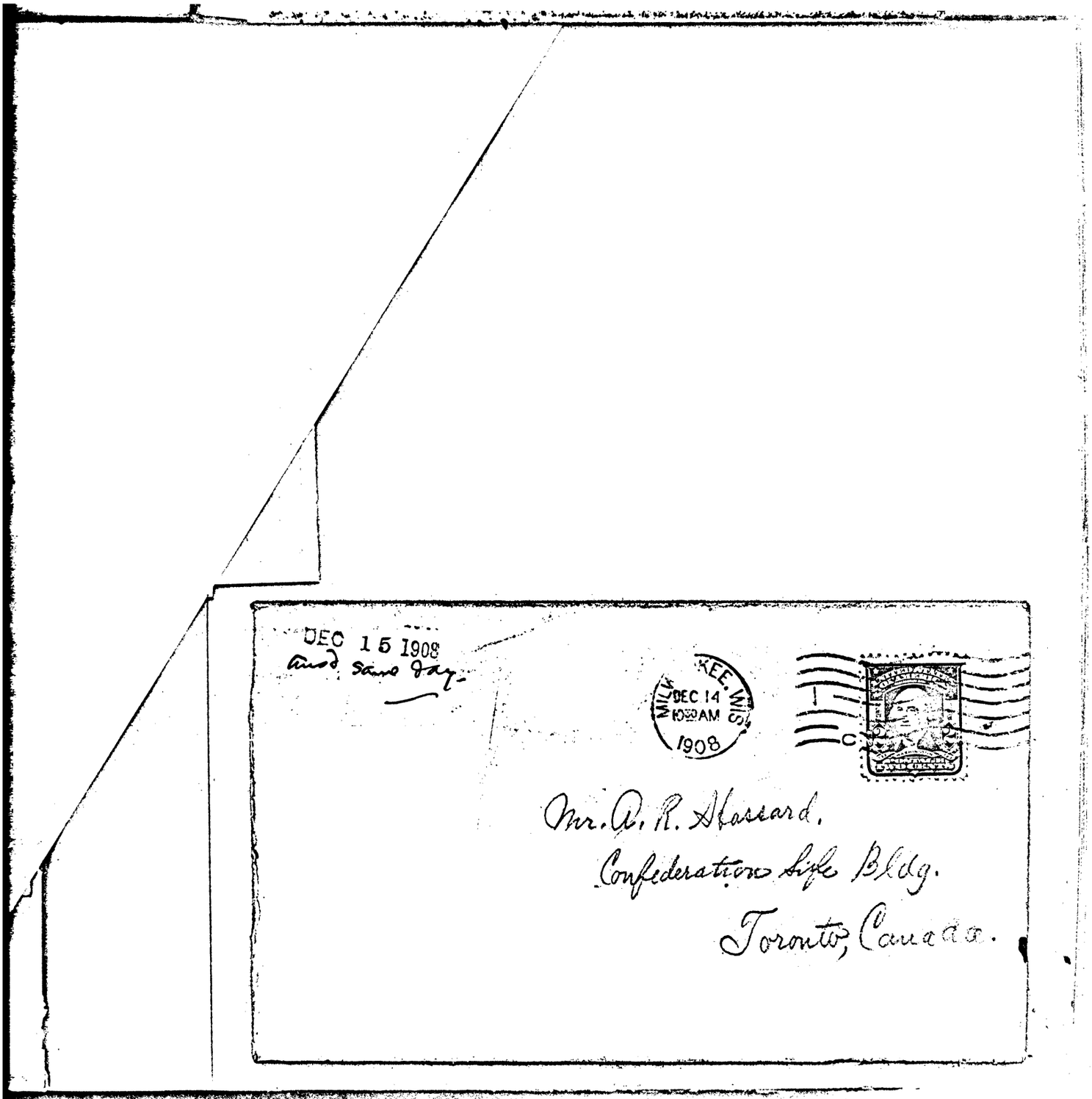
P.S. You are fortunate in possessing a "typewriter".

Answer.
How do you see Saturn?

refractor? A 4 inch would satisfy me, if it was good. I made my reflector because I am not so well provided with the fitting means as to buy a refractor. My 6½ inch stood outside, sun or rain, cats and dogs, rats and mice, flies etc., and it was always ready for me when I wanted to use it. Sometimes a spider crawled into the eyepiece tube and built a tunnel-web there and kept me guessing for awhile, but I always found the intruder and asked him if he would vacate. He always vacated in a hurry, without stopping to say good-by. The local optician wanted $25 for two disks of glass, crown and flint, 6 in. diameter, which is ridiculously dead, but almost. What do think of it. I wrote to Prof. Barnard of Yerkes Observatory, and he told me that my mounting is to frail for a driving clock. Accordingly, I'll make a heavier one, with polar axis 4 inches in diameter, and a 3 inch declination axis.

Make your 7 in. down to perfection, and you will have a very convenient telescope. It will have to be very good to beat your 4 inch.

If you want eyepieces, state what power you want, and the focal length of your telescope, and the exact inside diameter of your focussing tube down to the thousandth of an inch, if possible (not necessary to go to the millionths) Or send the tube to me. Also state what kind. The ordinary kind are $2.50. The special, highest grade, $4.50. I just finished one yesterday morning, of the latter kind, giving a power of 160 diameters, and it seperates beautifully, distinctly showing ε Lyræ double, mags. 5.5, 6 distance apart 1".2 Also the star numbered 10 in the same constellation, mags.


DEC 15 1908
Rec'd same day.
MILWAUKEE, WIS.
DEC 14
10:30 AM
1908
Mr. A. R. Hassard.
Confederation Life Bldg.
Toronto, Canada.

DEC 23 1908 25

COTTAGE GROVE DEC 21 1908 6PM WIS.

A. R. Hassard Esq.
Confederation Life Bldg.
Toronto.
Ont.

Dec 20 1905

A. R. Hasson

Dear sir I have been very busy lately
one day more will finish the 8½ in for H. J. Bullmer
and an 8½ in is ground for James Hill.
The new idea I gave to. Dave Freedman was about the ~~same~~
spear shaped polishers you and I have been using
I also now think the Hyperbola is as easy as any other
od curve to take away. I never tried putty powder to polish
ith You wrote that you tried 400 on ϵ Lyrae. that is
much higher power than our winter air will admit of
have seen only one good night in Dec so far. My telesc
s very bad and if I had not seen as well with it that
e night I would think the curve was very bad. you
ay not get a good night again until the last of Feb
The parabolic curve on my long focus 8½ in is very small
ut very bad in fact Hyperbolic on the 8½ in of 40 inch focus
I was sure the parabola was enough on your glass, as the
t of focus images of a bright star the same on each
ide of the focus. that is a sure sign of a good glass
I am keeping the 9½ in you gave me to test once in a
hile to see if the curve changes
I was 7 minutes getting the parabola, from the start
ith 3 inch stroke. My first article brought ~~me~~ a
tter from William R. Brooks He thought it was
reat. I am thinking of making a 15" in before

More comes around.

I do not strain my silvering solution, and only stir it until it starts to grow dark then dip the speculum in and let it hang until the bath grows muddy.

The silver will not form on the speculum in a splendid film with out distilled water. all other water has some lime or other organisms, which keep the silver from rising I do not bother about the little black particles in the bath they have done no harm to me. but have had none of them lately. I will run doors in my tube like you have it is a bother to have to ~~take~~ take the speculum out to wipe it. I advised Dave Freedman to give up emery and use corborundum I told him that if he would wash the glasses carefuly he would not be bothered with scratches, and to run the rouge through water

I have a ~~professo~~ professonal polisher now it sets tight to the glass in every part, and the squares are exactly square. when I slide the glass off it sticks tight even when it sets on only two squares

I mixed one ounce of oil of turpentine with the pitch and it works like a charm. I polished the 8½ inch in two hours. but will work one hour longer to get the polish perfect and not have a single sand hole in the glass. Very respectfuly yours John E. Wallick.

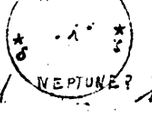
Milwaukee, Dec. 22nd. 1905.

Dear Mr. Hazard:

Judging from your last letter, you apparently think I am discouraged with my telescope. This is not so. In fact, I am highly pleased with it, and would not be without it; it shows so very much more than my refractors. A man that has ground and polished three mirrors cannot be discouraged. The reflector needs so much coddling, that's the trouble. A refractor is the lazy man's instrument. Perhaps I'm lazy. I have no covers for my mirrors or tube, but cover it up with a spare blanket. I just finished the last eyepiece to complete my set, and a fine set they are. I now have 12 eyepieces, giving powers from 32 to 576. The one I use most is 128. I also made a new finder of 2 inches aperture and 12 inches focus. It is achromatic, has a very large field, and is vastly better than my first finder of 1in. aperture. In the eyepiece I have two cross hairs, and I can find any object immediately with any power. I have also finished my new mirror-cell, and it is satisfactory. I will relate some experiences I had making objectives. First as to flint. I took the flint of my 2 inch, ground a crown lens of 8in. focus, combined the two and had an objective of 42 in. focus where I wanted 30. I then made another crown lens, also of 8in. focus, but of different refractive index, and got an objective of 22in. focus. Another lens gave me 25½ in. focus, and still another, 13in. This beats me for the time being. When I made my 4in. I got a piece of flint 8 pat, where I wanted 5. Another attempt and I got 13in. My 3 inch I made myself, and got 42in., but the flint is not thick enough, so it isn't achromatic.

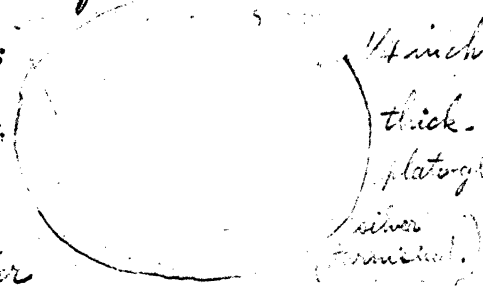
Your 4 inch ought to stand 200 easily. It should take 400 without losing definition. My 4 inch took powers upto 250 satisfactorily. A long focus glass takes high powers better than a short

Yes, one. A reflector should have the focus in the ratio of 8 to 1. A refractor 12 to 15 to 1. As you say, 200 to 300 is about the handiest power to use. I always use the lowest power that will plainly show the desired object. I can see the six stars in the Trapezium of Orion steadily with power 150. The star marked σ is an easy quadruple (106). The star 32 Orionis is a very close double, which is in contact with 256. The distance apart is 0".4. I would like to have you examine these objects and tell me how you see them. My 100 power drawing of Saturn was too large. This is the exact size, according to close measurement, as seen (Dec. 21st. 3 min.). I find the wind my greatest enemy to satisfactory observing, so I am going to build an observatory, dome and all, in spring. Present prevailing pecuniary difficulties prevent me from doing so now. It's too near to Christmas. I suppose you are already married. Judging from your pictures you are about 10 years older than I am. (Dim. 21½). The inclosed picture is a good likeness, but the one taken with the binch is outrageous. I don't wear glasses. My friend, who took that picture, does, and I thought I'd look more distinguished if I'd put them on. So much for vanity. I also send a picture of my micrometer cell, as it was in the lathe. Its outer diameter is 12 inches. I am watching the stars in Gemini, to see which is Neptune. This is the region, as seen in the finder.



You should have used kerosene as a lubricant when drilling and tapping aluminum. I also have my flat mounted in a brass cell, with adjusting screws. It is very solid. I think a 13 inch shell fired at it would rebound. My picture shows it fairly distinct. You are quite a mechanic, judging from your ideas on saw-repairing. I've had about 6 years experience at the machinist trade, and feel able to tackle most any job. I've fixed furnaces, scratch-tubes, stoves, engines, boats, engines, motors, and hundreds of other things. I fix my blades, if they break, just

as you do, only I don't stop to wind a wet rag around it. I stop the temper-drawing with the tongs used to hold the blade-end in the flame. I am used to hardening and tempering tools, dies, gold, brass, and whatnot. As for drilling, my lathe is always ready. I can drill a 3/4 inch hole 3/4 inch deep, through crucible steel in 10 minutes. Very slow, compared with what they do in the machine-shops. I made a diagonal rack and pinion on the lathe last week, and will put it in place some time. Do you mean to say you was making a 9 ½ in. refractor? You would have had an awful job with the crown lens without iron grinding tools. My reflector beats a 6 in. refractor, so I don't think it would pay to make a 6 in. If silver don't tarnish too fast, I'll make the 15 inch. This is the size of my flat, as drawn by tracing around its edge:



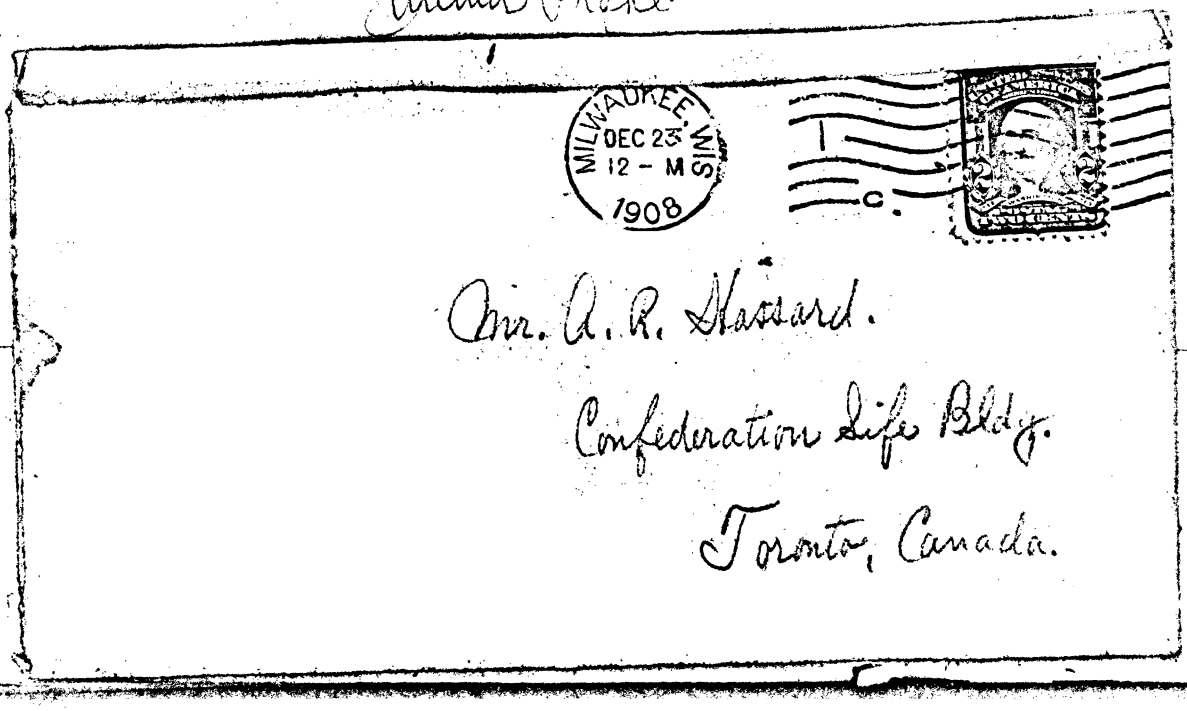
I formerly used a flat spectacle lens. Anything over 1 in. will do.

The picture of myself and telescope, you will notice, is covered with white spots. This was caused by not waiting for the developer powder to dissolve. Therefore, take warning.

I am running out of paper, so I'll stop now. Wishing you and yours the merriest Christmas, I remain

Yours friend

Arthur Pratt.



Mr. A. R. Hassard.

Confederation Life Bldg.

Toronto, Canada.

JAN - 5 1909

Milwaukee, Jan. 3, 1909.

Mr. A. R. Hassard,

Dear Sir:

Have received your double letter and was pleased to hear from you again. You are very industrious, grinding so many mirrors. You will soon be an expert at getting the curve right. Why dont you grind a short focus mirror for celestial photography? I ground and polished a 6 in. on Christmas day. Its focus is 24 inches, and it will be used to photograph the brighter clusters and nebulæ. I will mount it in a short tube and fasten it to the 5 inch, which will be used to guide it, by means of cross-hairs (of my own) in the focus of the eyepiece. This is how I'll connect the two instruments, and view.

Two pieces of board saw out to receive the two tubes. Then I will make a

The pictures in Craig Smith & Carpenter's "Moon", and never saw them till now, and you can imagine the sensation of realizing these boyhood dreams. At that time I studied the heavens with a 1 in. spyglass, and thought it a powerful instrument. Then I read about the wonders a large telescope would show; Saturn's ring, The Moon, and the star-clusters & Nebulæ. And now I am privileged to actually behold all these wonders far better than I ever expected to see them! Therefore, dear friend, do not think I am giving you somewhat fanciful observations. I am in the habit of recording everything I examine, and have done so since 1902, and think I am not likely to see imaginary things. The objects I mentioned are not at all near the limit of visibility, but almost 10 years of peering through all kinds of optical instruments has trained my eye, so I can see a good deal more than my friends can see

frame somewhat like the one that supports the flat, to hold a small plate (3½x3½) in the focal plane. There will still be enough mirror-surface left equal to a 4½ inch lens. I expect to reach stars to the 10th mag. in one hour's exposure. Tried to get the Eng. Mechanic in town here, but no news-dealer seems to have it. I looked over a whole stack of them at Mr. Mellish's house and they contain some very interesting articles. Also some extremely useless ones. I never saw any paper that would tolerate such a worthless amount of argument among its subscribers. Why, I actually saw the editor's note, telling these wranglers to stop their useless talk. Still the amount of interesting papers outweighs these spots. I do not believe in performing miracles with small telescopes, as so many do in the Eng. Mech. One writer actually states that he saw 10 stars in σ Orionis (I forget) with a 2 inch "apochromatic"! I never saw more than 6 with my 2 in.:  The 8 inch shows 9 under favorable circumstances:  I can see the 6 stars of θ Orionis distinctly when the air is clear and steady. In fact, I use this ½ faint star object, and η Orionis, to test the state of the atmosphere. If I cannot see these two objects I know that the night is a bad one. I can only see the 6 stars of θ with my own eyepiece, 100 diameters, and only see 5 with an ordinary eyepiece giving power 128. I did not mention these objects as phenomenal seeing, but merely to give you an idea of the quality of my instrument. And it is still so very new, this using such a powerful telescope, as compared with my refractors. The novelty of it has not worn off yet. Just now I am examining all the objects in Webb's "Celestial Objects", and sketching them. The Moon is simply grand. Many years ago, when I was only 11 years old, I read of the clefts on the Moon, saw

JAN - 5 1909

It is experience that counts. A very difficult
which I never saw well so far, which you might
try with your larger mirror is a little star 23 Gem.
Procyon. The mags. are: 9.5, 9.8. dist. 0.7."
Mr. Mellish saw this plain with 6 in.
Burnham was in the habit of stopping down his
6 in. refractor, when he was on the Lick observatory
site, and this is how he saw the 5 stars in θ Orionis.
After he saw them with 6 in. I always use the full
aperture (7 3/4 in.) Just now I am making some
eyepieces for an amateur in Ohio. He wants the
best. Where did you get yours?
I would like to fill this sheet, but don't know

JAN -- 5 1909

JAN 19 1909

MILWAUKEE WIS
JAN 3
10-PM
1909

Mr. A. R. Hassard,
Confederation Life Bldg.
Toronto, Canada.

what to write, so I'll close. I wish you all success with your mirrors; and hoping that you did not misunderstand me in my previous letter, and will not in this one, I remain

Yours truly,

Arthur Pratt.

Milliken (Milwaukee)

P.S. I made some new reducing solution for silvering, and it is slower than the precession of the equinoxes. It took 2 hours to silver my 6in. Because the stuff is not old enough yet.

Chr.

Another P.S. I am returning some papers Sir. Quellich sent me. telling me to return them to you after I read them. I thought I had done so, but just came across them now. Hoping you are not, etc.

JAN 23 1909
JAN 25 1909

MILWAUKEE, WIS.
JAN 22
11-AM
1909

1 c.

Mr. A. R. Hassard.
Confederation Life Bldg.
Toronto. Canada.

After 5 days, return to JAN -7 1909
JAN 19 1909

John E. Mallett
COTTAGE GROVE, WIS.

26

COTTAGE GROVE
JAN
1909
6PM
WIS.

2 UNITED STATES TWO CENTS

A. R. Hassard Esq.
Confederation Life Bldg.
Toronto.
Ont.

JAN -7 1909 Jan 4 1909

A. R. Hassard.

Dear Sir, Your last letter was very interesting, also your articles in the E. M. are very good. A letter (402) says "they seem to upset ones former notions", Good Mr Ellison does not understand you at all, tell him it is very bad to have the polisher much smaller than the speculum e also uses a very thin polisher, I find that ½ inch of pitch is best, also he says, "the polishing should be done with any hard pitch" (which is very bad,)

just tried your advise about using beeswax, and it dandy I polished Trullmers 8½ in and did not get a scratch, also James Hille 8½ in is without a scratch, I ill never polish again without beeswax, thank you.

sent for a few copies of the E. M. but only my one came your 9½ in does not do the best of work on a good night, I ill take it back and refigure it all at my own expence as must be that I did not do a good job, I must not let single bad glass leave my hands or some critic may get and spoil my pratice, You must have a splendid lass when Jupiter comes on, also Mars.

saw 5 stars in the trap- with my 6 in. 6 are easy th 8½ in, You are bothered with the street lights so u can not see very faint objects, but I think you ill score on the Moon and planets when it comes ing, we have had a few good nights lately

One evening I saw the dark ring and the divi
in the rings, also Encke such a night Saturn is wo
ful. Mizar in showed 10 stars in sigma Orionis
I very much doubt Barnhams seeing 6 stars in the trap
with a 3 in refractor as the sixth star is of the 12th
magnitude. The 11½ in refractor Herschell used was a
poor one it was refigured some years later, and all of his
reflectors were very bad, he did not have the shadow test
and so could not get even a bad curve, but very bad.
F. G. Tullmer #. 327, Elmwood Ave, Medina. Ohio.
I only get the E M once a month so it is hard to keep in
touch with questions. You are just right about observing,
there is not much in the E.M. now about observing we
must get out some interesting things soon. I have heard
from several about my articles in the E. M. your articles
are splendid I wish I could do as good. I can not write
so much. I am sending you a dandy paper about the
solar system, I do not know who wrote it but it is very good
I will now send a drawing of my mounting to the E.M.
I use pitch so soft that it presses down with about two
hours work then I cut the groves in deeper with a short
knife; I think the shadows of the mountains on the
terminator of the moon are very interesting sights.
Do you think Mr Breasheor ought to charge $85 for an 8½
inch speculum,? I think that is quite steep, I charge
$20 now and use every one one at least one good night before
sending it away. very respectfully Yours John E. [illegible]

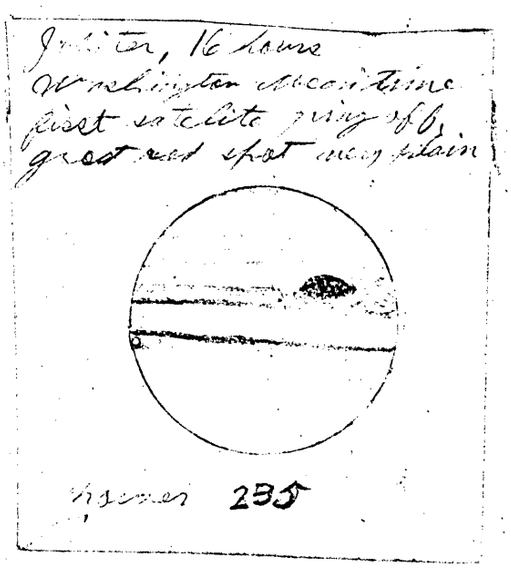
JAN 23 1909

Milwaukee, Jan. 22nd. 1909.

Dear Mr. Hassard:

I was glad to hear from you again. I was wondering if you were busy at another mirror. You are doing well in making so many telescopes. Nothing like getting experience, you know. At present I am not doing anything, except using my telescope every clear evening. Few nights are steady. I was out the evening of Jan. 20. The sky was very clear and no wind was blowing to vibrate the instrument; I looked at Saturn with 200 and could not see the ring. All I saw was an irregular spot of light flickering continously. With 100 the view was fairly good, three satellites being seen. There have been some nights lately when I could not even divide ε Orionis.

According to my experience, you are totally mistaken



about a telescope of poor definition revealing as faint an object as a good instrument of the same dimensions. The poor glass could not show a star as a point, but as a small spot of light spread over a considerable area, depending on the quality of the curve, thereby spreading the light of the faint object over a larger space, which naturally would reduce its brightness. This has been my experience throughout. I find σ Orionis very interesting. This is how I see it, power 100

The arrows point at three stars near the limit of vision, and I cannot see them steady enough to mark their exact position. I never saw more than six stars when my 6 inch had a poor curve. 11 stars.

About two months ago I bought a pair of felt boots to keep my feet warm. I am glad I bought them, as they have saved me from catching a cold, something I always got every winter. The winter of 1906-07 I was laid up for 3 months with rheumatism. I also made a door in the tube so I can cover the mirror. Also made the cover. The flat has a little over two, lined with green felt. Then I have a cover for the whole tube. Then, last Sunday I silvered the mirror (having it in too long of course, and getting a yellowish film) and now I always "cover up" when I am through observing. The silver film is the hardest and best I ever got, standing brisk rubbing without coming off and the silvering dish, a piece of my mother's best chinaware is not clean yet.

I set the lenses of my eyepieces just ½ the sum of their focal lengths apart. No scratches or defects are seen, because there aren't any. I mount them in brass cells, using my lathe. They must be mounted absolutely true; if not, all objects looked at will have short tails of light. When I was at Mr. Mellish's place, he had only one cover for his instrument, and his silver was the brightest I have ever seen. — I do not live in the centre of our city, about 4 miles from the southern

edge, and my southern sky now extends down to the horizon. All the other sides are rotten, the east having the lake, with the factories along its shore; and the northern also has factories. They all have admirable chimneys too. The western side is fairly satisfactory, barring housetops. Mr. Mellish is to be envied his fine location. The sky is perfectly black out there, but it is very lonely.

I would write more, but can't think of anything just now. Besides this sheet is almost full, and you probably cannot spare a month to read (and decipher) one of my letters, so I'll stop ~~stopping~~ to hear from you soon again, and about your doings. I remain

Astrophisically yours,
Arthur R. Hall

After 5 days, return to
.....Mr. E. Mellish.....
COTTAGE GROVE, WIS.

FEB - 1 1909
FEB - 2 1909

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COTTAGE GR... JAN 23 1909 1 PM WIS.
UNITED STATES TWO CENTS

C. R. Hassard
Confederation Life Bldg
Toronto
Ont

Jan 27 1909

C. S. R. Hassard

Dear Sir

I should have answered your letter sooner, but it has been so very clear nearly every night it was so warm last Saturday night that I was out for three hours without a coat on, and without hat or any thing more than I wear in the house, I never saw so warm a January, the telescope has done its very best lately, as soon as spring comes I will send all kinds of drawings to the E.C.A. I have been up every morning using the telescope three or four hours, I saw the great red spot on Jupiter the morning of the 27th. We are quite well supplied with telescopes now, you have a 9½ in 7 in, a 6 in, a 4 in, a 2 in, I have a 9½ in, two 8½ in, one 6 in Arthur Prahl has an 8 in, and a 6 in, and a 2 in, and a 3 in, Mr Fulmer, has an 8½ in, and a 2 in, C, von Kelt, has ~~an 8 in~~ a 6 in Mr J, Bowes has an 5½ in, and a fine, 2 in. Hutchinson has, a splendid 4 in, C Mathers has a 2⅝ in refractor, James Hill. Grant City, Miss. will soon get the 8½ in, I just sent it, he also has a 2½ in refractor Mr Freedman, is making a 10½ in, I have several others on the way for trial, to find out whether they are really interested or not Do you want a catalogue of all the stars down to the 7th mag. if you do just say so and I think I can get you one, I will get one my self now, I do not know about making a 15½ in glass, it will be very unhandy, it will have a focal length of 10 feet and the tube will be 17 inches through, then the wind gets a good sweep here and any small breeze will shake it, yet if I do make one I will have a 6 in polar axis, and a 4 in equatorial axis, it would cost about $25. to make all these things, and then the air is not near as still with that size as with, 8½ in, and 8½ in shows a great

lot on the moon and planets, my 8½ in has such a long focus that it leans a very high power with ease, the 15½ in would have a focus of 170 inches if it was to have the same ratio, the 8½ inch and a telescope 14 feet long would be very unhandy, out side of an observatory of course I will have such a one sometime, in three years I think last night I spent three and a half hours on the moon and found a lot of clefts which I never saw before, it was a splendid night I saw one star occulted, the division in Saturns ring is very easy I saw the snow caps on Mars this morning, and one of the pear. yet Mars has only a diameter of 5½" and it is very low in the south I am sure I can see a number of the canals next fall.

Did I ever tell you that I saw venus at inferior conjunction in 1906 with the 6 in as a ring like this ○. Did you see Mercury last week, it was bright as Sirius,

can you figure out the occultations from the nautical Almanac I do it and find about three times as many occultations as are list given, I have got to make a new tube for my long 8½ in the tube is just big enough for the glass to fit into, and then it steals definition with one inch around the edge,

&c I have not got any cover for my glasses I do not have any bother about the dew only when I am using it, I silver my glasses twice a year, snow will not do at all for the silvering, nothing but distilled water will give the glass a true coat of silver, I use 100 grains of silver on the 8½ in mirror and get a coat so thick that the sun hardly shows through it

very truly yours, John E. Mellish,

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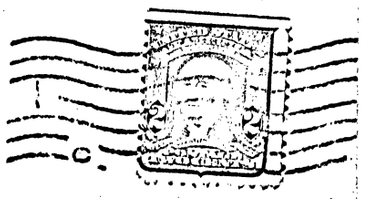
FEB - 2 1909

FEB - 2 1909

MILWAUKEE, WIS.
FEB 1
11-AM
1909



Mr. A. R. Howard.
Confederation Life Building,
Toronto.
Canada.

Milwaukee, Jan. 31st, 1909.

Mr. A. R. Hassard,

Have yours of the 25th. As some people would say, I was "tickled to death" to hear from you again. I am not very ticklish. Neither can I find much religion in my make-up, so you needn't bother having an artist draw an elaborate copy of the commandment relating to Sunday silvering. $3 would buy half an aluminum cell. I usually silver Sunday mornings as I prefer daylight for such work. How did you get your two flats silvered so well? Was it accident or design? Are they bright yet? I never get my flats as good as I would like to have them.

You seem to have plenty of glass, grinding so many mirrors. What do you intend to do with so many telescopes?

The 15 inch has been intruding itself on my brain again.

Mr. Mellish wrote that he would start one & I would. I am thinking it over. You ought to collect the dew falling on your mirrors and use it 4 distilled water. I have two shots of heavy cardboard in the cover nearest the mirror and it does the work. I intend to line the entire inside of the tube with cardboard.

Never, never, never, never (250 times) grind a speculum on a tool larger than itself. You will have such a splendid hyperbolic curve that all your figuring will make but little headway with it. I ground my 6 in. on a 7 3/4 in tool, and never got it good. The memory of the time I spent over it seems like a nightmare. My 8 in. I ground on the same tool, and the spherical curve was ground right into the glass, making the final figuring easy. We had a snow-storm here such as we seldom get. I got three pictures of winter landscapes. Will send copies as soon as possible. I have observed the moon lately, but it is as easy to make out minute detail as it is to read the date of a coin lying in three feet of water. After the moon is gone, and it isn't too cold, I will probably try celestial photography again. I inclose a picture of Mr. Mellish when I was up there; he looks like a Fiji Islander and, as usual, I forgot the hat, but it is a pretty fair likeness. How are you getting along with your camera?

As to your idea about the nebular theory, I wish to state that I have know views on the subject, but to nebular theory, which is rather nebulous, sounds the most reasonable, so I am believing in it at present. The D. D. D. ought to set to work and find out the machinery of the heavens.

I don't no what more 2 write, so I'll stop. Write soon and tell me of your escapades. If you don't know what to write, write anyhow. Ever Arthur Prahl

FEB 11 1909

of 1200 diameters on the Moon, Saturn, and Mars. The air was perfectly still and the views we had of the Moon were such as can never be forgotten. We actually saw a world before us.

If you fix up your 15 in. with ropes, spars, etc. you will have a source of constant amusement. You must have a very rigid mounting. I am going to construct a new equatorial this coming summer. The polar axis will have a diameter of 6 in., the decl., 4 inches. The polar axis should always be at least half the diameter of the objective or mirror in diameter. The equatorial I am using now is the one I used for the 3 in. refractor. It is almost satisfactory.—

I have come across a book in our Public Library which proves, by facts and figures, that the earth is a flat surface, with the sun and stars revolving around it. It was edited in A. D. 1897. Here is one sentence I remember. "The sun, as our eye correctly informs us, is a very small luminous body traveling around the earth." I closed the book after reading that, as I felt my senses leaving me. If the author would have been there, I would have given him the thrashing of his life. It explains perspective, circumnavigation, and other familiar phenomena. The writer believes that the earth was created in six days, but does not prove that. Neither does he prove that the sun revolves around the earth. He says: "We must believe what our eyes shows us". He ought to look at some optical illusions. This is quite a diversion from the Nebular Theory, isn't it?

Last Saturday the air was fairly steady. So, out of curiosity I tried very high powers on the Moon and Jupiter. I went as high as 400. It is interesting to get views of our neighbors in space, to bring them as near as possible. For detail observing I used 128. I have come across a new eyepiece lately. It is achromatic, orthoscopic, and aplanatic, giving an unheard of large field. I intend to construct one. It has three lenses in it.

Be sure and write soon, and let me know how the 15 in. is progressing. I am highly interested in your project.

Yours as ever.

Arthur Radle

N. B. I stop now, to hunt for information concerning achromatic objectives.

FEB 11 1909

Milwaukee, Feb. 16, 1909.

Dear Mr. Hassard:

I wish you luck with the winch, and hope that you will not be gray-haired before it is done. And be sure to emery it very fine, down to the 120 minute grade, so that the curve will be ground into the glass, and not polished in. It certainly is a large job, but that, of course, must not deter a person, much less a M. A. O. D. S. For my part, I never grind another mirror, but will turn my attention solely to refractors. This because I have had great success lately in constructing achromatic lenses. I have succeeded to a large extent in eliminating rule-of-thumb methods from this work, and find that I can control the focus, chromatic aberration, etc., very satisfactorily

FEB 11 1909

MILWAUKEE WIS
FEB 10
11-AM
1909

Mr. A. R. Hassard.
Confederation Life Bldg.
Toronto, Canada.

My reflector had a fine silver film, gotten about 3 weeks ago. It is on yet, but looks dull and comes off if I try to wipe it. I only used the telescope 3 or 4 times, the rest of the time it lay in my attic room, all the covers in their places. I don't know why the silver deteriorates so soon, unless it is the air, laden with factory smoke and gases. Verily, a reflector is a running expense. I never had the least intention of ever constructing one, until last year about this time an astronomically inclined friend made me a present of two 6 in glass disks, which he had bought after reading about Mr. Brellish discovering a comet. He never started grinding them; I made a mirror out of each one. After buying the 8 in. disk, which I had intended to grind to a 30 inch focus, for celestial photography, curiosity overcame me, and I thought the heavens would look pretty good with an 8 in. glass, so I made another reflector. I am not sorry, either, that I made it. But I have never lost sight of my original intention, which was, to purchase, construct or obtain in some way a perfect 6 in. refractor. I intend to realize this dream soon. I know that a reflector is child's play compared to making a perfect objective, but all things come to him that waits (and works). A good 6 in. would reveal more objects than my 8 in. mirror would, and would give a sharper image, with more light. Being smaller, it would not be bothered by atmospheric disturbances as much as the 8 in. I intend to make small objectives first, then gradually increase their size, until I can make a perfect 6 in. I am entering a field of optics now about which the books remain silent, and the man that knows will not impart his knowledge to another, as it is too dearly earned. The reason I will not make the 10 inch is

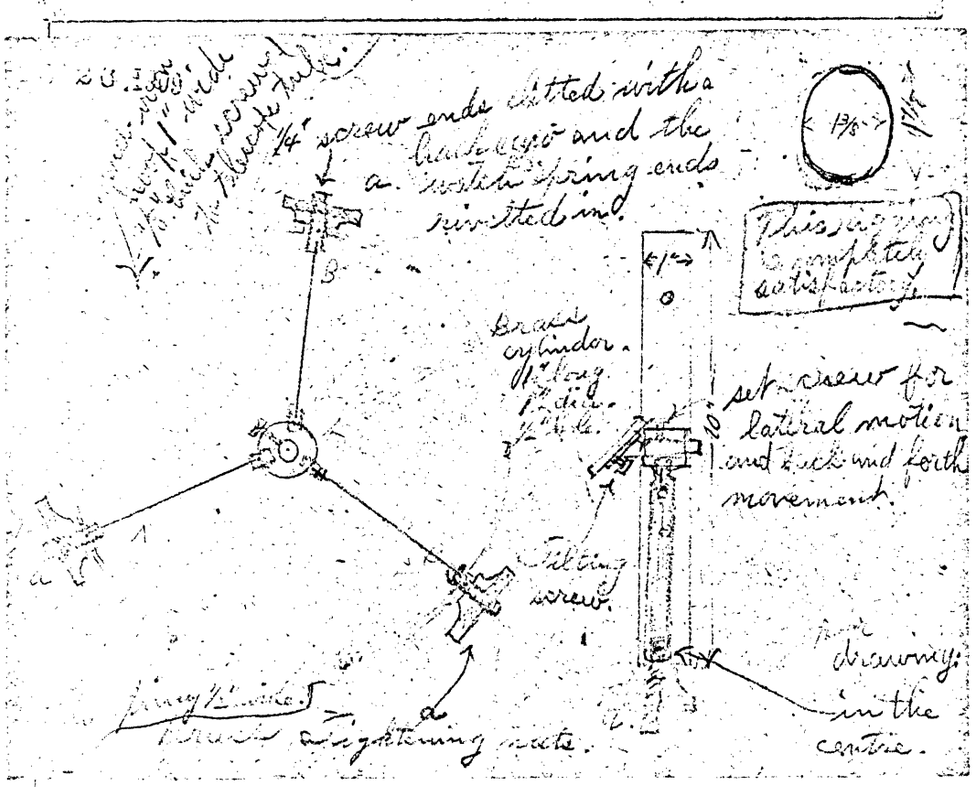
T6

mainly on account of atmospheric conditions. The silver does not last long enough, and it is rather unwieldy an instrument. I had it all figured out, even to having my photograph taken, sitting in the tube. But a person changes his mind sometimes. A 10 in. refractor would be handier to use than the reflector, and would be more durable. I hope that you will get the curve perfect without much trouble. The moon ought to present a grand sight. A friend of mine has a 10 in. refractor a splendid instrument, and I go to see him occasionally and then we explore the heavens. Rarely is the air steady enough to use over 300 on it. but it shows fine. One night in August, 1907, we used a power

FEB 19 1909

MILWAUKEE WIS. FEB 17 3 - PM. 1909

Jno. A. R. Hassard.
Confederation Life Bldg
Toronto,
Canada



FEB 26 1909

MILWAUKEE WIS. FEB 25 10 30 AM. 1909

Jno. A. R. Hassard.
Confederation Life Bldg.
Toronto, Canada.

Milwaukee, Feb. 17, 1909.

Dear Mr. Hassard:

I was so delighted with your last, that I read it several times. You have probably misunderstood me in my last letter. You said it had a most doleful sound. But do not judge by appearances, as the flat-earth believers do. How can a person that has constructed a reflector ever be discouraged. As you have also done so, you will admit that this is impossible. I am not downhearted at all about my reflector. Somehow it doesn't satisfy me. It has not the neat definition nor the stable qualities of a refractor. But, when I see the belts of Jupiter or scan the mountain scenery of the moon with my 3 inch alongside, I feel that it was worth the trouble. Still, an achromatic objective has many

Milwaukee, Feb. 24, 1909.

Dear Mr. Hassard.

Your most interesting epistle on hand. You are doing well on your 15 in. Naturally it is a slow job, but extremely fascinating. If your mirror is hyperbolic you ought to reduce the diameter of your polisher. If your friend has a good 5½ in. objective, don't, by any means, separate the two lenses composing it. If you do, the telescope will never perform the way it did before.

I am getting still deeper into the problem of making an objective. in fact I am almost lost, but have my wits about me. Just now I am studying Seidel's Theory of the five aberrations, and, the more I learn the more interesting it gets. The problems to be solved are: find the refraction index of the glass, the dispersive power, astigmatism, coma, chromatic and spherical aberration

attractions for me, also many mysteries concerning its construction so, when such problems present themselves they must of course be solved.

You ought to let the little pits, if not numbered by hundreds, go in your 15in. Scratches, pits, ravines, caverns, etc., are not detrimental to good definition, they merely obstruct a little light. Some day I'll send you a photo of the surface of my 8in. You will wonder that anything can be seen with it.

For fine grinding and polishing, use strokes one-fourth the diameter of the mirror, and they must be elliptical. This, to my experience, will impart the spherical surface to the glass.

I finished an achromatic lens lately, of the most wretched quality. I made another, using different glass, and don't know where I am at. I am getting plenty of experience all right and learning with each failure. The whole secret is, to find the refractive index of your glass, and grind the curves accordingly.

Your description of the optical instrument sold in your city makes my mouth water, figuratively speaking. What did you mean by the reflector having the regulation shaped flat? Isn't different from ours, and do you know its dimensions? I think you could help me some concerning objectives. Could you measure the lenses of your 4inch, if it isn't too much trouble? The central thickness of each lens, and the edge thickness? Could you give the focus of the crown without the flint? If you have a lens-measure you could find the radii of the curves. My 3in., 36in. focus has the following curves, expressed in dioptres:

crown +1.37, +2.75 } +4.12 = 12in.
flint −2.75, +.12 } −2.62 } 36in.

All this would help. At present I am at work on a 3½" objectglass, grinding the crown, the flint I haven't got yet. I am also making an eyepiece for a man's

A reflector only has the last. I could, given two pieces of glass, compute the curves necessary to make it achromatic and could ~~it for~~ correct it for violet rays for photography or for visual purposes. Of course I am not expert at it yet, but must now get some practical experience. Correcting spherical abberation will then be the most difficult problem.

I silvered 8 plates on Washington's washday, using melted snow instead of distilled water, and really I don't think they could be brighter. They are the very brightest I ever silvered and I am highly pleased, and am eagerly waiting for a clear sky. Cloudy weather is the rule now. I also learned something about silvering. I used to have the bother of seeing the silver appear on the glass in patches, resulting in a film of uneven brightness. This time I gently rocked the dish as in developing a photographic plate, after the reducing solution was in and the plate was immersed. After 3 or 4 minutes I stopped rocking, and the silver suddenly appeared over the entire surface, perfectly even and no tarnish. I have powdered sugar in my reducing solution. I also silvered a little mirror I made some time ago. Its diameter is 3¼ in., 36 in. focus and the curve is a beauty.

Many thanks for your drawings and information about plate. I will make a "regulation shaped" one some time. I should think you would cut yours elliptical. I have 8 plates cut this way, with nice smooth edges. I could take one of these and get it "regulation shaped" in about 5 minutes, only they are all silvered now, so I'll let them alone. I have not seen the Eng. Mech. since I was at Mrs. Mellish's place, and I can't find any bookseller that has it. I don't exactly care about subscribing to this paper, but would like to buy the numbers singly. Do you get paid for the articles you write?

Milwaukee, Feb. 17, 1909.

Dear Jr. Hassard:

I was so delighted with your last, that I read it several times. You have probably misunderstood me in my last letter. You said it had a most doleful sound. But do not judge by appearances, as the flat-earth believers do. How can a person that has constructed a reflector ever be discouraged. As you have also done so, you will admit that this is impossible. I am not downhearted at all about my reflector. Somehow it doesn't satisfy me. It has not the neat definition nor the stable qualities of a refractor. But, when I see the belts of Jupiter or scan the mountain scenery of the moon, with my 3 inch alongside, I feel that it was worth the trouble. Still, an achromatic objective has many

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Also. I have also bought a small water motor to run my lens-grinding machines. It is dandy.
I am waiting 4 summer 2 arrive. We have all sorts of weather, none good. Mars is my favorite planet to study. In 1907 I had some splendid views with my 2 & 3 in. telescopes and made over 60 drawings. 8 inches of aperture is so much more than three, that it surely will reveal many interesting details of this interesting planet. And 15 in. ——?
Mr. Pollock expects to see some canals with 8½ in. I think this is expecting too much. Wishing you the best of luck with your work, I remain

Ever

Arthur Prahl.

As for me writing an article on lensmaking, I hardly think I will do so. No books are written on this subject, as the secrets of the art are not common property, and I don't care to have <u>all</u> the opticians against me. I am not permitted to sell lenses below a certain figure. Lens-making calls for more work with pencil and paper than actual grinding. I am getting my methods by a whole lot of experience and study and can make single lenses as perfect as possible, and intend to make achromats just as good, but I am not a competent optician by any means yet.

Let me hear about your work soon again.

Sincerely yours, [illegible]

Heard anything about the [illegible], Mr. Gullich? I [illegible]

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FEB 25 1909

After 5 days, return to

.....Gates & Mc Kee.....

COTTAGE GROVE, WIS.

COTTAGE GROVE
FEB
25
1909
6PM
WIS.

UNITED STATES
TWO CENTS

C. F. Hassard. B.
Confederation Life. B. Idg
Toronto.
Ont.

FEB 25 1909

Feb 20. 1907.

C. H. Hossard

Dear Sir. I have not yet got over the shock from the great storm of Jan 29. I am sending a photograph of the tele-phone line near here which has twenty wires and nearly all the posts are flat on the ground, the wires are all down yet. the ice was three inches thick on the wires and each post had a weight of 4000 pounds of ice to hold up.

I took a lot of photographs and have sold several hundred of them, I am also sending a photograph of my self and telescope,

I have not yet seen the E.M. ~~got~~ for Feb 5. yet,

I have not got a store E.M. for Jan 29 yet but if I do will send you one.

I have not used my telescope but once in the last five weeks and then only for 30 minutes or less,

I was glad to get those two letters you sent, both are very interesting and the writers must be really interested,

I will write to them both now,

I do not understand why you have trouble with the silver film mine is as thick and hard as a silver dollar, and I can rub it as hard as I wish to and it will not come off,

I will be glad when spring comes it is ~~phosperating~~ to sit around and study all of the time when one would much realher be out and using the telescope

we must start at Jupiter in earnest as soon as the sky is clear enough to see something,

I have not seen popular astronomy yet for Jan, or Feb will do so soon,

I have not heard from W. E. C anothere for a coons age, in fact only once, since he wrote you first.

I will not write to the E.M. until I can make some observations and send in some drawings of the moon and Jupiter and Mars.

I have not ground any glass for a month I have an 8½ in speculum, done to sell it is a most perfect glass the curve is the most perfect it is possible to get, it is not one fourth of an inch out of the way, I mean the parabola ~~is~~ is exactly half way between center and edge thus ⌒ I am sure it will show the most exacting tests for any 8½ in speculum,

Do you write to Mr Breakey any more, ?

I am writing down the names of a lot of amateurs on the other side of this sheet, they are not all members of our society, I do not know whether they are really interested or not.

Very truly Yours Jah. E. Mc Clintock

[illegible] using a 9½ in making also inst
[illegible] using an 8½ in. thinking of making a 15½ in
Wilbur Pratt using an 8 in made by him self.
H.G. Jutimer, using an 8½ in, the speculum made by Mr
Linton van Pelt making a 6 in speculum.
Wm. D. Barnes, Council Grove, Kansas. using 8½ in, by Mr 2
H.G. Jutimer, 327 Elmwood ave, Medina. Ohio.
Linton van Pelt Charleston. Ind.
J. H. Atkinson. Jefferson. South Carolina. using a
2 in refractor
W. G. Carothers, Houston Texas, using a 2 5/8 in, made
Dave, Freedman, City Hall, Cleveland. Ohio.
have been writing to a very interesting man
R. Stephens. 605 Keith & Perry Bldg, Kansas City
Mo. He made a 12 in speculum some thirty one years
ago and wrote a lot in the E.M. lately I think in 1905
M. A. Ryerson, thinking of making an 8½ in speculum
Box 502. Belding. Mich.
J. Thomas Schmidt, Box Saginaw. Mich.
I think he is now making an 8½ in
G. H. Welch. 14 Bank St, Brunswick. Maine.
left one very important member out it is
James Hall. Grant city. Mo.
I made him an 8½ in, he is only 16 years old and is
one of the most earnest amateurs I ever wrote to.
John West. Mortlach. Sask. made a 6 in
H. E. Marr. Haskins. Iowa. making some reflectors
Dr. G. H. Brickett. Augusta. Maine.
Dr. R. A. Bonnitz. ~~Augusta~~ Austin Minn.
There are a host of amateurs whom I have written to
but they do not like to write very much,
I once got a card from, a Fletcher. of England
asking how to make a telescope,

Very truly Yours

John E. Mellish

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MAR - 8 1909

COTTAGE GROVE
MAR
5
1909
6 PM
WIS.

A. R. Hassard. B. C. L.
Confederation Life Bldg.
Toronto.
Ont.

MAR - 8 1909

Mar 1 1909.

A. R. Hassord

Dear Sir

I am greatly pleased about your 15 in, I do not think that there is a bit of pleasure Dave Freedman wrote that his glass with an eyepiece gave the artificial star out of focus like this ⊙ that seems to me like pleasure, and I told him so to, I never saw anything like it in my glasses,

I hardly think it would be a good plan to work with a full sized polisher now that you have used a good 15 in but silver it and use it one good night a plane mirror will show good, it is always good to under correct the specula, I do not know why but if a speculum is brought to the full parabola it will not show as good as it did before. I tried it on two 8½ in glasses lately.

Here is the shadow test of my famous 6 in speculum which I discovered the comets with. And it gave the splendid views of jupiter which I sent you,

Yet Dr Prall was very much surprised at the bad surface of it, but the canals are not very deep about 1.000.000 of an inch. or something like that.

I also tried to see a difference between a glass which was properly polished and one which was ~~was~~ not polished very good, but there was no difference unless the glass which was not polished gave the best definition on double stars. I have just bought a very good camera it takes pictures all sizes from 6 X 7 down, I got it cheap, $20.

She $30. taken in the whole outfit, I have been enlarging some pictures with it, & will soon take a photograph of my medals and send you

Very truly yours

John E. McCall.

P.S. I have sold $12.10 worth of pictures of the great storm of Jan 29. I expect to make $50. on it yet this spring.

Leo Holcomb is a member of our society, Thank G

Feb. 25, 1909.,

Dear Mr. Mellish,

I thought you had died, or were in the hospital, or lost in a snow drift. But now that I have heard from you why it snow matter. You have had an interesting time, Iam sure.

I have finished the 15 inch mirror; it shows like the enclosed illustration. I am a little afraid of polishing further because I might spoil whatI already have done. The curve is more of a sphere than a parabola. The central hollow will about be covered by the flat, but the other does not look promising. My surface is not as good as I usually get. I fear I went to the polishing from the fine grinding too soon. My polisher has been cut away in many places, and this brought on the sphere. Likely also it brought in those hollows. What would be the effect of making a full sized polisher, and polish with very short strokes say 1 inch long for two or three hours? Would it be sure to level it down? Or would it have the effect of rubbing down both high and low places, and make the hollows as bad as ever? You have had some experience with such troubles; please let me know what you think of this suggestion. Or should I use longer strokes? I suppose I had better cut it away just a little at the hollows, so as to avoid rubbing there. I want to get this job a fairly good one. The eyepieces show but very little stray light. I had a bad hyperbola at first, but it went away with a few hours polishing. I began the mirror on Feb. 1., and brought it to this perfection on Feb. 24; if I worked 1 hour a day itwould be 24 hours in all that I was working. There was no work done on Sundays; and some days I did work more than that; possibly 30 hours were spent in the work; and this included time that I was not working either; for example resting and considering matters. I would like to get a finer polish; and that is why Ispeak of a few hours' more work; there are no scratches; not a single one; and only 2 or 3 tiny holes in the job. So I am rather satisfied. No handle was used on the glass at all. I just held it by the outer edges, and rubbed it back and forth. It was quite heavy rubbing; but was not too tedious. I used no beeswax whatever, the great weight of the glass I think prevented any of the pitch projecting far enough to do damage; and If I heard the slightest indication of a piece of hard rouge or if a sign of scratching appeared, I moved the glass slowly and weightily upon the pitch, and crushed it into silence. When testing with the eyepiece, there is no sign of a double image whatever; does that prove that there is no flexure? My glass is about 1 1/8 inches thick. The focal length is about 124 inches.

We have had poor skies lately; like you I have done very little observing lately at all. One night lately however the sky was not very clear - stars only to the 4th or 4.5 mag. could be observed; I saw the companion to Polaris better then than I ever did before. My lowest power for the 15 inch I shall make of 2 spectacle lenses which I shall cut circular; they will have to be about 4 inches apart. They should make a brilliant illumination and their ~~power~~ power would be about 30 to 50. Write me soon again please.

Yours faithfully A. R. Hassard,

D E LESLIE — Department of Public Health and Sanitation — MARTIN FRIEDRICH M D, HEALTH OFFICER

Cement Testing Laboratory
City Hall
Dec 22 '08

A. R. Hassard Esq.,
Confederation Life Bldg.
Toronto Canada.

Dear Sir:

I was glad and surprised to receive your letter. Thanks for the valuable information. A mishap forced me to discard my 6" speculum. When about more than 1/2 polished a scratch appeared. I returned to the graded emeries. The suction during the final grinding was so strong that a piece broke off at the edge in direction of a fracture, which seemed absolutely harmless. Now do you avoid the high suction between the surfaces when polishing or using the fine grades of emery?

I am going to make a 9½" mirror out of 1½" thick glass. I rounded one piece a few days ago with a simple machine of my own construction. It took me 3½ hours to round it; the cut is very neat. Will send you a photo of the machine, taken while in operation, i.e. when cutting the other glass.

I think very well of our A.A.O.S. If it were not for the organization I would have to waste much time with books to secure the desired information

as to the material for making the telescope tube and its attachments I will need some points.
What is the focus of your 9½" mirror? What are the powers of the eye pieces?

The photo of your telescope impressed my friends. I showed it to a chronic joker who always made fun of my work and hope that it taught him to have a better opinion of telescope making.

I was in Pittsburg Pa in Sept and visited John Brashear's lens works where a friend of mine is employed. He is one of the best workmen in the country. He gave me a good many hints and helps. The rough grinding is done by machines which grind the same way as when you sit and grind, the polishing of large lenses is done by hand. They use hardened steel dust for all preliminary work. Roughly speaking my friend said that 50 lbs steel dust or grains will do the work that requires a barrel of carborundum. He advised me to let steel dust alone as its use might prove troublesome for the tyro. Looking out of a window of that factory an observatory recently built is seen on an elevated land. It is minus an objective, and has waited over a year for the rough glass from France. When it comes Brashear will make the lens. Pittsburg is an awfully smoky city. I guess I could not see a barn door 100 ft away on a smoky & foggy morning. I am sorry for the big Pittsburg telescope

I am a practical photographer and wish to make use of photography with the telescope. I have not much hope in this line because clock work motion is required. This machine is out of reach of the amateur whose pocket book is not worth the trouble of opening.

Yours Truly

Hoping to hear from you soon
will elegid to grind the mirror next week & must know the focus

David Freedman

D. Freedman

From City of Cleveland
Department of Public Health
and Sanitation

DEC 23 1908

DEC 23 1908

Answd Same Day

CLEVELAND, OHIO
DEC 22
2 30 PM
1908

Mr A. R. Hassard Esq.,
Confederation Life Building.
Toronto, Canada.

JAN - 6 1909

Cement Testing Lab
City Hall
Cleveland O. U.S.A.

Dear Mr Nassard: Jan 5, 09.

Recd your letter this A. M.
and I am glad that you are interested in
the cutting machine. The vertical shaft is
a heavy steel, one inch seamless Shelby tube 18" long.
I have another fine tube of the same size which
was given me for a song. I guess you will
have to sing too for it but the distance
is too great for your song to be audible
I will give it to you for nothing as I have
no use for it. If purchased in a store it
would cost about 75 ¢. If the express
charges. C.O.D satisf. you take it. Weight
is nearly 2 lbs. The bench or support
is 12" square, made of 2 pieces one inch
thick poplar, glued crosswise. Waterproof
it with paint. The cutter is a wooden
circle made of 2 pcs. 5/8 inch pine glued crosswise
to prevent warping. Paint this. Be sure
that the shaft is in center. The wooden
circle must be 1/8 inch larger than the diameter

of the specalum. The cylinder or ring as you call it is of tough sheet iron or steel about 1/16" thick. Use no brass. My sheet steel was too soft for the work. After the cylinder is mounted on the wooden circle cut out six V gaps with a file or hack saw. Don't cut the gaps when the shet iron is flat. The bearings of the vertical shaft are babbit metal — fits loosely — not very loose. The shaft slides up and down easily The lid on the top is a device to lift shaft & cutter while in motion. #30 Carborundum. you found 8 corners cut off. Yes, I cut 2 piece of glass. The first piece took 3 1/2 hours and 1 lb of Carborum. The cutter had four V gaps and took so much time to cut. The second glass took 2 1/2 hours. I had to reverse the sheet steel cylinder in the second cutting because it was badly worn. I used six V gaps. Took a little over 3/4 lb Carborum. Use plenty of water. Don't feed dry Carborum. I was foolish to secure 1 1/2" thick glass. The cutting of one disc if 1 inch thick would have taken 1 hour 40 min. I got a piece of window glass and cemented it to the thick glass to prevent the glass from splintering when getting through with the cut. See photo. Make Portland cement to a consistency

of soft putty, and 3. be sure that no air bubbles exist in the path of the cut to be made, i.e. air bubbles in the cement. Put the window glass over the cement. Tap the glass down letting the excess of cement run out. The layer of cement between the glasses should be 1/8" thick. Put a weight on the top and leave overnight. Dont try to substitute Plaster of Paris for Cement. It is no good, when wet it comes off. Use no clamps to hold the glass while cutting, nails will do. See picture. The window glass + cement will get off more or less easily when you use the cutting thro. with the soln.

As to the Photos I mailed you I use the ordinary brands of glossy paper Solio, Disco, Klor. The variety of colors you get depends upon the time spent in washing to remove the excess of Silver before toning, and the duration of toning.

My friend who works at Brashear in Pbgh. Pa gave me the idea of the machine He is one of the best glass grinders in the country and has given me lots of advice before I started with the 9 1/2" glass He said that it is

not necessary to bother about the ~~aperture~~ diameter and focal length of a mirror. They have no rigid ratio. He says I can make a 8½ or 9½ either 4, 5, 6, 10, or 200 ft focus as I please. Their 12½" mirrors are 7½ ft. Their "comet seekers" of 8½ are 4 ft focus, low power, large field, great light grasp. A very long focus was all right during those days when the correction of surfaces was probably not well understood

as to thickness of glass he says an excessive thickness is a positive drawback for an amateur. He has to wait so long for the temperature to become uniform after taking his mirror out into the open.

No I have not seen your articles in the ~~R~~ English Mechanics. Mr Mellish sent me the address & subscription price of that paper but cant find it, I mislaid his letter. Please send me the addess of publishers & price per year.

90/12½
450 36/5
25 1 = 7⅕

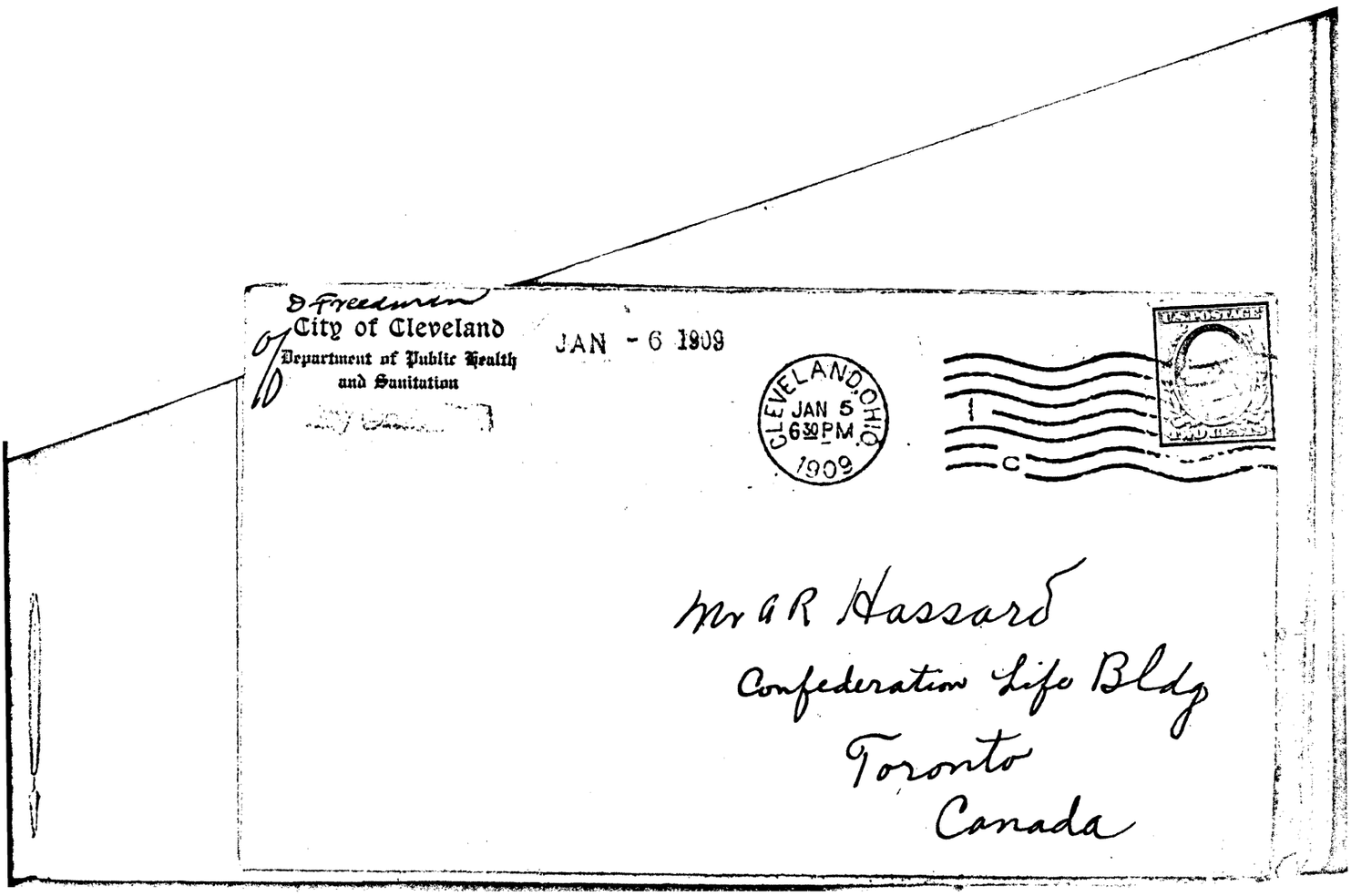
5

What copies of 1905 contain Ainslee's articles? What length of stroke did you use in polishing your 9 1/2 mirror? Did you sit or walk around? How long did it take you to polish?

You asked me how long I have been interested in Astronomy and what I have read on the subject etc.
I studied Astronomy when at College That was in 1904 — The course was brief. I never had the privilege of using the 6" refractor, the teacher would call us out some nights when there was but little to see — that was in Spring. He would not let any one use the telescope with the eye — his eyes away from it. It was Mr Bellish's article in the Popular Mechanics that started me. No I have no other instruments.

Yours

Dewey Fredine



D Freedman
City of Cleveland
Department of Public Health
and Sanitation

JAN - 6 1909

CLEVELAND, OHIO
JAN 5
6 30 PM
1909

U.S. POSTAGE
1 C

Mr A R Hassard
Confederation Life Bldg
Toronto
Canada

I had to melt some rosin to harden it somewhat. The worst trouble seems to make the polisher. It is hard to push the speculum over the polisher at times.

Very truly yours

Dave Freedman

JAN 19 1909

Cement Laboratory
City Hall
Cleveland O.

Mr A. R. Hassard
Toronto Ont.
Canada.

Dear Mr Hassard:

I have been very busy for some time and regret I could not answer. Received the copy of English Mechanics and the separate article, I will return these this week. Your article in the paper was very instructive and eliminated all my doubts as to ~~finishing~~ the mirror. I think I will make my eye pieces when I understand the length of focus etc. Have seen small lenses ground in Brashear's factory. I am having much trouble with polishing. I used brown rope pitch as used on ships to stop leaks. I substituted common tar and think the result will be better. The tar was very soft that

JAN 19 1909
and JAN 19 1909

CLEVELAND, OHIO
JAN 18
9:30 A.M.
1909

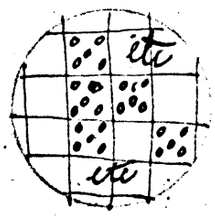
U.S. POSTAGE
1 CENT

Mr A. R. Hassard
Confederation Life Bldg
Toronto Ont.
Canada

Cement Lab.
City Hall
Cleveland O. U.S.A.

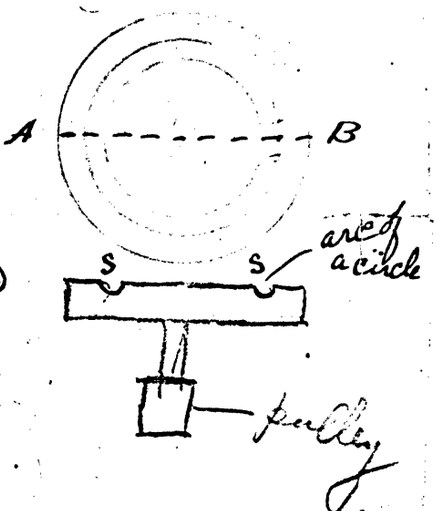
Dear Mr Hassard

Recd yours of Jan 19, I followed your advice to make smaller facets on the polisher although I was not in favor of it because some men say that small facets tend to give rings. The result of the polishing was surprising - a scratch of long standing vanished in three hours. The mirror is polished completely and is absolutely free from scratches. Some pits are left in the centre which would take a week to remove. I have seen a polisher in the lens factory It appeared like this drawing. Each facet was about 1½ inches square and had five holes of the size of a lead pencil cross section.



Will start with the figuring as soon as I can secure the right eye pieces for the pinhole testing. How many lenses are in one eye piece? Double Convex if only one?

My 1½ × 9½" Speculum weighs 10½ lbs
Focus is 87 inches. What is the material
you used for tube construction? What is
the inside diameter of your tube? Do you
Know of a copy of English Mechanics that
describes how to make eye piece lenses ie foci
etc. What was the # of English Mechanics
of 1905 that contained Mr Ainslee's Article
What other copies of the past would help me
along with the rest of my work? Will subscribe
for the weekly as soon as I have enough money.
your suggestion about making a steel die
on a lathe is good but it takes special
attachments to the lathe to secure a true
curve. The best way to make a convex lens
is to get a large cast iron
disc as per diagram.
C shows how the disc
would appear if cut
through A B. All you
have to do is to cement a
piece of optical glass
to a handle and
rotate it in the groove S.



Here is another way of making a die. Drill
slightly into a piece of steel and shape the
cavity with an automobile or bicycle steel ball
by grinding with ~~Carborundum~~ Carborundum

How large does Neptune appear with your 9 1/2 reflector? Uranus? Are the satellites of Uranus visible?

I send you 3 samples of pitch or tar (the commercial names are confusing here). Sample # 1 was too soft. Remedy for softness is to boil out the excess of volatile matter, or to melt rosin. I used rosin and got # 2 pretty hard. This, i.e. #2 is the stuff I used this morning. Rope pitch when chewed does not give an offensive taste.

Hoping to hear from you soon.

Truly Yours
Dave Friedman

Have you received the copy of English Mech I returned?

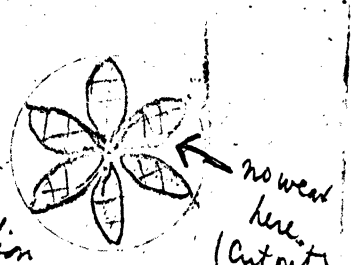
D. Friedman
City of Cleveland
Department of Public Health and Sanitation
JAN 23 1909
CLEVELAND, OHIO JAN 21 8 30 PM 1909

Mr A. R. Hassard
Confederation Life Bldg
Toronto
Canada

Cement Laboratory
City Hall Feb 1908
Cleveland O.

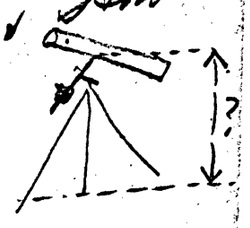
Dear Mr Hassard:

I am still with the Speculum work. The knife-edge test shows that the mirror is an oblate spheroid. The shadows are like this figure. I made a polisher having six petals and have not been able to correct the mirror after 6 hours of work. The oblate spheroid seems to resist correction. With the 1/3 inch focus eye piece it showed two elliptical rings or chainlinks like this figure 8 before I started with correction work. Now it shows the rings O. The rear ring is thinned.



What is the size of your flat reflecting mirror i e of your 9½" reflector Is it oval shaped or a circle. How is it held to the tube so as to keep it fixed 45 degrees. Is it movable by means of a lever or rod?

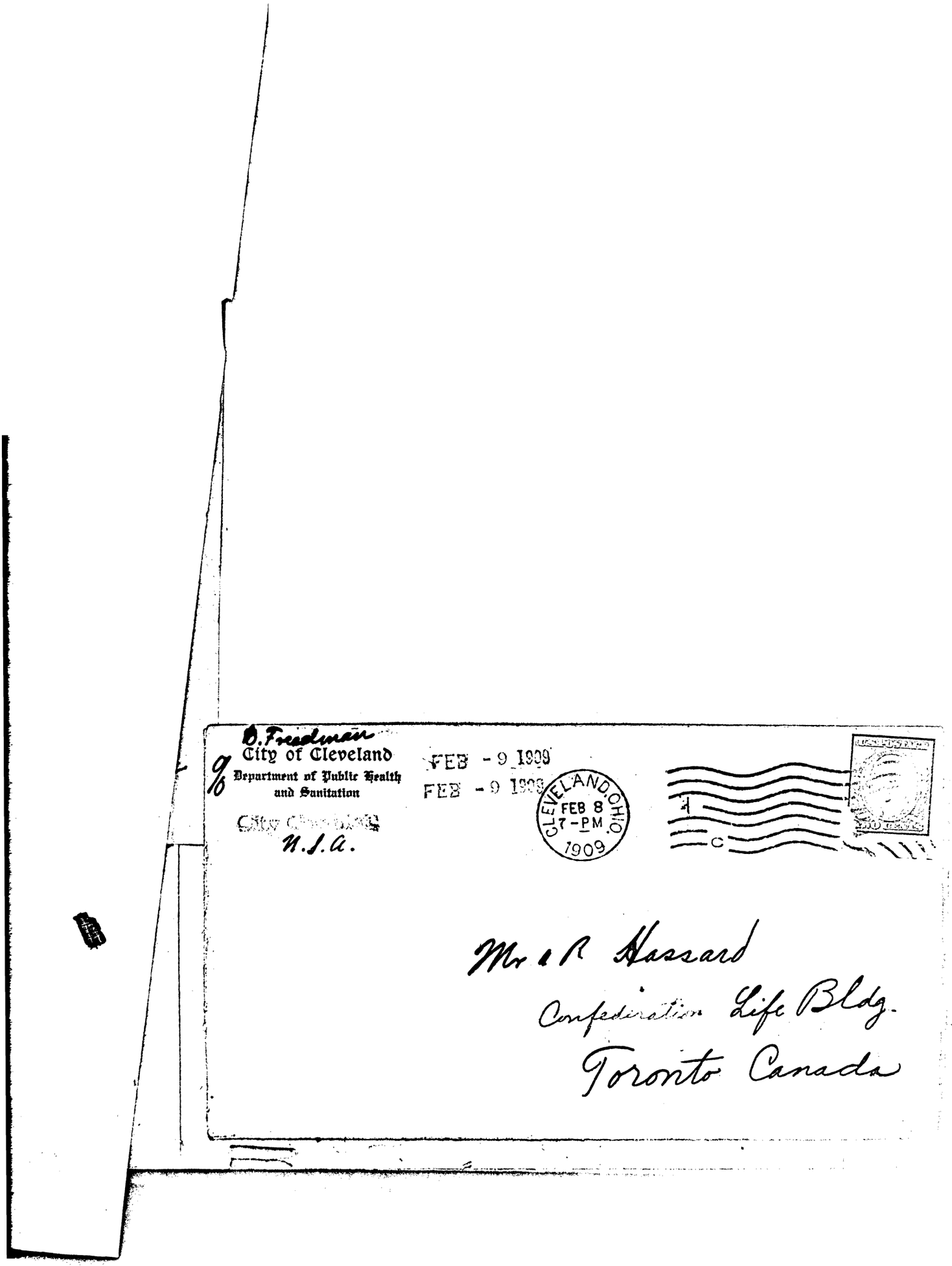
Have secured a 7½ ft long Galvanized
tube of 1 ft diameter 185 lbs weight
and want to start
with the tripod making. Your photo shows
that your telescope holding joints are
the same as an ordinary telescope. Did
you make the bearings for the axes out of
tubes? I think I will make patterns
and get brass castings. What I wish
most is to secure a gear and screw
so as to have right ascension motion
by means of a rod. Do you have this
device on your telescope? If so where
did you get the gear and screw? How
high is your tripod or stand?



Hoping to hear from you
soon

Truly Yours
Dave Freedman.

Have secured the E. Mechanics for 2.50 per
year. I send you an envelope of the N.Y
foreign bookst magazines agent.



D. Friedman
City of Cleveland
Department of Public Health
and Sanitation
City Clearing
N.S.A.

FEB - 9 1909
FEB - 9 1909

CLEVELAND, OHIO
FEB 8
7 - PM
1909

Mr. R Hazzard
Confederation Life Bldg.
Toronto Canada

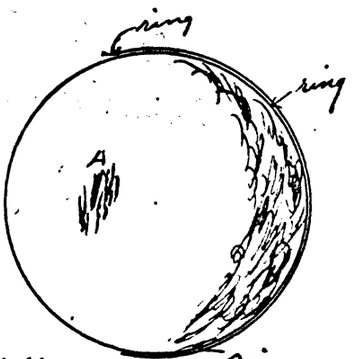
City of Cleveland

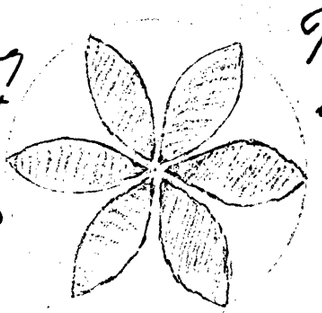
Department of Public Health and Sanitation

Cement Lab. City Hall
February 12 naught nine.

Dear Mr Hassard:

Recd your letter and thank you for answering so quickly. The drawing of the shadow I sent you were wrong. I tested the mirror more carefully moving the knife from left to right, exactly as the book Glass working by heat & by abrasion directs. The shadows appear like this figure Tested it every hour yesterday and noticed that there was a gradual change i.e. A. is disappearing slowly. I cant understand why there is a brilliant "halo" or light at the edge of the mirror. It is about 1/8 inch or 1/4 inch thick. Have you had this experience? If so how remedied? Was my polisher O.K.? I made it very exactly like this drawing which I cut out silver ten 1/4" plate glass?





The space in the centre is of the size of a canadian cents piece. Is your flat

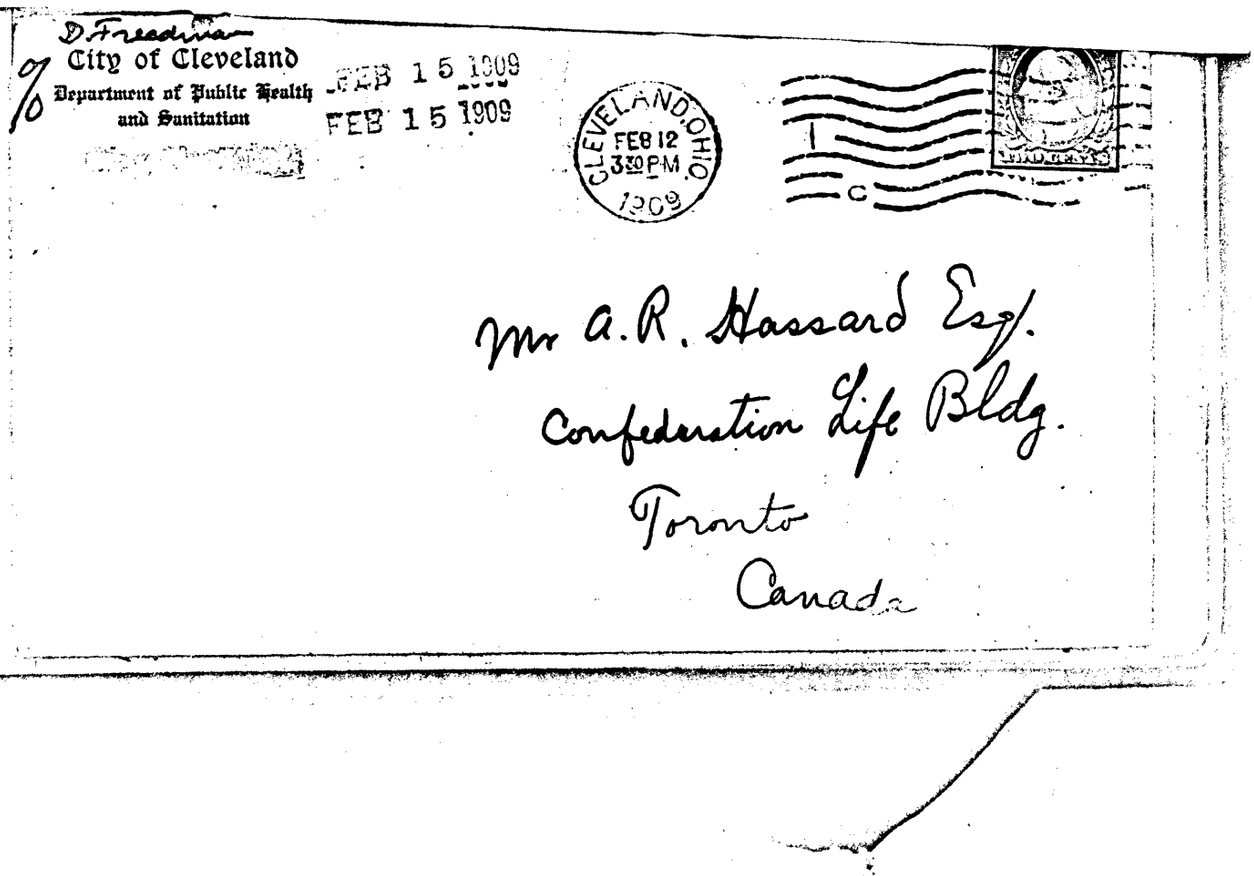
I am going to make the stand as best as possible A local gear makers offers a gear and worm cheap.

I have not yet received a copy of the E. M.
I guess the paper will come next week.
My subscription starts with Dec 25 / 1908
so I will have all the copies which contain
your articles. Have ~~dont~~ heard from
Mr Mellish last week. Do you think
it would be well to have altitude motion on my,
reflector? It is not hard to make such
joints on an equatorial telescope.

Hoping to hear from you

Yours

Dan Friedman


D. Freedman
City of Cleveland
Department of Public Health
and Sanitation
FEB 15 1909
FEB 15 1909
CLEVELAND, OHIO
FEB 12
3 30 P.M.
1909
C
Mr A.R. Hassard Esq.
Confederation Life Bldg.
Toronto
Canada

114

CARNEGIE INSTITUTION OF WASHINGTON
MOUNT WILSON SOLAR OBSERVATORY
PASADENA, CALIFORNIA

OCT 21 1908

PASADENA, CAL.
OCT 16
6-PM
1908

Mr. A. R. Hassard,

Confederation Life Building,

Toronto,

Canada.

CARNEGIE INSTITUTION OF WASHINGTON

MOUNT WILSON SOLAR OBSERVATORY

PASADENA, CALIFORNIA

October 16th, 1908.

Mr. A. R. Hassard,

Confederation Life Building,

Toronto, Canada.

Dear Mr. Hassard:-

I have your letter of September 26th, and regret not having been able to answer sooner. I think you have a somewhat mistaken idea of the testing: if you will imagine your mirror to be a surface of revolution illuminated by light shining tangentially along its surface, from the right, (your knife edge advancing from the left), you will readily see how the lights and shades due to the zonal surface should appear. A bright arc is always the illuminated slope of a high ring, and a dark arc is the unilluminated slope of such a ring. It is an entire mistake, in general, to say that a bright area is necessarily high and a dark region necessarily low.

I remember your stating in a previous letter that you had read so many articles on the subject that you were entirely at sea. I do not wonder that this is the case, if you depend upon such information as is published in the English Mechanic, for example. If you get a standard work on the subject, such as Draper's and my own (published by the Smithsonian Institution in 1894), you will learn far more than I can possibly tell you in a letter.

I remain,

Yours very truly,

G. W. Ritchey

Supt. of Instrument Construction.

OLD PHONE 207

EXPERT REPAIRING

HENRY L. SCHALL

PHONOGRAPHS, RECORDS, CAMERAS AND PHOTO SUPPLIES. BOOKS, NEWS, MAGAZINES, CIGARS, TOBACCO AND POST CARDS

256 N. MAIN STREET

DECATUR, ILL. 3-30 1909

Mr. A.R. Haccard

Toronto Canada.

Dear Sir:.

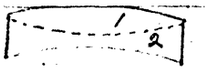
I have been going to write to you for some time but have depended on Mr Holcomb to get all the information which we needed in the construction of our telescopes, but I find that he forgot to ask about some things which I wanted to know about, and I wanted to get in touch with you myself.

.to begin with, I would like to know about an eye piece. What power would you suggest for 10" mirror? What diameter are the lenses in the eye piece? are they plano-convex? are they both the same size? have they both the same curvature and focal length? if not how do they compare as to focal length? Is it necessary to have a 'finder' on the telescope?

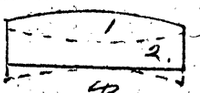
if so, what do you suggest? What is your idea for mounting for the flat?

I ask a great many questions about the eye piece because I have several camera lenses on hands which possibly could be used in the eye piece.

a & B are sketches of the lens. a. before grinding B. after grinding 1-& 2- are cemented together



a.



B.

By grinding the back or concave side plane it becomes a plano-convex. These lenses are all made up of two pieces of glass. so.  and cemented together to make one corrected lens. Now do you think, that by grinding them as I suggest, they would do for eye pieces they have an average focal length of 6½ inches before grinding.

I got some scratches on my mirror and had to go back to fine grinding. I got

After five days return to
HENRY L. SCHALL
Dealer in
Phonographs, Records, Cameras and
Photo Supplies
256 N Main St. DECATUR, ILL.

DEC MAR 30 10-30P 19 09 ILL.

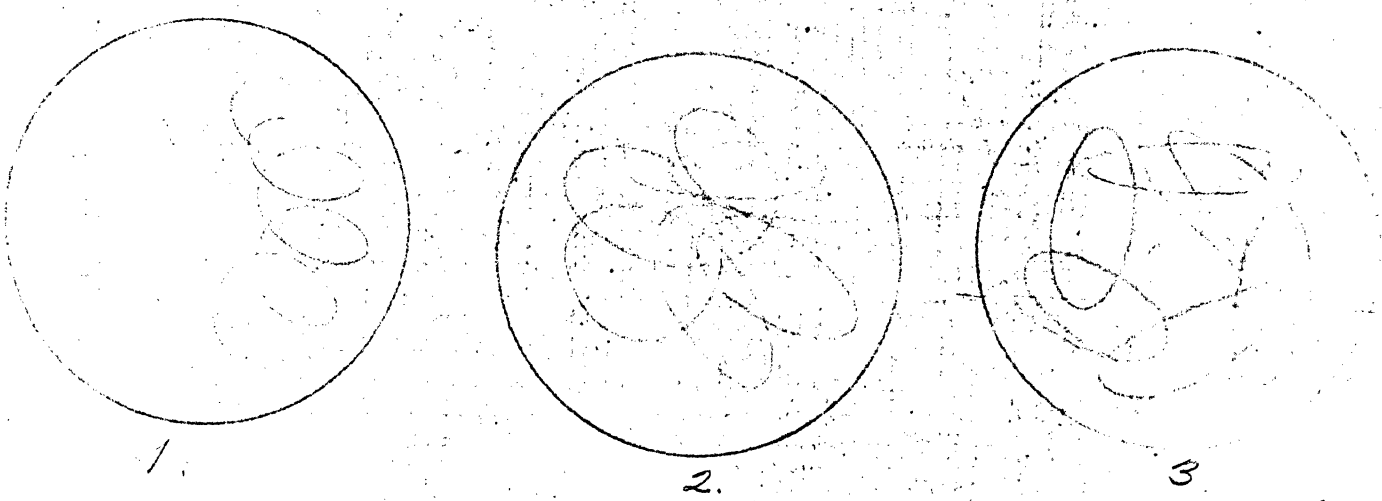
A. R. Hassard

Toronto.

Canada,

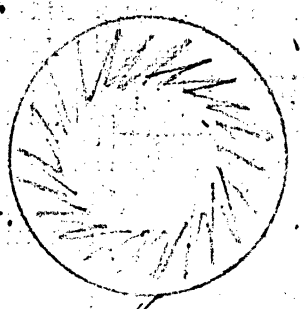
DECATUR, ILL. 19

a world of experience in working glass before I got through with it. I hope I have got the correct curve I done the best I could with the Focault test. (that is such a delicate operation)



1. 2. 3

1, 2, & 3 some of motions I used in polishing.
#1 regular. (as possible).
3 " " " "
2 irregular.
4 " short straight strokes.



4

My Speculum polished half way out from the center, first, then to the center and then from the center to the edge. My Specelum is fair but I think Mr Holcomb's is better.

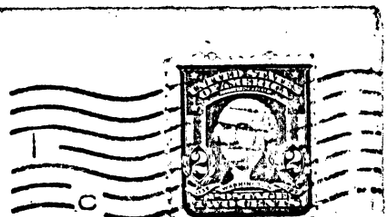
Hoping to hear from you soon.

Yours truly,

Henry. L. Schall.

APR. - 6 1909

MILWAUKEE, WIS.
APR 5
10:30 AM
1909



Mr. A. R. Kassard.
Confederation Life Co. Ltg.
Toronto, Canada.

Milwaukee, April 4, 1909.

Dear Mr. Hassard:

I've been waiting to hear from you and won't wait any longer. Shake hands, for I am now in the same boat with you. Not not in the same but in a somewhat smaller one. On Wednesday the 14th I begin grinding a 14 in. mirror. I told my friend that if he could get a piece about 12 in. across I might make another telescope. Well, he said: "Might as well make it a little larger." So you see I'm in for a pretty large amount of work. I have already made the cell for it of hard-wood, 18 in. diameter, have my emery on hand, in fact, almost everything except the glass. The glass is a piece of French mirror-plate, 1/2 in. thick, ground and polished plane on both sides, and edged. This is a splendid glass, good for a crown lens of a refractor, as I've had previous experience with it. I ground a good many eyepiece lenses out of French mirror-plate, as this is the kind of glass used in the ordinary spyglasses, and it is very good. The disk cost me $3, and I'll grind it on a 12 in. disk 2 in. thick, and will polish with an 8 in. polisher, moving the polisher over the glass. In this way I expect to prevent the mirror from being ground hyperbolic, but spherical. The final touching up will be done with a few long strokes. Sounds easy, but ——————

Well, I've told you enough about my doings, how are you coming along? Are you so busy that you can't write? Is your 15 in done? How will you manage with your tube? I'm looking around for an old second-hand smoke-stack. A good way would be to make a frame of band iron, and cover with sheet iron. Say, bandiron 1 in. wide 1/8 in. thick, bent into hoops and held together by long strips of 1 1/2 in x 1/4 stuff. The rotating tube cradle could be made of 3" x 1/4 material. I don't know just what to do. My new equatorial is strong enough, so I've that worry saved.

I wrote to Mr. Ballish about my doings, and he's all up in the air. He wants to start on a 15 in. immediately. I could find the price of a 15 in. disk 2 in. thick, in fact I've sent an inquiry already. Then, when we three have our instruments done, what a powerful battery it will be! We will be able to use 1000 diameters in good air. Maybe we won't see the canals on Mars, but I think we will. Send me

Moon, wow! it'll be just grand! Jupiter, Saturn, to say nothing of the star-clusters, 13 M, etc, and the wonders of Ira 3 M, ——————— how long do you think we will be satisfied with 15 in. Does about a 24 in. or a 40 in.? what?

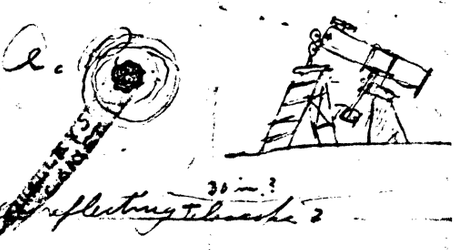
Well, write soon, and let me know of your successes and failures.

Ever yours, with best wishes

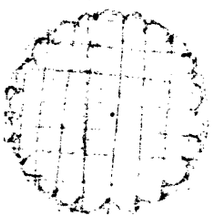
N. B (almost forgot)! Mr. Mellish says that Lord Arthur Prak very likely will be able to pay me a visit next Sunday. I wish you lived around here. We could have a convention every once in a while. Wouldn't that be great?

I've forgotten all about achromats. Now everything is reflecting, i.e. isoreflecting, reflecting, ruminating, meditating, cogitating & every other "t-ting" that you can think of, on how to get a thing done so it will be satisfactory in every way.

Don't every factory chimney and every steamer smoke stack look like a large reflecting telescope?



This is the form of polisher used by Ritchey, who made the 5 foot in California



for curving an exacting hyperbolicuron

Toronto, North America, Apl. 7, 1909.

Dear Mr Prahl,

You must have received my last letter by now. I wrote it some days ago. It is pleasant to know how you are doing. Since writing it I have had the Charles Dickens of a time. On Saturday afternoon last I looked carefully at my mirror and decided that it was not finely enough ground, so at once prepared for re-fine-grinding it. The trouble in the fine grinding is that one is apt to skip one grade or go from one grade to another too quickly. But I determined to do this right if it took me until 1940. So I went back about 3 grades in the emery (fine) when I found a scratch nearly as wide as the line dividing Wisconsin from Illinois which looked as if it had been made by Lucifer himself. So I had to go back to the beginning of the flour emery, and it took me about 7 hours to get it ready for the polishing. I polished it hard and with long strokes at first, and reduced the focal length by about 1 inch, I think. The last 3 or 4 grades, for I must have divided the flour emery into about 12 or 15 grades, I used with strokes about 1 in long. As a result of this, which took a good 2 hours, the surface is nearly a perfect sphere. I have been inactive a little since, and have spent only about 2 or 3 hours on the polishing. I have some tiny holes in the glass, due to my being scarce of the emery of one particular grade, but they are few and far between. The rest of the grinding is excellent. In the test my surface deviates from the sphere but very slightly, and would do even as it is, only probably I shall strive for a greater perfection. I have used a full sized polisher. I found the centre refused to polish, just as is the previous case, but by giving the glass the old motion I did before the polish has come on all over - there is a ring out towards the edge, whose focal length is about 2 inches shorter than the rest, but when I am nearly done I shall get rid of it with a ring polisher. If you use an 8 inch polisher, tell me all about how you will use it. Dont make your cell 18 in. in diameter make it just the 14 inches and bend a piece of tin around it, to come up a little above the edge of the mirror, and then bend the upper edge over the edge of the glass all around. Hold the two ends of the tin together with a few rivets, and a little solder if you like, and then have the glass rest on a piece of brussels carpet, and when carpet, glass and ring are adjusted, have the ring of tin held to the wood with a few screws. Then have 3 L shaped pieces of iron, 1 inch by 1/4 inch fastened by brass bolts to the bottom of the cell, and projecting, so as to let the turned part of the L's run up the side of the tube. Then you can have the tube cut in 3 places to let these L shaped pieces in and in that way the cell will be free from the ground and not touch it at all. Make your tube simply of sheet iron, about guage 18 or 20 should do nicely. I don't think there will be any flexure. Cut several doors in its side, - 1 to remove the cover of mirror, and about 2 other small ones, to let you get your hand in to adjust bolts, etc. The tube should be 17 in. in diameter by about 10 ft. long. Dont, for goodness sake adopt the silly English method of making a tube of a square wooden box. It is childish. I have written Mr Mellish, but have not heard from him lately. Ask him to not forget me. Write again soon.

Sincerely Yours, A. R. Hassard

After five days return to

HENRY L. SCHALL

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Toronto

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DECATUR, ILL. 4-4- 1909

Mr A R Hassard.
Toronto Canada

Dear Sir:-

Mr Holcomb made exhaustive tests with our Specula and found that we had a Hyperbolic curve, our mirrors looked much alike, mine was the worse if anything. He told me what was wrong with it and I began testing myself to see if I could see what he says. I did but not with the knife edge. I enclose drawing which shows my method of testing for Hyperbola, it is certainly fine and is so easy. you don't have to imagine a hill here and a hole there. I will write down what I find as I correct my mirror and tell you from time to time.

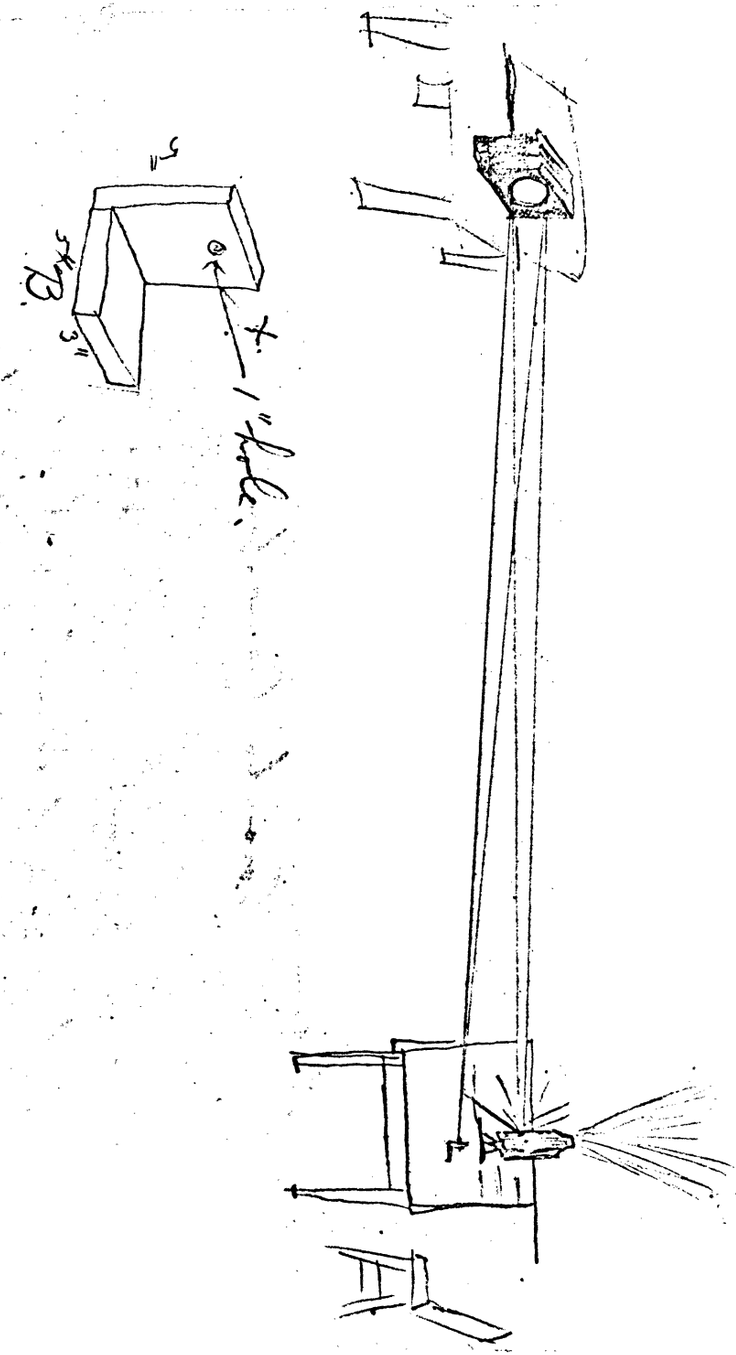
I am very much obliged for the information contained in your letter it was a treasure.

I had my mount for the 'flat' made when I received your letter, I will send you a Photo of it some time. I think it is good

Truly Yours
Henry L Schall.

find focal length of mirror by allowing full light of lamp to shine on same, move lamp back & forth until the image of flame is thrown six inches from lamp on left side but exactly even with flame set up a piece of white cardboard beside the lamp to throw the image of the flame on. When you get the exact focal length the image of the flame will be "sharp." (not blurred) Next, put your screen or opague chimney on lamp have a 1/8 inch hole punched or cut in screen (make edges of hole smooth)

Before putting on screen set "B." so that the image of flame is thrown exactly in the hole "x." now place your screen in place and look through x, you will see the mirror lighted up very bright, now move "B" forward

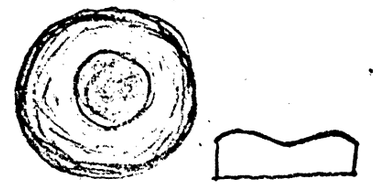


Of course I don't know how near I can correct my mirror by my test, but I intend to follow the Focault test too and mine and if I can find an easier way than the Focault it certainly will be easier for amatures to work up a mirror by. the Focault to many good to one must be done exact. My test is exact enough too but you have so much more light to work with and you see the shape no guess work.

W. S. S.

about 1 inch at the same time, move your head forward the same distance which should put your eye exactly at focal length. (double focal length, to be correct) a white image is sharpest by former test. now move your eye from side to side still looking through X. do this very slowly and you will see the shape of the mirror, not so much by shadow as in the Focault test but just as it is illustrated in that little book you sent Mr. Holcomb.

this test showed my mirror to look like this.



FEB 15 1909

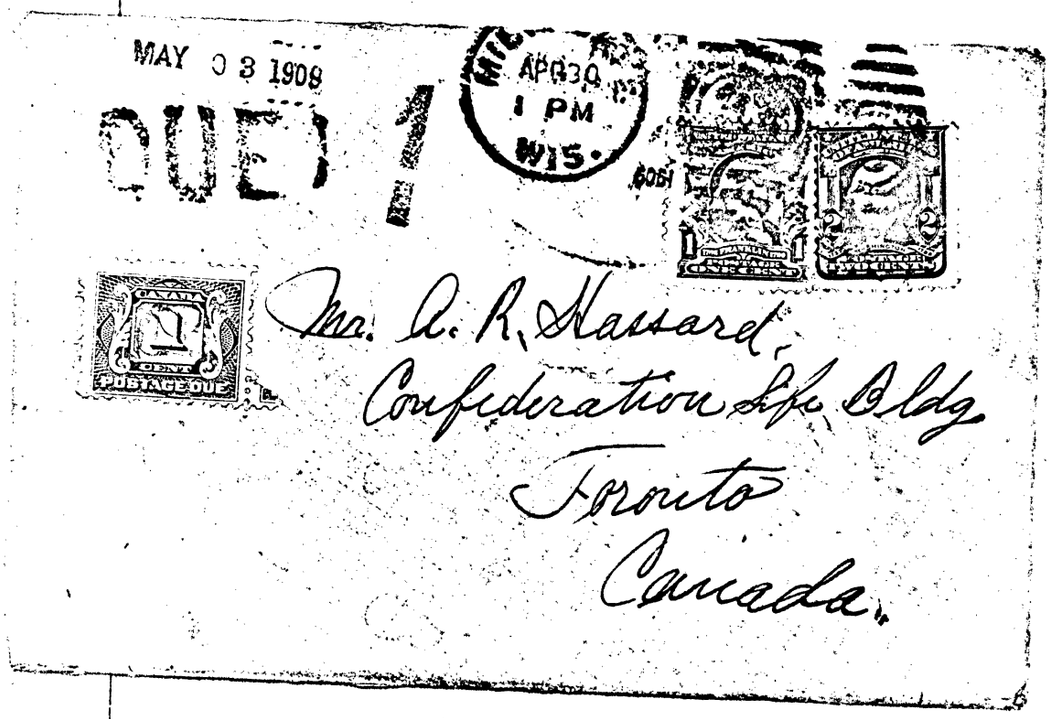
Dear Mr. Freedman,

I hasten to reply so that you will go no further astray. You are using the wrong kind of polisher. The leaf shape you are using is to correct the HYPERBOLA; if you have the light to your RIGHT hand, and are moving the knife edge from the LEFT to the RIGHT, you have the oblate spheroid; that is, a hill at the edge and another in the centre. To remove these you will need to make action greatest at centre and edges, cutting away the polisher considerably at spots about half way between centre and edge. Your present polisher having excess of action towards the centre is wearing the centre away a little, hence the reduction in the central moiré. Let the action be very full in the centre; cut nothing away there, and make your strokes about 2 inches long. The ring at the edge is no harm; your cell cover will come on the glass about 1/4 inch, or should. That is why mirrors are the half inch over always;- viz;- 9 1/2, 10 1/2, 14 1/2. The half inch is to let the cover come on to cover that turned back ring. Once that ring is there it is next to impossible to remove it; it is said it can be prevented coming in the first place by having the polisher about 1/4 inch smaller than the mirror, but I doubt it. Whenever you cut out any at the central part, you should cut it a little off the centre, or the exact central cut will tend to produce rings. Perfect symmetry of polisher makes a ringed mirror; slightly irregular polisher makes a perfect mirror. In case I forget to tell you, the finest grinding should be done with the shortest possible stroke; that tends to making the curve spherical before coming to the polishing. A little late to mention this, but it may not be unwise to know it. All my mirrors have the bright "halo" at the edge. I cover that part with the cell's cover and or ring, and it gives no bother. I am just now polishing my 15 inch. It is hard work pushing it across the polisher, but I don't work long at a time at it. My tube will be 16 ft. long.

You should have both altitude and azimuth motion; if mounted as an equatorial it will necessarily have both. You can't do with one merely hoping, you get along all right, let me hear from you again regarding your progress.

Yours sincerely,

A. R. Hassard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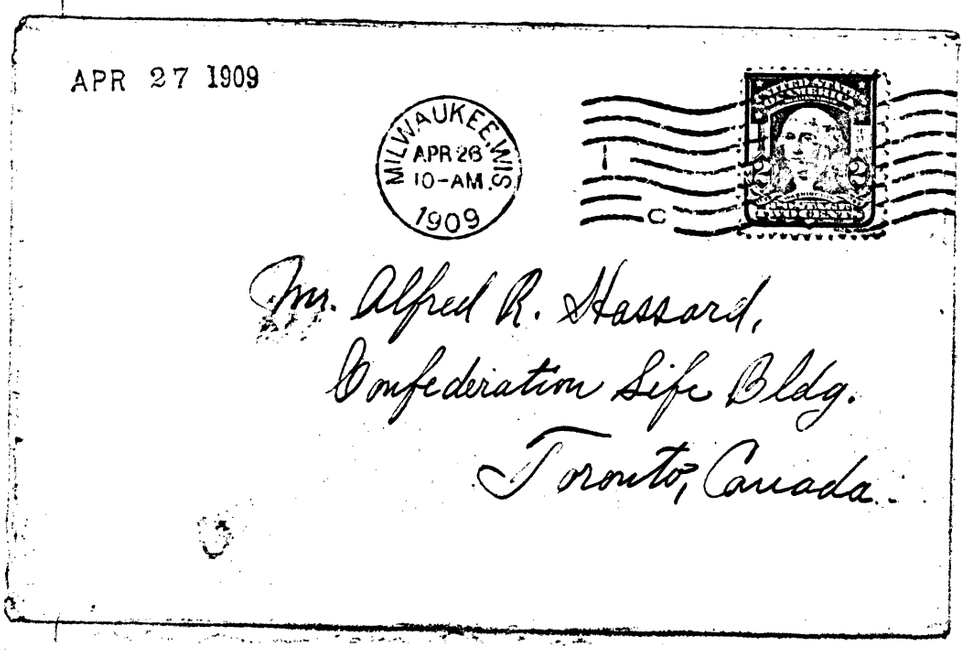
Canada.

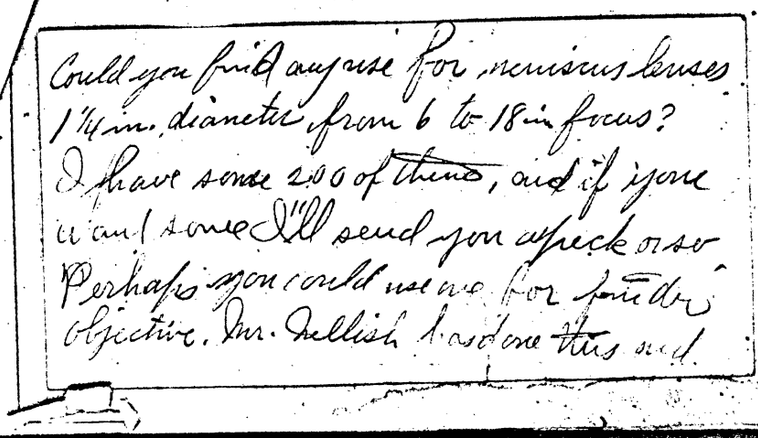

APR 27 1909
MILWAUKEE WIS.
APR 28
10-AM.
1909
Mrs. Alfred R. Hassard,
Confederation Life Bldg.
Toronto, Canada.

APR 27 1909

Milwaukee, April 25, 1909.

Dear Mr. Hazard,

I congratulate you on having finished your mirror. How did you manage to get it without a scratch? But why did you make the tube out of wood and oilcloth? Fancy the thing catching fire. Of course, if you are after the minimum weight, it's all right, but I don't see how you will be able to keep both mirrors aligned for an hour. It is too unstable. A good idea about the mounting is to get a wrought-iron pipe, 4 inches or more in diameter, with a "tee" screwed on it:  and a short piece of pipe screwed on each end of the tee with a smaller pipe, which will just fit inside, for a declination axis. Should my mounting prove too weak, I will most likely try this plan. Such pipes can be bought at a scrap-iron yard. I had intended to make my tube the same as you made yours, of band and sheet-iron instead of wood, but the materials would cost between $4.50 and 5.00 so I'll drop that idea, and write to a wrecking concern in Chicago for a price on an old smoke-stack. They have a large assortment of all sizes. Best of all I would like a double tube, so as to avoid temperature-change and get rid of the confounded astigmatism caused by such changes. I will make my instrument regardless of weight, in fact I think this will be an advantage, as the instrument won't be so likely to vibrate with every breath of air that stirs. But stop! I almost forgot! I have my 14 in. glass! I think of it, soliloquize over it, I really have it! It arrived the 19th. inst. and it is a beauty. Both sides ground and polished perfectly flat, the edge ground and polished perfectly, it is an ideal piece of glass, well worth the utmost of efforts to get it down to


Could you find any use for meniscus lenses
1¼ in. dianetic from 6 to 18 in focus?
I have some 200 of them, and if you
want some I'll send you a peck or so
Perhaps you could use one for finder
objective. Mr. Bellish has done this and

absolute perfection. I bought some No. 30 carborundum and rough-ground it on a piece 1/2 in. thick. I had intended to grind on a 12 in. disk, but by some mistake they made both the same diameter, and it looks too good to monkey with. I used only 3 lbs. of the carb. about 4 hours work and then, as near as I could figure it out, the focus was 10 ft. Now, as the fine-grinding progresses, I find the focus is 130 inches or so. Well, it don't matter, just a little more climbing, that's all. The centre of the lower glass don't seem to be doing any work, it is still rough, about 3 inches are, but I hang the mirror over the edge, and the fine surface came on about even all over the surface. But isn't it a grand work? I have worked nearly all day to-day and after this letter is done I'll go to it again. So far I've not had any trouble.

You ask me what ~~you~~ Mr. Mellish and I did during his visit here. Well, for one thing, he learned me how to silver. He silvered three flats so bright and with such a coating of silver that I cannot look trough it, as when I silvered, and when they were dry, what did he do but take a piece of chamois skin, dipped it in dry rouge, and actually rubbed the silver without its coming off! This (to me) miraculous feat he accomplished by leaving them in very long, about three times as long as I did, and the silver certainly rose with a vengeance. He used my ~~telescope~~ two evenings, and he says it is better than his own. He also was immensely pleased with my lathe, and says that he must get one as soon as possible.

Be sure and write soon again, and tell me how you see the Moon and Jupiter with your miniature Lord Rosse's Telescope. Ever yours, Arthur Graf

SOON YOU'LL GET A PICTURE of the 14 in. beside my 8 in. HAVEN'T TIME TO PRINT ONE NOW

EARNGEY & HASSARD
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CONFEDERATION LIFE BUILDING.
YONGE AND RICHMOND STS.,
TORONTO. - - CANADA.

MAR 20 1909

Dear Mr. Mellish & Mr Prahl,

Having some things to say to both of you in common, permit me to address you jointly. I have been at work for a very long time on my 15 inch mirror; far longer in fact than I should have been, but here is the reason. I finished the coarse grinding successfully; and then proceeded with the fine grinding. When it had favourably proceeded, I looked around and found some emery, which seemed to me to be flour emery, it was so fine. And I proceeded with it in the customary manner, until the fine grinding, as it appeared to me was done. Then I began to polish, and spent nearly two weeks of odd hours on it. With all my work the polishing left the glass full of tiny holes; in fact there was as much of the area of the glass filled with the tiny holes as there was of the clear glass. It had been some time since I did any polishing that hadgiven me trouble, and it seemed that the polishing still further would be of some avail, but it was not. Then I went back and fine ground some more, and then again polished, when a curious circumstance occurred. After an hour of polishing the central part and the circumference grew bright, while the remainder remained in the condition it was after leaving the grinding table. I continued with the polishing, when the central part roughened, and other parts grew polished and change after change of this nature occurred. An examination of the surface revealed the fact that the tiny holes were still present, although in reduced quantities. Then I decided to buy a new supply of flour emery, and when it arrived, imagine my surprise to find that it was not the flour emery, but a grade just a shade coarser which I had been using. One has to be very careful, for a dealer is apt to hand a person a sample, and when one has not the flour emery to compare with it, the sample may bejust too coarse. A good way to know that the emery is the flour grade is to compare it with ordinary wheat flour, and the two should be just the same coarseness. However I went to work with it, reducing it to about eight grades; the last grade being deduced from the liquid left in suspension after about 4 hours' standing, and ground the glass to a beautiful surface; so fine in fact that after 10 minutes' work on thepolisher it would reflect light in great abundance. The polish is now coming on rapidly, but it takes care to keep the polisher even, for the centre has a marked tendency to become depressed after standing untouched even for a short time. You will inquire the reason for the glass in the earlier polishing becoming polished and then losing its polish on the polisher. I must have wasted half a pound of rouge in solving that difficulty, but the truth is that I learned a great deal as a consequence. I had made the polisher of pitch, and used no beeswax on its surface, and the pitch was so hard that it simply ground the glass instead of polishing it. One must have a rather soft surface for the polisher to do good work; and there is no surface that is so well fitted to do the work as the surface formed of beeswax. It is true that hard pitch can be softened with turpentine, but the proportions to use are not always the same, while beeswax is weesbax all the time. Possibly with a smaller mirror than a 15 inch one hard pitch might do, but that would likely be

due to the fact that the smaller mirror's weight would not be sufficient to press down very hard on the pitch. The last stages of the fine grinding I did with quite short strokes, - not over 2 or 3 inches in length; and the mirror is now nearly spherical. It should be done in a few hours' more of work. I am sorry I have had such a time with it, but it has been a great experience, and I have learned a lot in the doing of it. Had some of the English Mechanic critics done a little more than indulge in a little of their absurd criticism, I might have profited by their knowledge; but they don't seem to have any to spare, - it all seems to be on this side of the Atlantic. As soon as I have this telescope done, I think I shall write a letter descriptive of it and the difficulties I have had, and I shall have a word or two to say about some of the Reverend critics of that journal, who have not enough reverence to read simple English correctly, let alone to give other people instruction.

Everything else has been standing with me astronomically, and now I shall hurry this work to a close, for I want to have the 15 inch in operation soon.

What do you people think of this idea? Make a 15 inch lens, and mount it - a single object glass, and use it just as an achromatic. A few nights ago I took the flint glass out of an objective, leaving just the crown lens, and it did not seem very much to hurt definition. Could not one be tried in that way? Make some tests of that, and let us know what you think. I fancy except colour, it would be all right.

What are you people doing? Please write, and tell me many things.

With best wishes, Faithfully Yours,

A. R. Hassard,

SOLAR OBSERVATION WITH REFLECTOR —SATURN.

[536.]—I have often seen the use of an unsilvered mirror on the sun suggested; but from the infrequency of its mention in the pages of "Ours," I can only conclude that the great advantage of this method seems to be not so well known as it might be. I should therefore like to be allowed a little space to describe my arrangement.

I have two 9in. mirrors, of 63 and 78in. focus respectively. The latter is in regular use for ordinary observation, and is, of course, silvered. the tube—a wooden one—is so arranged that the shorter-focus mirror can be quickly put in place, the board on which it rests being hung from a hook, and adjusted by two screws, according to Mr. Edwin Holmes's plan. The blocks through which these screws pass are placed at the corners of the tube, so as not to interfere with the light to the silvered mirror when that is in use. The board with its unsilvered mirror can be put in place in a few seconds, and comes into perfect adjustment at once. The back of the mirror is polished, but this makes no perceptible difference to the brilliancy or contrast of the image, since the intensity of the light reflected from the back of the mirror, and passing through the glass twice, being so very small compared with the concentrated beam from the concave surface.

The advantages of this plan are great. No solar diagonal is needed, so that the image is not reversed "right and left," and correct orientation is preserved; no heat (or next to none) reaches the flat or the eyepiece, and the view is pleasantly horizontal. I get far better definition this way than with a solar diagonal and a silvered mirror, and can use much higher powers. Of course, projection of the image is out of the question, and (I imagine, but do not know) spectroscopic work also; but the silvered mirror is still there, ready to be called on.

Now I can hear my readers saying, "But we haven't all got two specula." This is, of course, an objection in many cases. Still, those who, like myself, have "shuffled one lump of glass over another" with success would easily supply the deficiency. The extra mirror need not be more than 6in. in diameter to give a good view, as 200 is about the highest power that would ever be used—in fact, 120 is usually quite sufficient under the atmospheric conditions usually prevailing when the sun is under observation. Anyone who has produced an 8½in. to stand 500 would have little difficulty in producing a 6in. to stand 150, and at far less expense than that of a good diagonal. I commend this plan to your amateur speculum-workers.

Last evening (January 12) I had a superb view of Saturn in the 9in. With powers up to 570 the image was sharp and steady, while with 282 the view was quite wonderful. The minutest

E: No. 2287. JAN. 22, 1909.

detail of the ring seemed to stand out as in an engraving, and the outer ring, in particular, showed a distinct shading-off to the edge, commencing at about half the breadth of this ring. Cassini's division was, of course, quite obvious, and distinctly darker at preceding extremity of image, the crape ring so light in colour (especially on the preceding side) that it might almost have been taken for a bright ring. The main shading on the ball ended at about 55° of latitude, and the Equatorial portion of the ball a dull yellow, contrasting with the brightness of the inner ring. Such was the definition that the limb of the planet could be seen through the crape ring, despite the small obliquity of the plane of the rings. The shadow of the ball on the ring curved outwards, as though the ring were convex.

M. A. Ainslie.

MAR 12 1909

Dear Sir,

If you will consult the issues of the English Mechanic for Dec. 11, and 25, 1908 and Jan. 22, and Feb. 5 of 1909 you will find 4 articles in which I have gone quite fully into the making of the reflecting telescope. There are 2 kinds of telescopes in very common use, one is the reflecting and the other the refracting telescope. In the latter one looks through the glass as in an opera or field glass, and in the other, the images are reflected by a mirror. In the diagram enclosed R R are the telescope tube. A A are rays of light from a star. The mirror C is hollowed on its surface S S S and that surface is covered with a thin film of silver. When the light passing down A A reaches the silver S S S it is reflected. Were the mirror C flat the light would go back along the lines A A just as it came. The mirror being concave the light comes back at an angle and all the rays converge at the focal point E. But for an observer to have his eye at E would necessitate his head covering up the tube, so we fix a small flat mirror at F which is also silvered ON ITS FACE, and that throws the rays of light out through the eyepieces E E along the lines G G where they are received by the eye. If One's eyes were affixed to long rods projecting out a foot or so in front of one's face, the eye could conveniently be set at E. There is a little book which contains a most instructive part on making the mirror, and which I have been able to get here. I have bought it and sent it along for 50 d. - you may be able to get it there. It is called Glass working by heat and by abrasion. Then if you can get access to the back numbers of English Mechanic you will find a series of articles by Mr. Ainslee in 1904-5. They are most useful. But the little book contains lots of good information. Only one side of the mirror needs to be hollowed (not rounded as you say.) The figuring means getting the proper curve to the fraction of an inch - even to the one one-hundred thousandth of an inch, which is not hard to do. You had better get the book I refer to, it will start you. A 6 inch reflector will do splendid work, and will be a source of continual delight. It will magnify the moon at least 200 times, and if the figuring be well done, ever\more; but then the light grows a little dim. It will show 4 or 5 of Saturn's moons and its rings, and Jupiter's 4 moons and belts, as well as many other interesting objects.

Get this book I mention, and if you cannot get it in England send me 2/6 and I will get it for you. Then go ahead and if you wish more information I shall be glad to help you.

Faithfully Yours,

A. R. Hassard,

J Slater
16 Lloyd St
Leigh Lancashire England

Feb: 28th 1909

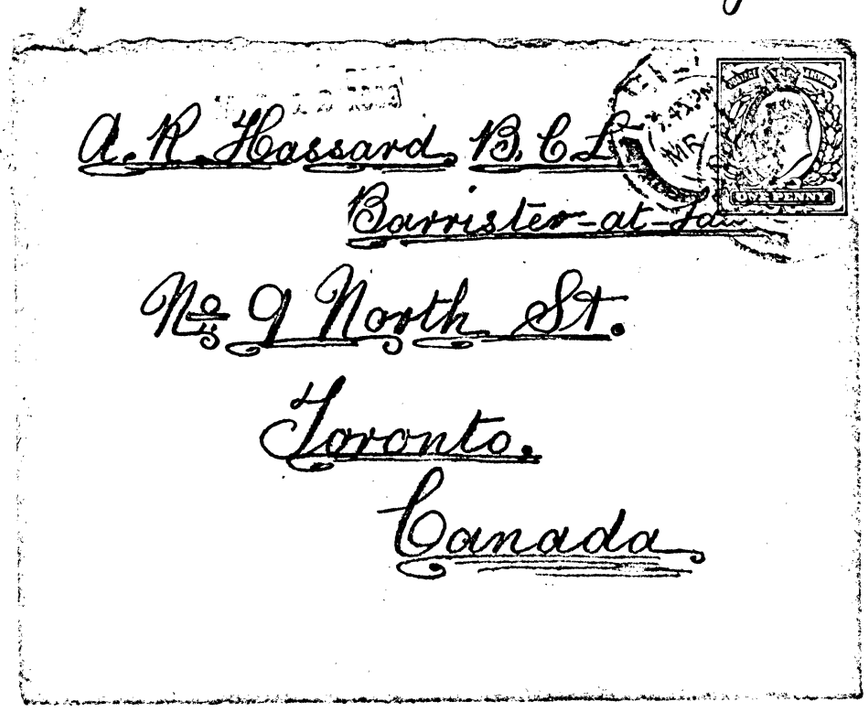
16 Lloyd St.
Leigh
Lancashire
England.

Dear Sir.

Seeing in the "English Mechanic's" of Feb 5th 1909. the making of a Reflecting Telescope, I want to asked you for information regarding the making of a Reflecting Telescope; if you will be so kind as to put me in the right direction, I should be very thankful. I am a young and starting Astronomer, and having no instruments to work with, I should like yours. I am asking for an understanding of a Reflecting Telescope and the drawings and real measurements. I do not know what a Reflecting Telescope is supposed to do regarding its work towards the Heavens, so will you enlighten me in your answering letter. I am a Mechanic and Tool Maker by trade, being used to Machinery. such as Turning Lathe, Milling Machine and also Planer and Slotter. I thank I can manage the fittings of it after an understanding with you. I am stuck mostly at the making of a Mirror, and also the use of a Flat, and the positions I have to place them to get their proper focus. will you kindly explain all this. In the making of a mirror does it require bothe faces to be ground, also does the face require to be of a rounded nature something like this [glass 1" thick] or has it to be flat. you must excuse me if I am wrong; I do not know, I am pleading to you for help, because I am in the dark in the matter. When you have got you disc, comented on an handle or fastened to a wood face plate, on your lathe, can't your grinding be completed in the lathe so that when you take your 1 mirror from the lathe it will be finished. Will you give me some drawings of all the parts, and their real measurements, and the real positions of the glasses, aslso the materials I shall require. What is meant by the figuring of the mirror. Will you tell me how to make a mirror from the first operation to the last, and about the flat, also the Eyepieces. What do you mean by the silvering.

In your paper on the making of a Reflecting Telescope you say the support of the flat and the making of the adpters for the eyepiece have not been described; So will you explain to me, the use of a Reflecting Telescope and the power with a 6in. mirror. I am very anxious to learn and know the Vaut of the Heavens, and through not being able to possess instruments to see them with, I am getting a little down-hearted I am not well-off enough to buy instruments. As you say in you paper; "If one were rich enough to possess the materials the whole operation might be completed with a certain and unreasoning continuity; It is so. Don't forget the mirror that is mostly my stumbling block. So I will now bring my enquiring letter to a close hoping to hear from you soon; and put in the measurements, and the things I shall require, with my best respects of love to you, from an unknown friend.

I remain
Yours faithfully, a friend
J. Slater.
16 Lloyd St.
Leigh
Lancashire
England.



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April 22 1908

A. R. Hassard

Dear Friend

I was very glad to read your splendid artick for the E. M.

I am sending you a list of letters and some articles from the E. M. all by J. R. Stephens.,

I want to stort on a 16 in glass, 2¼ inches thick soon, I will have to sell my two 8½ in shecula first, I will advertise them in Popular Astronomy, I think.,

I went to Milwaukee the morning of the 11th and came home the evening of the 14th, and found a letter from Prof A. S. Flint of Ahaelburn Observatory saying that Professor Barnard would give a lecture and show a lot of slides of astronomical subjects the evening of the 15th, so I went to Madison thursday noon and saw Barnard and had a fine visit with him all the after noon, the pictures were splendid. I wish you could have seen them.

He asked me to come and visit him as soon as I could. Mr Prahl and I will go and stay at Barnards house a few days in July or August. I have never been at Yerkes Observatory yet on a good night.

We have had three clear evenings in a row now and this evening will be clear I think. I am in a rush to have you get to seeing the 15 in.

The prospects of a clear night makes me feel lively. my 8½ in works splendidly now how is your 9± in now.

Very respectfully Yours John E. Mellish

FORM 71. MAR 22 1909

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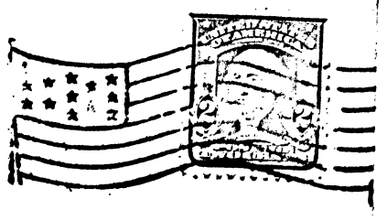


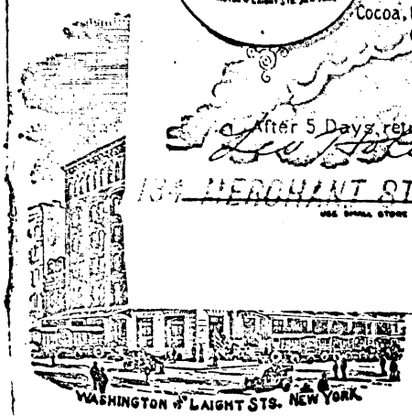
Mr. A. R. Hassard

Toronto

Canada

(Confederation Life Building)

Form 90



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March 19, 1909

Mr. A. R. Hassard

Toronto, Canada.

Dear Sir:-

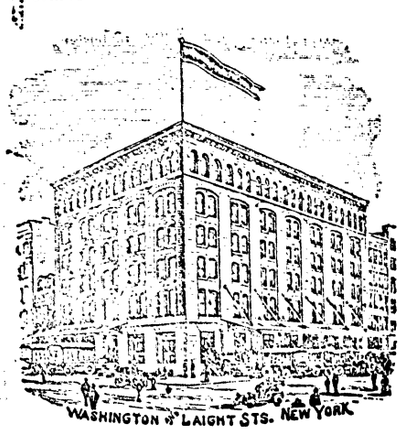
I am progressing nicely with my speculum and am just now ready for silvering. I made an exhaustive Foucault test and it proves correct, I also had an instrument put on it for the purpose of testing the curvature of a glass, and it proves perfect. The work on it cost me not less than 30 hours hard labor but I feel none the worse for it, and I believe I could complete another with less labor and time. I used about 3/4 lb. of no 30 carborundum the washings of which I used for the fine grinding. at the finish I found I had several scratches, so

abandoned the carborundum and went on to a fine elutriated emery, and finished up with no scratches, but I have since found out that I finished with a glass full of pits altogether to deep to go on to a polisher. consequently I put in 2/3 of the whole time consumed on the glass - on the polisher.

I am going to commence work on the mounting next week. I hope to be using the telescope before the first of may. My friend has reached the same stage in the work that I have, and met with similar experience and even worse in the polishing.

I am going to ask you for a little information in regard to the eyepieces: that we should use, we are thinking of making our own, and are uncertain what

Form 99



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size glass to use. what should be the thickness at edge and centre; and what powers should be used for our size glass? If you are able to pick up two or three pool tables send them along C.O.D. or give us prices and will send you the money for them.

I will be glad to hear from you at your earliest convenience

Yours truly,

Leo Holcomb

P.S. Will you give us a pointer or two in regard to adapters for eyepiece.

(from below) will spoil definition. Pits on the surface of the glass are harmful only in so far as they obstruct light. A glass whose surface is covered with pits which take up half its space is no better than a clear glass half its area. But your's will be much better than that. I congratulate you both on your success so far. A.R.H.

Dear Mr Holcomb,

Glad again to hear from you. Enclosed is a copy of a letter which I wrote a few days ago, and which may contain some information regarding the troubles I have had with the finest grinding. My 15 in. has not a pit on its face except I think 2, and the merest trifles in the the way of scratches.

I do not understand what you mean when you say that you applied an instrument to test the curvature of the glass. Do you mean a spherometer? If so, it would not very much help you, because the difference in the surface between a good curve and a bad one is measured in millionths of inches, and I know of no mechanical device which could do this. Tell me how you did it.

Regarding the making of eyepieces, I never did this except to make a low power one out of a couple of spectacle lenses; find their focal lengths, in inches. (mine were about 6 inches each; add them together, 12 inches, divide by two, 6 inches, put the 2 glasses this far apart mount and the eyepiece is made. The closer together the lenses are the higher the power. You should with a 10 inch mirror have powers about 50, 100, 200 325, and 4 or 500. I never care for high powers for you will find it is light that really is needed, not magnification. I find on my 9 1/2 inch that 200 is about best. 300 and 400 shake fearfully, and are hard to keep in the field. If I can use 400 with my 15 inch I shall be blessed. Theoretically one should be able to use 100 power with a refractor with each inch of aperture; but 50 is all that is recommended. I find when one gets over 25 the light grows dim. It is said that Herschell used with his 48 inch mirror 200 power most of the time. It was light he wanted most of all. With my 15 inch I shall have powers, about, 75, 150, 300, 450 and 650. The 150 and 300and possibly 450 will be most in use.

I would earnestly recommend you to write to Mr Arthur Prahl, 433 10th Ave Milwaukee, Wis. - he is an expert on the eye-piece question, - he is a member of our American Amateur Astronomical Society. He will be glad to give you lots of pointers.

About the adapters. I would make the piece that works with the rackwork about 1 or 1 1/2 in. brass tubing. the projecting ends of it (let it project say 3 inches) I would slit up 1 inch, in 3 or 4 places press the slit ends together slightly, and they will snugly yet not with too much friction grip the next smaller piece, which, treat in the same way. Go on down using smaller and smaller brass tubing until you have a size which will take in the eye-pieces. Let the rackwork move gently but firmly. It must be without any jarring. What shapes were the polishers, and where were they cut away?

Faithfully Yours,

A. R. Hassard,

P.S. Will you please return me the enclosed copy of letter after you and your friend read it? It might be well to make a copy of it, as it may be useful later on. Did you get a turned down edge? If not, how did you avoid it? If you got it, see that it is covered up, as it

MAR 12 1909

Form 8023. 50M RP

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IN REPLY, PLEASE REFER TO

St. Paul, Minn.,
March 10, 1909.

Mr. A. Hassard.
Toronto, Canada.

Dear Friend:

Your answer to my query about your telescope was duly received. I thank you very much for the information and I will consult those articles. I will send you 50¢ for the book on April first. I will not be able until then to start work on the reflector. As you so kindly wish to help me I beg leave to ask you the following questions.

Could you please tell me how much your 6 in. reflector cost making and all? Where I could procure the most suitable lenses for eyepieces (or is it better, which I think, to buy the eyepieces already made.)? I want to get all the information I can before I start making it. Also please let me know if a 1½ in. thick glass for the mirror would be allright.

If you will please answer the above questions, you will greatly oblige,

Yours thankful Co-astronomer (amateur),
Henry M. Leibert.

Address: 675 Sherburne Ave,
St. Paul, Minn.

APR 1 1 1909

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A. R. Hassard

Confederation Life Bldg.

Toronto.

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Mr. A. R. J. Hassard

Young & Richmond Sts,

Toronto,

Canada.

Milwaukee, Dec. 22, 1899.

Dear Mr. Hassard:

Was glad to hear from you once more. I suppose the 15 inch occupies most of your spare time. You certainly are getting some valuable experience. I found beeswax to polish very fine, when I made my 6 inch, when I used a polisher of beeswax alone, no pitch. It polishes slower, but behaves better. My 8 inch I polished on soft tar, 7/8 inch thick. You are doing a grand work, and I am almost tempted to make another telescope again.

You state that you shall hurry your work to a close. Now, whatever you do, hasten slowly. I rushed work on my 8 inch, and the scratches on it are an unpleasant reminder of my folly.

Do you know, I've made a new equatorial. I am delighted with its performance, as it is much more massive than my old one. The polar axis is 6 inches in diameter, the decl., 2 inches. As I have departed somewhat from the ordinary style, I give a description of it, and will send photos as soon as possible. Perhaps it will give you some ideas in regard to mounting your monster. Have you bought a step-ladder yet? Or will you stand on a box.

A friend of mine, on seeing my telescope, asked me where I got the glass. I told him and he said: "If you had told me, I could have got you a piece like that for nothing." I said that I would still take a piece. He asked: "How big a piece do you want?" And I said, at a venture: "Oh, about a foot in diameter and 1½ or 2 in. thick." He said that he would let me know. I am waiting to hear from him and am all excited about it. If he gets a glass disk why, I'll have to make another telescope, that's all. Couldn't let such a piece lay around you know.

You mention some Eng. Mech. readers as indulging in absurd criticism concerning your glass. Don't it queer that they should do so, especially when they have never seen your work? I should think they would encourage a person. Perhaps they are jealous.

I am using my Telescope every clear night now, observing the planet Jupiter. I had some splendid views of transits of some of the satellites, and the distinctness with which they can be seen, together with the changing belts, gives one a whole lot of pleasure. I draw everything I see as good as I can. Already I am quite familiar with the markings on his surface, and recognize them as they are presented to view by his swift rotation. Still, if I had a larger instrument ——

You mention the idea of making a non-achromatic refractor. Have you ever tried it? If not, do so, on a small scale. It will never satisfy you, as the seven colors of light cannot be focussed in one plane. To accomplish this a flint-glass lens is used, ground to such curves that it will be prism enough to collect the ends of the spectrum and bring them in one place. Some four years ago I made an 8 inch Telescope this way, and could not see more than with my small refractors, although objects appeared much brighter. To counteract the chromatic aberration of a lens, a flint lens must be used with it, or else it would have to be ground to a very long focus, about 4 inches to each inch of aperture. Now be sure and write soon, and tell me how your work progresses. By the way, how long did the rough-grinding take?

Yours sincerely,

Arthur Prahl.

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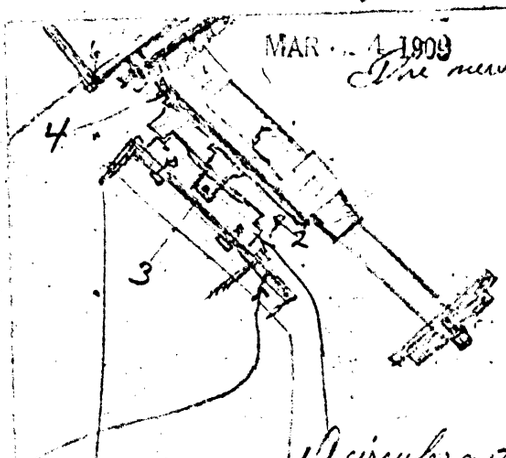
MAR 1 1909

The new equatorial.



Cr iron plate 8×12 ×1" screwed to the foot with 4 inch bolts.

1. A circular cast iron disk 6 in. diameter, 1/2 in. thick.
2. Another disk, turned down so as to fit No. 1. without shake.
3. A steel screw 1 1/4 in. dia. holding the two together.
4. Cr iron plate 4 X 12 X 1/2" thick, bolted on No. 3. The bearings for declination axis (5) are bolted to this plate. Declination axis: 2 in. dia. 3 inches long. (about that.) The upper end of declination axis carries another plate, screwed on. 3X3X1/2" with holes for thumb-screws to pass through which screw into the cradle the telescope tube rotates on. (6)

MAR 24 1909

MILWAUKEE, WIS. MAR 23 10:30 A.M. 1909

Mr. A. R. Harland
Confederation Life Bldg.
Toronto, Canada.

Toronto, April 2, 1909.

Dear Mr Prahl,

A letter is due you, and here it shall be. I am still at my 15 inch mirror. I have gone back to the fine grinding 3 times, and I rather think this time it is final. My first surface was full of fine pits, etc., which looked as if they would obstruct about half the light. Still in that condition I got a good curve, it was fairly spherical. However I went back and got a very good surface, but the figuring was so slow that I thought it better to go back to the fine grinding again. I rather think now that it is easier and quicker to go back to the fine grinding to get the curve than to bring it from hyperbola back, or perhaps even from oblate spheriod. For with the fine grinding properly done polishing should not take more than 4 or 5 hours, and your curve is there at the finish. So I went back and did the fine grinding a third time. I am always learning. I have still a number of little pits, which are likely the product of about 2 or 3 grades back of the flour emery from the finest grade of all. However it looks as if they would not be very serious, and I want to avoid going over the whole thing again. I rather think now that the flour emery should be sifted out about 10 times. Draper did it eight times, I think, but Brashear thinks 6 times sufficient. And there should be no harm in grinding with each grade a good half hour or hour. A person ought to take about a half day off to prepare the flour emeries, seeing that they are thoroughly mixed each time. That will mean a lot in the end. With the fine grinding done to perfection, I think the polishing can be done in 2 or 3 hours. Well, I have come to the third time polishing and it has been exasperating. I made over the polisher 3 times, and did my level best to get the tool to touch the glass in every spot. Of course the eye cannot tell whether that occurs or not, but I half believe I succeeded. And the polish came on all over except in the central 3 inches. What would you have done in that case? That seems to be why half sized polishers are advocated. It would seem that with a polisher 15 in. in diameter, the very best efforts cannot make a perfect contact all over. Up to 12 inches I would think there would not be much difficulty. But above that it seems there is. Here is how I overcame the difficulty. Instead of rubbing the mirror across the whole surface of the polisher, I ran it across it with at least 1/3 of the mirror's diameter projecting over the polisher's edge ALL THE TIME. As a result the central unpolished portion wonderfully improved after even 10 minutes' operation; and in 1 hour it was practically gone. The curve is a perfectly spherical one, except for a ring 1 inch wide at the edge, and still a slight mound in the centre, and although I have been less than 2 hours at the polishing, the surface is very good. I did not stop to study the physics of my method, but did it as a sort of last resort, and the result has been most gratifying. I shall continue in this manner until the polish is complete, when I think the centre will be satisfactory, and the outer ring I shall remove with a polisher made of a simple ring of pitch and make the strokes about 1 or 2 inches long. I shall write you more when I proceed further. Write now please and tell me some things you.

Faithfully Yours,

A. R. Hassard,

March 27, 1909.

Dear Mr Holcomb,

Your difficulty in testing is with the size of your hole, I think You say you made the hole with a needle, and then filed it, or did some filing, I don't just understand what. The hole must be so small that nothing larger than the POINT of the very finest needle will enter it, and that only to the distance of say 1/16 or 1/8 inch, for the finest needle very rapidly becomes large a short distance from the point. The hole thus made is about 1/150 to 1/250 in. in diameter. I don't see how you could punch with a fine needle a hole through tin, for tin is quite thick, and a fine needle would break before it would penetrate. My way is to take a nail or awl and punch a fairly large hole through the tin, and fasten across that hole a piece of tinfoil, and through the tinfoil you can just insett the point of a needle, and you will have a very small hole. I have also used instead of the tinfoil a small square of very thin brass. Then once that is done , arrange for the test. Look at enclosed diagram. Unless the mirror approach to the proper curve, you will find that there are many focal points, running from A to B. Some rays will cross at A, some at B, and some at points intervening. My knife edge is like fig. 2. D is a block of wood, 1 in. by 4 x 5 in. nailed to another piece of board C, of about the same size. E is a hole in D to let the rays of light come through. K is the knife edge in my case made of a piece of tin, with the edge M filed very straight and true. It moves on a pivot P, a fine nail will do, and is operated with the handle H. Move the handle in the direction of the arrow and the other end of the blade will cut across the hole E. The testing is very delicate to do. When the blade is inside the principal focus (i.e. the focus of the greater number of rays of light) and is moved in the direction of the arrow in fig 2, the shadows on the mirror will move in the direction of the [redacted] arrow in fig. 3. Draw the knife blade holder, (fig 2) away from the speculum, and the shadows will travel the other way. Now try to get it between these two points and see how the shadows behave. If you have the hyperbola the mirror will work as follows;- On the knife blade being moved across the cone of rays a dark shadow will come on at K (fig. 4) and another at L. These are explained by the disgram just beneath fig 4. and these shadows will enlarge until the whole glass is darkened. If you have the oblate spheriod the shadows will come on as in fig. 5. If you have rings, the shadows will come on like fig. 6. These are precisely what I am at now in my 15 inch. But I'll get them out soon. The knife edge must be moved VERY SLOWLY, - I think your trouble is also partly caused by your knife edge being much inside or much outside the points A B of fig. 1. A good way to approximate the focal point, is to pit a sheet of cardboard X (fig.1) between lamp and knife edge apparatus (fig 2,) as in fig 1, to keep light away from the testing apparatus, and in front of testing apparatus place another sheet of cardboard, as in the dotted line N fig.1. Remove the screen from around the lamp, and let the full blaze fall on the mirror. The image of the blaze , - the lamp will then be thrown inverted on N. Move N backward and forward, and where the blaze is brightest and best defined, is the principal focal point. Then place the screen around the lamp, Remove the cardboard N, and test. If further trouble ensues, lay aside the mirror write me, read Shakespeare, and think no more about it till I answer. A. R. Hassard

APR 14 1909

Milwaukee, April 11, 1909.

Dear Mr. Hassard:

Well, he's here. That is, Mr. J. E. Mellish, the distinguished astronomer and telescope-manufacturer, has honored me with a visit. He is now sitting beside me, writing with my pen. We have just spent a delightful day, and have just stopped using my 8 in. reflector. Seeing is poor, so we had to desist. My infernal, confounded, nerve-racking, brain-cracking 14 inch glass hasn't arrived yet. How is your glass now? Have you already got the tube? I ground a 7 inch mirror just for practice. I didn't care much how it come out, and It has a very good surface, 1 slight scratch and some pits in the centre. When a person works indifferently, it seems he is more apt to make a good job out of it.

Well, I have a fit of thinklessness, which renders me unable to write much more so I'll give this pencil a wrest.

Let us hear from u soon, of your doings.

Ever yours
Arthur Prahl

I just silvered my 8 in. yesterday, Saturday, and the silver is the brightest ever. Tomorrow I watch Mr. Mellish silver a f… and will absorb some knowledge in doing so. Somehow, the 8… seems plenty large enough, we don't feel any desire for a larger instrument, but, Progress is the motto of the A. A. O. S.

G. PRAHL. a.π.φ.…

βη ουρε ανδ γετ ψουρ μιρρορ πηρφεκτ. J. E. MELLISH. a.π.μ.ε.…

a. a. o. o.

APR 14 1909

April 11 1909.

A. R. Hasson

Dear Friend,

I am at Mr Prabk and wish you was here too, we have just been out with the 8 in and it is the first time I have looked through it it is fine it beats mine all to bits even if it is a bad night, I want to make a 16 inch but do not know whether I can get the glass this spring or not, if not I will have to make a longer tube for my 8½ in glass, How are you getting along with the 15 inch just think of the views of Mars on a perfect summers night and the stars the ring nebula in Lyra will be splendid, We have not had one good night in the last month. I hope it will not be this way all the rest of the year

Do you ever hear from W. H. Carothers, I have not heard from him for a long time,
I do not work at glasses any more, I am a photographer now and expect to be all summer I have all I can do now
I do not hear anything about the star catalogues I wrote about, I wrote to Howard for comet circulars, they are sent out first every time a comet is discovered, I wrote to them three times and next time I will tell them to be quick and come to time or I will send you over,
I think the english are a foolish set, I am english but not of the thick headed kind,
Your article in the E. M. for Feb 5th is good I learnt something about the mountings out of it,
I will soon start observing and will send some drawings in, if we all would do the same the E. M. would be valuable to the english amateurs,
I have some valuable letters from J. R. ~~Arthur~~ Stephens of Kansas City Mo, he wrote to the E. M. in 1906 you may have it
Mr Ellison has to give up observing now and talk about guns I thought all the time that hunting was his trade,
J. R. Stephens writes that Ellison was asked some

years ago how he got his perfect runner. He answered that that was his own business, now he wants to know why beeswax is used on the falsher "he is a humbug."

Very respectfully Yours

John E. Mullich.

I inclose a few pictures.
Most likely you will get written a weak osse.

Some more

m 99

HEADQUARTERS.

APR 17 1909

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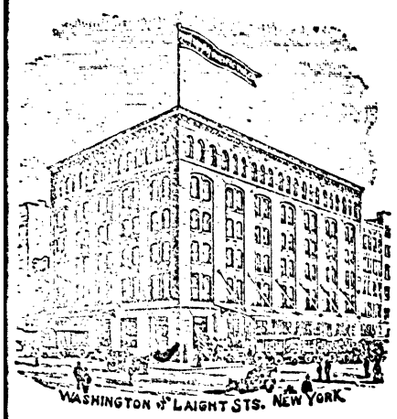
April 15 1909

Mr. A. R. Hassard
Toronto, Canada

Dear Sir;

I am getting along fairly well with my scope I guess, every thing considered. I had a fierce time trying to get the parabola if I should go into detail and tell you all about it, you would be bored and not benefited. I have followed your ideas which I have found to be practical and clear all the way through. I am now ready to silver, and would be glad to have a little information from you on that subject. In the book on glass working you have said that 3 times the amounts should be used for the 9½ in that

Form 99



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USE SMALL STORE STAMP

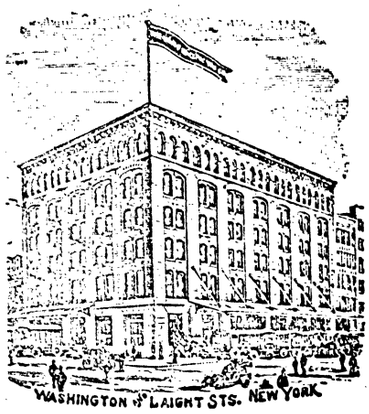
_____ 190___

is used for the 5/2 ni as given. my glass is 10 3/8 will the same amount used for 9/2 do for my 10 3/8-and "Flat"? What amount of solution "D" should be made up, and how much used? Where it says:- "add amonia solution drop by drop. A precipitate will form, and disappear as the amonia is slowly added and stirred in with a glass rod." how many time should that be repeated before adding solution "B"?

I want to get this silvering done right, my glass is in nice shape and I do not want to undo all I have gone through.

My Friend Schall allowed some party that pretended to understand silvering, silver his speculum, and I think that he has nearly ruined it, at least he will have it to do all over again. I hope you are getting

Form 99



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along Q.I. with your 15th, most likely you have it in operation by this time.

I am sending back the E.Ms you loaned me, and I thank you very much for the favor. What is the subscription price of E.M.? I think I shall subscribe for it.

I await your reply at earliest convenience.

Yours truly,

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LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our Correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

All communications should be addressed to the EDITOR *of the* ENGLISH MECHANIC, *Clement's House, Clement's Inn Passage, Strand, London, W.C.*

**** In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

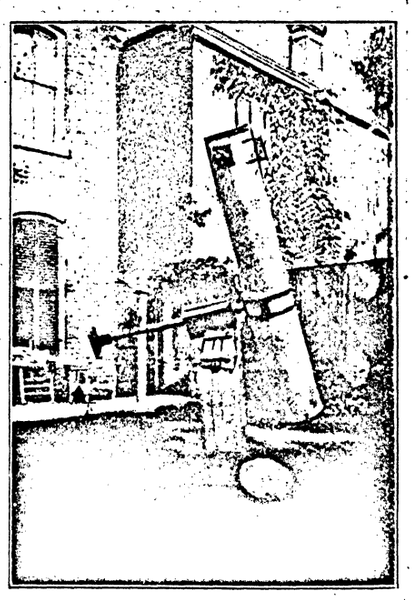
"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks; a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

GRINDING AND POLISHING MIRRORS.

[361.]—"Ours" has contained many articles on the making of astronomical telescopes, principally reflectors. Yet there seems to have been much that was of interest left unsaid. Having had some experience with this work, I take the liberty of making a few suggestions. Where the work is being done by hand, the grinding and polishing of the mirror is usually a tedious process. In my work, I much reduced the difficulty by doing the grinding and polishing on a small wooden stand, whose top was able to revolve. A small wooden table, on top of which a piece of plank, 2in. thick, and 10in. or 12in. square, is pivoted in any convenient way, will answer. The plank in my case was of pine. On this I fastened the under-glass or tool; any method of fastening will do. The method I adopted was to nail near the edges four small pieces of wood, slightly lower than the tool, and, having laid the tool within them, wedge the tool in with small wedges of wood. These held the tool very firmly. Then I seated myself during the whole operation, and during the grinding and polishing I kept the pivoted top of the table revolving as much as I could. This wholly dispensed with the arduous task of constantly travelling round the tool's support.

There is another feature which has been given little, if any, prominence, and which, if more generally known, would also very much reduce labour, in the grinding process particularly. During the coarse grinding, which should always be done with carborundum, the greatest possible pressure, consistent with the nature of the material (glass), should be applied downwards to the portion of the mirror projecting over the tool. If this be not done, it will take ages to produce the concavity. The motion of the one glass over the other will produce a slight concavity, in the nature of things, by the simple operation of the rubbing; but to hasten the deepening of the concavity, it is necessary to expend pressure on the projecting part of the mirror at all times. Let the worker place his two hands on top of the mirror, with the thumbs around the handle in the centre, and with the fingers outstretched until they come close towards the edge of the mirror remote from his body. Then, as he pushes the mirror away from him, let him exert great downward pressure on the side or edge of the mirror remote from him with the ends of his fingers: all the pressure, in fact, that he can use, and the deepening of the cavity will be a very rapid operation. I did not know this when grinding my first 9½in. mirror, and, as a result, I was probably fifty hours in reaching the proper depth. Meantime, my mirror had been wearing fast away, and during the coarse grinding was reduced from 1⅜in. to about ⅞in. in thickness. The fear which had filled me, lest I might do anything to cause flexure in the glass, prevented me exerting any pressure on it whatever. There is very little danger of flexure, in my judgment, in the use of the glass of modern days. Nor is the vast thickness formerly recommended, a supreme essential. We have a man in Toronto who made a 10½in. mirror out of plate glass ⅜in. thick. An inch thick, and even thinner, for a mirror up to about 10in. in diameter, providing it be properly supported, should be very satisfactory. A young friend of mine out in Wisconsin is proposing to make a mirror of 15in. diameter out of glass 1½in. thick. Two of my 9½in. mirrors are 1¼in. and ⅞in. in thickness.

Carborundum will excavate a 9½in. mirror of 82in. focus in about four hours by adopting the plan indicated. Whenever sufficient of the carborundum has been used to render it necessary to wash off the tool and the speculum, which may be either each time new carborundum is applied, or once in four or five times—in my case preferably the latter—the washing-off should be done in some vessel which will contain all the washings. I used an article which might either be called a small tub, or a large pail. It had better be of wood, then contact with the mirror or tool will not have any tendency to do any damage. These washings should all be saved, for from them the finer grades of carborundum are derived, even down to the very finest grade of all, for the finest grinding. I would recommend the beginning of the grinding of the mirror with about No. 25 carborundum. In my case I could not procure it so coarse, and had to be content with No. 40. One pound of it will do, and out of that one pound all the other grades will come. Were one to use emery instead, such could not be done, because the emery grinds away into a kind of mud, while the carborundum merely breaks into smaller particles; these can be used, while the ground emery cannot. From the washings of the carborundum, as I have indicated, can be made the finest grades, which will bring on a very speedy polish, and a polish which will be most satisfactory. The fine grinding should take not more than about four hours. Polishing should not take more than four or five hours, although this last operation depends on the fineness of the last grinding. An extra fifteen minutes spent on the fine-grinding at the end may reduce the time required for polishing by many hours. In my own case, I polished one mirror in about five hours; but another took me nearly fifteen hours. The length of time consumed in the last polishing was occasioned by the fact that I had hurried from the fine grinding too soon. A little care taken in the last stages of the fine grinding will prevent the occurrence of scratches on the mirror. The last two mirrors I ground are almost perfectly free from scratches.



In one of Mr. Ainslie's letters, published in 1905, he referred to a curious circumstance regarding the polishing. He said that he was unable to get the mirror to revolve in both directions during polishing. He could revolve it in one direction, but it would "stick" if it were revolved in the contrary way. This same experience I had in my first or second mirror, but have never met with it since.

The making of the polisher need not be so complicated as is suggested by some writers. A very simple way to make it is to pour the melted pitch on the surface to be covered. On that surface, however, should first be laid a small hoop of wood, taken from an old wooden barrel, and which hoop has been bent or drawn together until it is a trifle larger than the speculum. The wooden hoop should first be well wetted. I have used an iron hoop with good results. The hoop I joined by tying the two ends, where they overlapped, with twine. A nail driven down at each of three or four places around it, so that the head of the nail would rest on the top of the hoop, will keep it in its place while the melted pitch is being poured into the receptacle thus made. Fill the hollow with pitch to the depth of about ½in. Pitch is very cheap—a penny or two per pound—and not more than three or four pounds will be required. When it has hardened, the nails can be removed, and the hoop be either lifted off, or chipped away with a chisel, in case it has adhered in any spots. In fact, I have poured the pitch on frequently without hoop or anything else. On top of the hardened pitch then carefully lay either the mirror, or a piece of cardboard the same size as the mirror, and with a lead pencil draw a circle on the pitch the size of the mirror. Then with a hammer and chisel chip away the part of the polisher outside the circle. Then hold the polisher face downwards over a fire or flame of a gas-stove, until it is soft, and press with the wet mirror until it takes the shape of the mirror. The grooves I made in the polisher simply by wetting a ruler and laying it edge down on the face of the heated pitch pad, or polisher. Press the ruler down, and the grooves will form easily. It is true that the mirror, on repressing the polisher, will partially close the grooves; but if they be made sufficiently wide, there will be left spaces within the facets which will be quite ample. When this is done, ½oz. of common beeswax should be melted, and with a small brush, or piece of cotton tied to a stick, the surface of the pitch should be coated with the beeswax. The coating need not be deep—in fact, a very light coating of the beeswax has proved sufficient. On that being done—for the beeswax will cool very fast—the polisher should again be heated and pressed with the wet mirror, to resume its proper shape. Before these pressings the mirror might be covered with a little wet rouge, and sticking will be greatly prevented. In this manner a polisher can be made very quickly, and without much trouble. It certainly is quicker than making the small squares recommended by Mr. Ainslie and others, although they are by no means to be despised.

The rouge is sure to have particles within it which will scratch the glass. I have bought rouge said to contain none, but have always been disappointed. The scratching particles were always present. To avoid them, I placed a quantity of the rouge in a glass bottle, and mixed it with some clean water. Generally, I used water that had been boiled, to keep it pure; but that is not necessary where the rouge will not have to stand for many days. The rouge and water I thoroughly stirred with a piece of cotton tied to the end of a stick, and after letting the mixture stand for one minute, I poured all of it except the bottom two or three spoonfuls into another glass bottle. If the mixture contained too much water in the second bottle, I let it stand until the top part became clear; the clear part I poured off, and left a very thin paste—even thinner than paste—in the bottom of the second bottle. This I used by painting the face of the mirror with it, using for so doing the brush or cotton tied to the stick. In this manner the mirrors escaped all scratching, and were very clear when polished. The same wooden handle which was used for grinding I used for polishing. I had no trouble with flexure at any time. Draper had; but it must be remembered that he used glass 1in. thick for his 15in. mirror. Mr. Ainslie had none, I think; and his 9in. glasses were only 1in. thick—at least, one of them was.

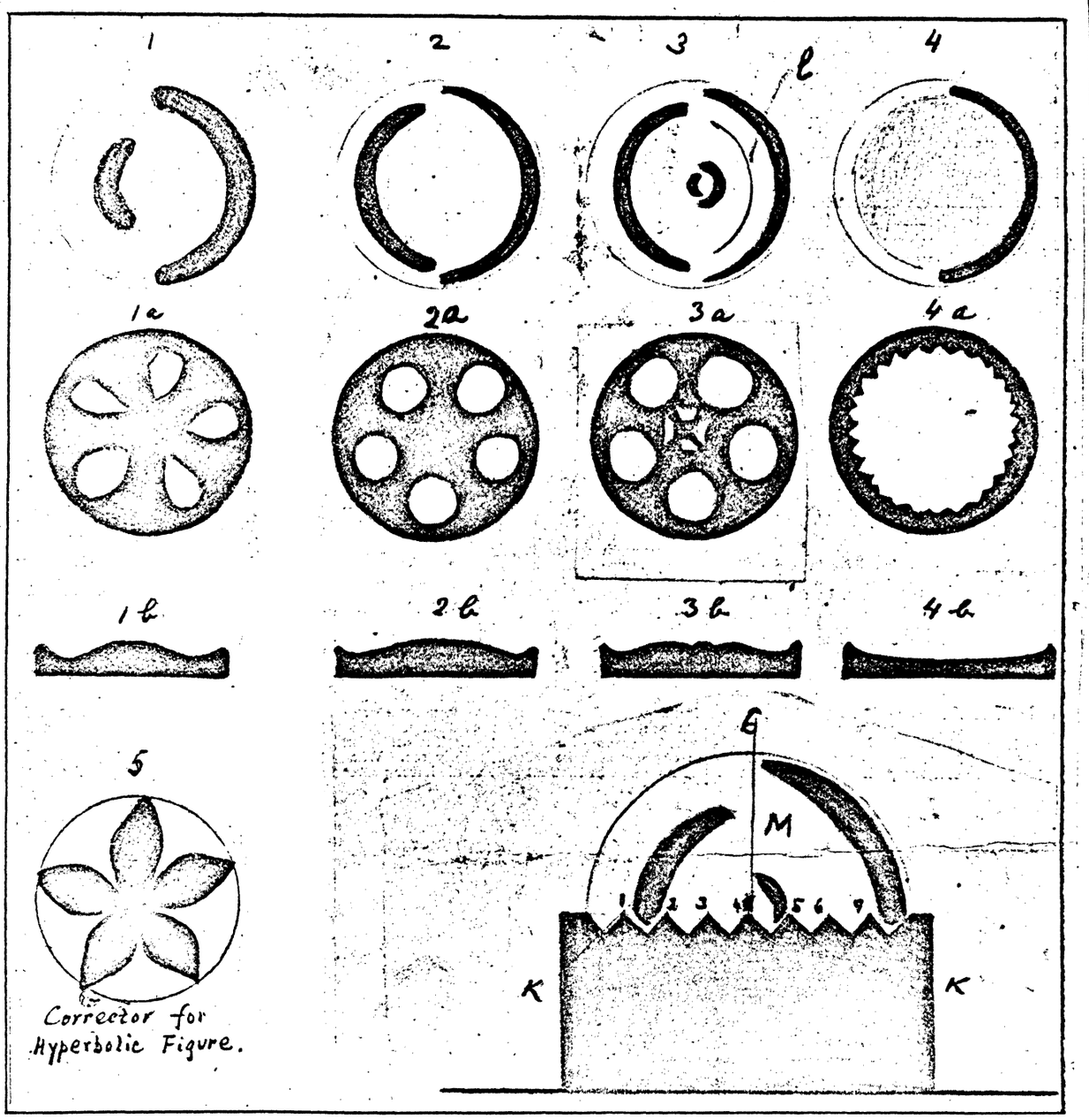
The hardest part of all is the figuring. If I may venture, I will say that we are, in my judgment, just on the threshold of our knowledge and improvements in this operation. Mr. Wassell, in his papers of twenty-five years ago, speaks of proceeding with the figuring for one period of twenty or thirty half-hours, then altering the polisher, and proceeding for another twenty or thirty half-hours again. The surface to be taken away in the figuring can never be much more than from one-millionth to five- or ten-thousandth of an inch. There must be some quick and correct method of doing this. Many of the articles published in the "E.M." indicate that all that requires to be done is to first polish to the sphere, and proceed from that to the parabola. There is no harder part in all telescope-making than getting even the sphere. From the sphere the parabola can be produced quite easily; but the sphere is the difficult part to get. On that subject I think Mr. John E. Mellish, of Wisconsin, U.S.A., will treat your readers soon to his experiences. But I can say that I know of his having taken in hand two mirrors that had curves on their faces of the most wretched kind, and bringing them to perfection in from two to four hours' work. And his work has been examined by men of world-wide renown.

It is possible I may communicate further on this subject. Meanwhile, here is a photograph of my 9½in. telescope, nearly all made by myself, and with the simplest tools.

A. R. Hassard, Barrister-at-Law.
9, North-street, Toronto, Canada.

FIGURING MIRROR FOR REFLECTING TELESCOPE.

[426.]—Proceeding from the close of my last letter, it is my desire to offer some suggestions regarding figuring the mirror for a reflecting telescope, which may be useful. In many of the articles published on this subject the authors seem to impress a reader with the fact that they have succeeded in obtaining a parabolic surface with surprising speed. A reader also is frequently discouraged because the parabola does not arrive with the rapidity the articles on the subject indicate. A description of the method of making a mirror from beginning to end has the shortest part of it usually devoted to the



figuring. The truth is, that the figuring is often ten times as tedious and protracted as all the other operations combined. One eminent writer, for example, advised the mirror-maker to graduate the polisher as soon as the polish appeared to be complete, and make the facets smaller at the rim than at the centre; this, he said, would reduce the oblate spheroid to a sphere, and from the sphere he could readily proceed to the parabola. Possibly that treatment effected its purpose in his case; but with me it failed most emphatically. Why it should not fail seems to me quite a mystery; in fact, it would be surprising to find it to succeed. When a high centre and a high edge require to be polished away, I cannot understand how they can be done simultaneously with a polisher which operates fully at the centre and only partially at the edge. In such a case I would recommend a mirror graduated as in Fig. 1*a* of the accompanying sketches. With it, the polish will be most at centre and edge, and thus reduce the mirror in the direction of the sphere. The simplest direction to give an amateur with regard to figuring is to place in front of his mirror, as in Fig. 6, a piece of cardboard, K, K, cut with the eight V-shaped spaces as shown. When looked at from beside the illuminated pin-hole, the location of the hills and hollows on the face of the mirror can be located very accurately. That being done, the polisher can be pared or cut away, to reduce the action of the rouge on the parts of the mirror which are dark, and cause greater action on those parts which are illuminated. Figs. 1, 2, 3, and 4 are diagrams illustrating the shadows which came on the last mirror I ground. These shadows may be reduced by the polishers cut as shown respectively in Figs. 1*a*, 2*a*, 3*a*, 4*a*, the apparent sections of the mirrors being operated on being shown by the figures respectively, 1*b*, 2*b*, 3*b*, and 4*b*. At Fig. 5 is a polisher which will correct a mirror which may have become hyperbolic. The ancient method of using the one form of polisher all the time, and shortening or lengthening the strokes of the mirror across its face, so as to correspond with the figure that is appearing, is altogether too slow and too uncertain for an amateur's use. The dark spots or semicircles on the side of a mirror nearest to the source of light indicate a sloping of the face of the glass down into a hollow. These parts of the mirror should be untouched; consequently, the polisher should be pared away liberally in places, to correspond with the hollows. It should be left full in the places where the light shines freely, for those places (on the same side of the mirror) indicate a projection on the mirror's face. In my last mirror I reached a stage where the mirror gave the appearance as shown in Fig. 4. It was risky to undertake arranging the polisher so as to act exclusively on the ring which the mirror thus seemed to bear around the edge. However, upon reflection, I decided to make the polisher as just a simple ring of pitch, with star points turned towards the inside; and with the polisher in this shape, and using strokes not over 1in. long, I succeeded in about one and a-half hours' polishing in removing the hill at the edge completely. To do this, it was necessary to test every few minutes. Ten minute intervals answered; at the end the intervals were about five minutes each. The shortness of the stroke in this instance was necessary, to avoid rubbing parts of the glass which were satisfactory already. During the other operations, short strokes are unnecessary. A stroke of one-third the diameter of the glass should be proper. Rings such as are in the mirror, Fig. 3, at 1, will polish away by being left to chance. As soon as the mirror reaches the sphere, it may be brought to the parabola in the old-fashioned way, having a polisher graduated so as to polish more at the centre than at the edge. The graduations should be made with an even reduction towards the outside edge.

In a sentence, the whole secret of figuring is to arrange the polisher by chipping away parts of it, so as to make action great at points corresponding with hills on the mirror's face, and less—in fact, not at all—in places which correspond with hollows. By following these directions, a mirror may be figured in from five to ten hours, instead of the 30 to 100 hours which that process formerly occupied.

Mr. Mellish, of Wisconsin, figured for me a mirror, which was most wretchedly uneven, in about three hours. He is a rapid worker; but another operator would not have taken more than five or six hours at the most.

In making my tube, I had a door down near

the mirror end, to admit of removing the cover from the mirror-cell readily. Lately, I have placed another door about half-way up the tube. This is convenient for many purposes, and can be made easily. The doors have common hinges riveted to them; the other parts of the hinges I affixed to the tube with machine-screws and nuts. Handles to the central portion of the tube can be affixed with the aid of this central opening without much trouble, and the interior can be blackened very easily through this and the other openings in the tube.

A. R. Hassard. B.C.L., Barrister-at-Law.
9, North-street, Toronto, Canada.

A FINE ADJUSTMENT FOR SPECTROSCOPE EYEPIECES.

[427.]—Most observers who have used the

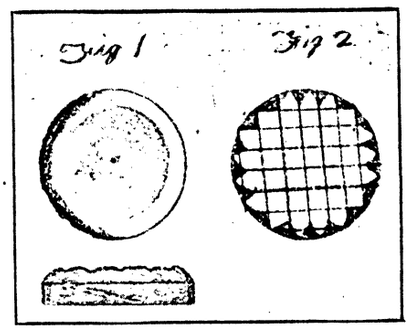
POLISHING SPECULA.

[425.]—It seems to be hard for one person to go by the experience of another when it comes to figuring a speculum. I always use strokes one-third the diameter of the speculum, or even longer, when the focus is less than nine times the diameter of the speculum, and shorter strokes with a longer focus. I made an 8½in. speculum, with a focus of only 40in.; when figuring it, I used from 3 to 3½in. strokes. It will bear a power of 120 easily.

My long focus—8½in., 94in. focus—was made last spring, and there was a rim ¼in. wide round the edge, which turned up a little, and a few days ago I started at it again, and by careful work, using 1in. strokes (it was impossible to get a perfect curve with long strokes) the speculum was brought again to the sphere, and

so perfect was it that with the brightest light and smallest needle-hole possible, there was not a sign of a curve on the whole surface. Then, by making a polisher with graduated facets, and using the finest rouge, with 1in. strokes for four minutes, the speculum under test gave a slight parabolic shadow, though not enough. Then after working three minutes longer the glass was tested in the tube, for the first time, on Vega, and it seemed to be perfect with knife-edge and high-power eyepiece. The glass shows as good yet, after silvering. It showed Saturn and the rings very sharp. Also Enceladus was an easy object, with the moon near, to the East. I think it will show Mimas on a dark night. δ Cygni is an easy object. It does not show a diffraction ring around a star, only some fine specks, and four parts of what might have been a ring. It shows seven clefts in Gassendi, and the seeing has not been good.

There is no glare on the edge of the moon. I also saw the old dark part of the moon when the moon's age was 9.4 days. I have seen the dark part several times at first quarter. The silvering must be very good to do this. Before making a 6in., my telescope was a splendid 2in. refractor, which gave splendid definition. The only thing I did not like about it was the size of the star-disc and the ring. Jupiter's satellites seemed to show as a disc; yet I found it did not show the satellite, only its spurious disc, for



when the satellites were on the limb of Jupiter, the satellite showed as plain as it did on the dark sky, but only about two-thirds the diameter it had when off the disc.

A bright star-disc with the 2in. was not bright like it is with the 8½in., and it faded somewhat at the edge, while with power of 580 on the 8½in. the stellar disc is intensely bright, clear to the edge.

I make the polisher $^3/_{16}$in. smaller than the speculum, and never have any bother about turned-down edges; only about $^1/_{16}$in wide, and it is impossible to do more than that.

In warm weather my flat always dews over two or three times a night. I then take a lamp and tip the tube up, so the eye-tube points down, and hold the lamp under. The dew soon leaves the flat, and in fifteen minutes it is free from heat, and is ready for the highest powers. The silver does not tarnish in several weeks of such usage.

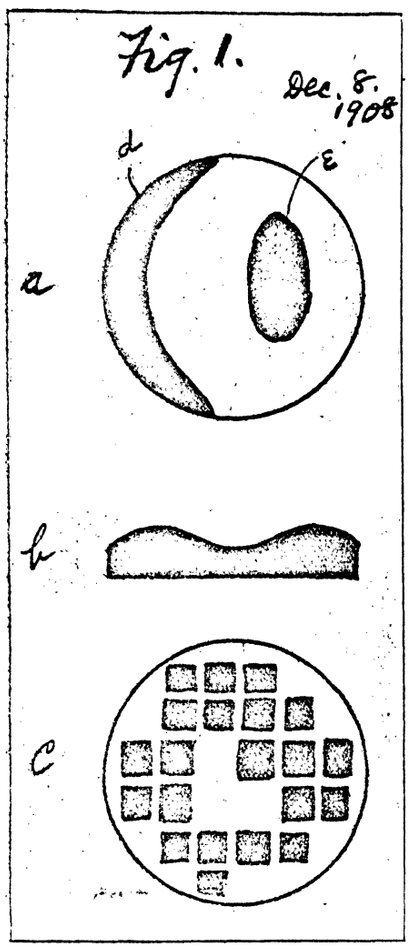
A friend lately came to me with an 8in. speculum he had been working on for some time past, and I refigured it for him. When he brought it, the surface was like Fig. 1. I made a polisher like Fig. 2, and went at it. The focus was 64in. I used 2½in. strokes for two hours, then tested, and the speculum was done to perfection. I never try to make a good glass by altering the length of stroke used. It is very hard to get the surface exactly right that way. My flat is only plate glass of good quality. I made a polisher the same size of the flat, with the facets ¼in. in diameter, and worked the flat over it with very small spiral strokes for fifteen minutes, then tested it, and ground ¼in. from the edge, and it is perfectly flat.

John E. Mellish.
Cottage-grove, Wis., U.S.A.

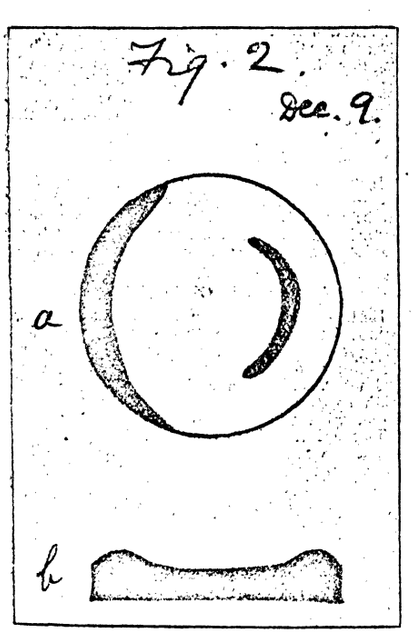
FIGURING A SEVEN-INCH MIRROR.

[538.]—The adventures encountered in figuring a 7in. mirror which I have lately completed may be of interest to your readers. During the last stages of the fine-grinding—which was done with the finest siftings of the washed combination of carborundum and ground-glass retained during the various processes of coarser grinding—by keeping the tool very wet, and exerting no pressure on the mirror whatever. I was able to move the mirror over the tool with almost lightning-like rapidity. The fine finish came very fast. A couple of hours nearly completed the grinding. The importance of correctly grading the finer powders as closely as possible cannot be emphasised too much. It almost invariably happens that, do what one will, coarser grains will settle to the bottom, and, after one has been polishing for a few minutes with fine car-

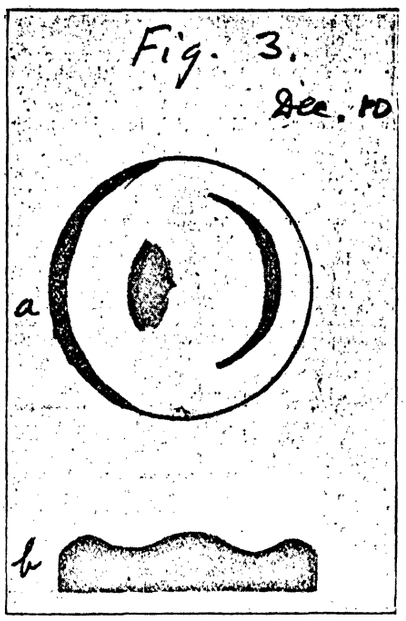
borundum, the next application to the tool will really be of a coarser grade. When this occurs, it is well to mix all the grades again thoroughly and sift them out over again. This will make



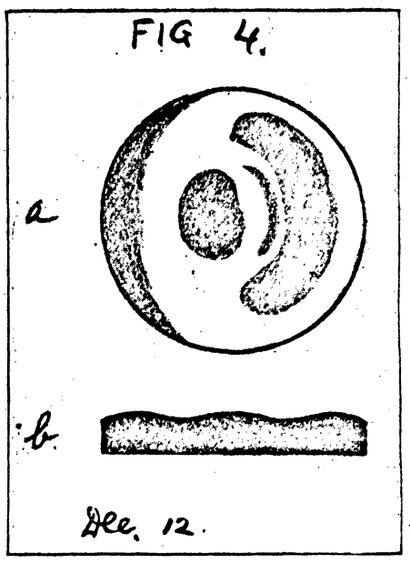
an improvement. With the 7in., I fear I did not polish with the finest grades long enough, for there are still a few tiny holes in the surface of the glass, which, although they will not noticeably interfere with the light, do not give



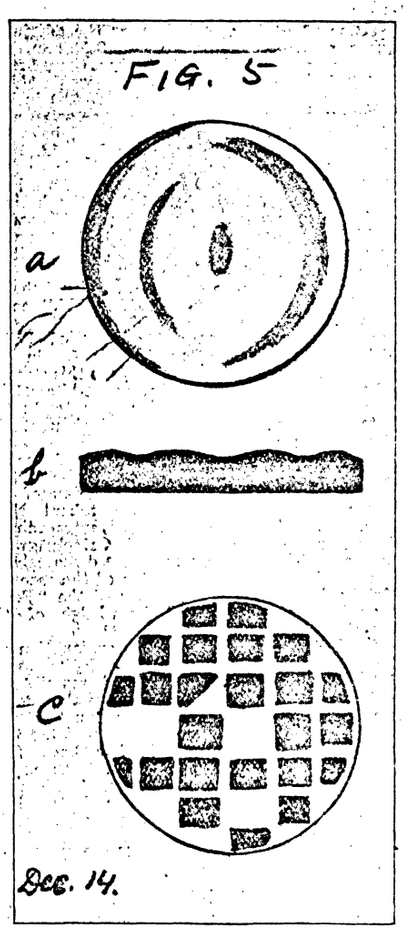
the work the best possible appearance. However, I do not intend to go over the work again, for there is always a natural disinclination in an operator doing over again something which is already passably well done. It was so pleasant, the movement of the mirror over the tool during the close of the fine-grinding, that I had not the heart to shorten the strokes, but made them a good one-third or two-fifths of the diameter of the mirror, if not longer. When it came to the polishing, I found the mirror quite hyperbolic, and when the polish had sufficiently appeared to render possible an observation of the form of the surface of the glass, the appearance was much as in Fig. 1 (*a*), a section of which appears at *b* in the same figure. In my judgment, a hyperbolic surface—for years the horror of the speculum manufacturer—is no harder to remove than any other kind of deformity in a surface. The shadows *d* and *e* were about as black as I ever saw. I, however, continued with a full-sized polisher until the polish was very near completion before altering the shape of the facets. The full-sized polisher was much more than full-sized, for, finding the ease with which the mirror moved over the pitch, I made it 8in. or 9in. in diameter, instead of slightly less than 7in. It is true the turned-back edge appeared; but since my judgment always directs me to hold the mirror in its cell by means of a small ring which cuts off from $\frac{1}{16}$in. to $\frac{1}{8}$in. all around, the ancient terror of a turned-back edge, never gives any trouble whatever. Glass is very cheap, and rather than go to the almost infinite pains to avoid the turned-back edge, I prefer making the mirror slightly



larger than is required. When coming to the figuring, however, it was necessary to make the polisher the same size as the mirror. My method of correcting the defective surfaces is to use a combination of the full-sized and local tool. By cutting away the facets wherever action is not required, the surface approached the condition that was required. To correct figure (1, *a*), the facets were cut away, leaving the tool as shown at Fig. 1, *c*. Each day I worked from a half to two hours, the mirror improving gradually during nearly all that time. When the mirror reached the shape shown in Fig. 2, *b*, further cutting away of the facets towards the central part of the tool was made. In this cutting away I did not wholly remove the facets; it was sufficient to merely chip off the tops of them, using a chisel and hammer for so doing. Then, when it became necessary to remodel the polisher, a slight warming of the polisher, and pressing of the mirror on top of it, served to make it into a full-sized tool. For some reason not quite explained, there appeared a central mound, as shown in Fig. 3, after it had disappeared, or, in fact, although it had not hitherto made its appearance; and it disappeared by increasing the action at the centre. The final appearance of the mirror before reaching the sphere is shown at Fig. 5, and the polisher employed to correct it is shown as Fig. 5, *c*. The remaking of the polisher was done very quickly. All that was required was to invert it over a hot fire for a moment or two, and press with the wet mirror. From beginning to end, this mirror occupied fourteen hours' time. I admit that it is not quite perfect yet; but another hour or two of careful polishing should finish it. There is scarcely anything in mirror-making so completely satisfying, as after numerous tests—indicating oblate spheroid, and hyperbola, and combinations of the two, as well as mirrors with rings—finding one part of a mirror very bright and another part



exasperatingly dark—finding that the mirror has become figured so that it darkens all over evenly and with flashing rapidity, on the slightest movement of the knife-edge or screen before the eye. A mirror even corrected only as far as shown in Fig. 5, will perform splendidly on the moon, sun, and planets; and also, with fair powers, on the stars. Nebulæ, too, will exhibit good views with it; but close doubles will not separate satisfactorily. My 7in. mirror



is 70in. in focal length; it was intended to be smaller; but the sun was not visible during any of the coarse-grinding days, and, rather than wait for it, I was content to guess at the focal

length, which, after all, is not very much out of the way. I am just now beginning a new 6in. mirror, which I shall mount very simply, and may perhaps have some notes to communicate respecting its progress.

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THE PLANET MERCURY.

[539.]—The greatest elongation of Mercury

REFLECTING TELESCOPES.

[8.]—Kindly permit me to reply to some inquiries made regarding the making of reflecting telescopes; but first it should be observed that my work is all of a very amateur nature, and any success I have had has been often after many failures. My experience has disclosed no difficulty with flexure in the mirrors. One I have mounted in an aluminium cell; but that I propose soon discarding, because of its weight, and using instead a base of two pieces of wood nailed cross-grained, each piece being 1in. thick, and turning them the same size as, or a little larger than, the mirror. On top of them I shall lay a circle of tapestry or Brussels-carpet, and the mirror will be held in place by a ring of sheet iron, with the top edge bent over the mirror, and the other end encircling the double wooden base, and held in place by a few screws. Fig. 2 illustrates my idea, and a detailed description of it occurs later.

My polishing and figuring are done using the same handle as was used during the entire grinding. Flexure with this handle is quite improbable. The use of beeswax as a surface for the polisher was suggested to me by Mr. Brashear. He said it would help to eliminate scratches. With its use, I seem to have been troubled with very few scratches during polishing and figuring. Most likely it serves to enable the mirror to secure a closer contact with the polisher in every part as well.

Regarding packing the mirror in the cell, this is satisfactorily done with little strips or wedges of tapestry, or Brussels-carpet. Cork, as one writer suggests, might answer quite well. The carpet, being firmest kind of cushion I knew of, was the article I have adopted.

I made no note of the time used in allowing the carborundum sediment to settle. My method was to stir the combined water and powdered carborundum and glass thoroughly, then pour into a two-quart glass jar. As soon as I saw a settlement of powder deep enough to make it worth while to separate it, I emptied the liquid into another glass jar, being careful not to disturb the already settled powder. This was accomplished by leaving half a cupful of water behind. Then, when using, it was not necessary to add any water, while the benefit of any further deposit from the small quantity of water remaining was secured. Five seconds, thirty seconds, one minute, five minutes, fifteen minutes, and an hour would be a useful set of periods for letting the settling occur. The water poured off at the end of an hour was not thrown away, but allowed to remain two or three days; any precipitation from it was welcome as still further refining the carborundum. This last was not necessary, in actual practice, but was employed whenever convenient.

The construction of the telescope is very simple. Having just completed the making of a 6in. mirror, and mounted it in a tube, cradle, and support, to be used in addition to my 9½in. instrument, a short description of its construction may be readable. The mirror is ¾in. thick, and was a piece of rough glass, such as is used for flooring and side-walk purposes. It cost me 40 cents, which included making it into a disc. The edges are ground and slightly bevelled, although, had they not been, I would have bevelled them in a few minutes with a whetstone. One hour served to complete the rough grinding. This was done with less than ½lb. of very coarse carborundum; the size is shown on the diagram (Fig. 4). It was, perhaps, too coarse, for it did make deep holes in places in the glass, but was the only kind at hand just then. However, with the fine grinding, which took about three hours, they all came out except three tiny holes—one the size of a pin-point, near the edge, and two others, very much smaller, but which will be covered by the flat mirror's shadow. These could have been taken out, only I feared that, in some unexpected way, they might happen to be replaced by scratches, and one scratch would shut out as much light as fifty small holes. The fine grinding I divided into three parts—the first with carborundum, for about 1½ hours; then, happening to have at hand some No. 60 and No. 80 emery I used them for about twenty minutes each. Their action, being much slower, was a change, at least; and it is said that a change is as good as a trip to the Lick Observatory. Another reason for using the emery is because I was not careful enough with some of the intermediate grades of carborundum washings, and found myself without them when

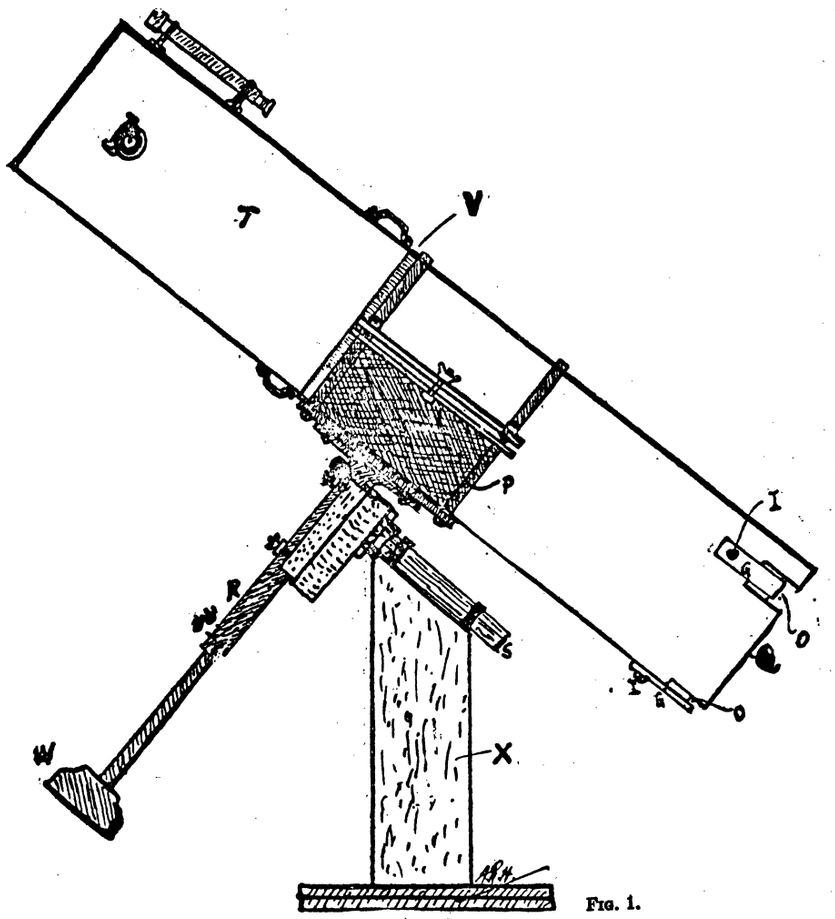


FIG. 1.

they were wanted. The element of common sense, mixed with a little carborundum, is very useful to determine, after examining the surface of the mirror, which particular coarseness or fineness of material is just the proper one to use. Often one has to go back a little, when it is seen, after a few minutes' operation, that the grade in use is slightly too fine. If one were rich enough to possess a pound or two of every possible grade of the grinding material, and proceeded from coarsest to finest, using each for, say, ten minutes, the whole operation might be completed with a certain and unreasoning continuity; but since economy is as much a virtue here as it would be if one were shipwrecked in a biscuit-box one hundred miles away from England, with nothing left to sustain life except a tin of sardines and a copy of the "E.M.," it is best to proceed with the customary sifting or elutriation, and use the washings derived from the coarser grindings. Sometimes a coarse grain or two will get into the finer grades, in spite of all precautions. A good way to avoid any trouble this may cause is, when the paste of carborundum and water is laid on the mirror (or tool), to press firmly with the mirror on the tool, giving the mirror meanwhile a slight movement over the tool, when the coarse grains will become ground and broken, and cease to give any trouble from scratching. A little careful observation of this suggestion will produce a mirror without a mark on its surface. When the finest grades of all—the last two—are being employed, during which it seems a pink water is all that is being used, and to detect any grinding, the ear has to be bent down close to the mirror, it is best to spend from 15 minutes to half an hour in using strokes just as short as possible—say, one or two inches in length only. This is a little tiresome, but it enables the surface to approach very close to the sphere. Some writers say that printed letters ⅛in. long can be read through the dry mirror when, at the end of the fine grinding, it is placed, ground side upward, on the printing. I consider the fine grinding very satisfactory if letters twice or three times that length, and thick in proportion, can be distinguished from one another in that manner. After the fine grinding I polished and figured the mirror in about five or six hours, the same being broken periods of operation.

The polisher must not be hard. A hard polisher is surely likely to cause scratches; and a thin polisher must not be tolerated. Pitch is comparatively inexpensive. Let the polishing-pad, then, be abundantly thick. Cover it as formerly suggested, with a thin—very thin—coating of beeswax, and the danger of scratches is reduced to almost a nullity. Some writers advocate the division of the polisher into large squares. My view of this is, if it be a machine that is used for polishing, then make the squares any size desired; if the polishing be done by hand, make the squares small. The only need of grooves in the polisher at all is to distribute evenly the rouge and water. The more numerous the grooves are, the greater will be the distribution. Press the wet ruler edge into the polisher-pad at intervals of ⅛in. The facets will then be about ⅛in. square, and the grooves ⅛in. wide. A polisher in this form is very satisfactory. Besides, when the time for figuring arrives, it renders quite easy the chipping away of correctly-located and not too large facets. The cell for the mirror is shown in Fig. 2. B and C are circular pieces of wood, 6½in. in diameter, and each ¾in. thick. They are put together, and the cell completed as described in the beginning of this letter. In Fig. 2, A is the mirror and D is the piece of carpeting as a rest or support. M M are nails holding B and C together. G G G are three straps of sheet iron screwed by screws, J J, to the bottom of C, and with the projections bent up to encircle the tube, to which they are affixed by the bolts I I I, which slide in the groove H for adjustment of the mirror. A little packing of carpeting L L serves to hold the mirror firmly but tenderly in the cell; and the mirror is held on D by the ring of sheet iron, E E, bent over at the top, T, and secured by three screws, F F F, although I have found with the 6in. carpet-tacks to be sufficient. In Fig. 3 the lettered parts correspond with Fig. 2. The mirror is covered by a little tin cover, K. All of this I made with the simplest of tools.

It would appear that I am going backwards in my descriptions; but in truth this is the best way to proceed with the telescope construction. Fig. 1 is a drawing of the telescope (a little, I fear, out of proportion: if possible, I shall include a photo of it with this letter). T being the tube. It is of sheet iron, a little heavier than stove-pipe iron, and the tube I had made by a tinsmith, who rolled the iron into a cylinder, and lapped the two edges together, not with rivets, but with a bend-over joint. The tube is 60in. long, and 7¾in. in diameter. It cost 75 cents (three shillings). In the bottom I cut three openings (o), to enable the cell to pass

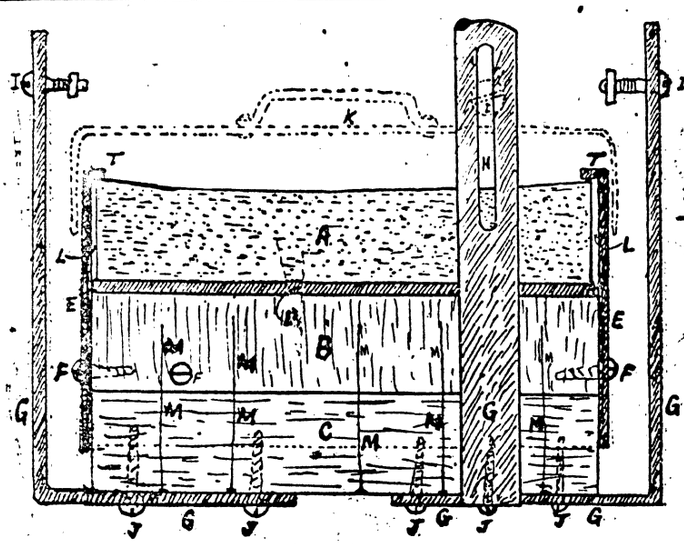
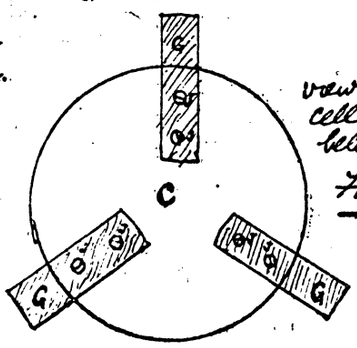


Fig. 2.

Section view of mirror in cell.

Fig. 4.

Side of the coarse Carborundum wheel.



View of cell from below.

Fig. 3.

up into the tube, so that when the tube is taken off the cradle P, and placed on the ground, it can rest on its end, C, and thus prevent the cell touching anything whereby its adjustment might be disturbed. The remainder of the mounting should appear from the drawings. R is the declination axis, S the polar axis, W the weight, and X is a block of wood, of any convenient size, for the pillar. In my case, it is 10in. square, about 2ft. high at its lowest point, and 2ft. 10in. at its highest. I use it at present for both 6in. and 9½in. telescopes. Firmly nail it to a platform a little larger than itself.

The cradle P is made of (in the 7½in.-diameter tube) a piece of sheet iron 12in. square and about ⅛in. thick—just enough to be fairly rigid. Have the tinsmith roll it into a semi-cylindrical form, with the upper edges—I might call them the terminations—7½in. apart. Complete the cylinder with two straps of thinner sheet iron 1in. to 1½in. wide, A A in Fig. 5. These are given a firmness by the cross-straps D D, which are riveted to A A at the four corners, 9 9 9 9. The front strap has an L-shaped projection, E, riveted to D, while a similar projection, F, is riveted to B. Through each of the projections of E and F is a hole, through which passes a bolt, having a wing-nut attached, to hold the two parts of the cylinder together. When the top part is released and thrown back, the telescope tube can be placed in the recess, the top part closed down, and the tube thus held in embrace. A band of iron 1in. wide and ¼in. thick (V, Fig. I) encircles the tube by being bolted or riveted to it. This prevents the tube slipping through the cradle. The band V being in place, it is not necessary to screw the top of the cradle down too tightly; then the tube may be rotated quite easily. The cradle is mounted on a piece of 2in. or 2½in. gas-piping (T, Fig. 5) by three pieces of iron bent and drilled as shown at R R, Fig 5. These are bolted and riveted to tube and cradle by the bolts or rivets S S S S. To the lower end of T is affixed any convenient kind of weight as a counterpoise. A rod of iron, to which a lump of iron is affixed securely, and the whole held in by the set-screws V V, for adjusting purposes, will answer very well. An iron ring, X, serves as a collar for the axis at the place where it rests in its mounting.

Fig. 6 is the mounting which holds the cradle. It consists of a block of wood 12in. long, 6in. wide, and 2in. thick. To it are nailed two pieces of 2in. by 2in. by 12in. strips, D, D, separated each by a groove 2in. (or 2½in.) wide, sufficient to let the pipe T (Fig. 5) revolve between them. The pipe is clasped by the piece of iron A, cut away as at B, the whole being self-explanatory. The support of the flat and the making of the adapters for the eyepiece have not been described. Another paper may give these subjects consideration.

The construction of the 6in. telescope cost me about 35s., divided in this manner. Glass, 40s.; another disc, secured formerly as the tool for a 7in. mirror, about the same price, but, being used for two glasses, divide the price, 20c.; tube, 75c.; cradle, 15c.; other pieces of iron, about 25c.; bolts, nuts, screws, nails, rivets, 25c.; carborundum and emery, 25c.; rouge, less than 10c.; flat, 2c.; wood—the base cost me a dollar, but a much less expensive one than that would do (still, wood is quite expensive); other wood, 15c.; paint, 10c.; lampblack, varnish, and turpentine to blacken the inside of the tube, 10c. (of both paint and lampblack, etc., much still is left); tin for covers, etc., 10c.; brass tubing for eyepiece adapters, 30c. (half of this nearly is left, too); hoop iron for band around tube and handles, 10c.; incidentals, say, 50c.; total, 4dol. 77c., or about £1. This does not include the silvering, finder, or eyepieces. Two dollars (8s.) should make the finder, and the eyepieces can be had at many prices. I have bought a good one for 1dol. 25c., and, again, a poor one for 2dol., also a very good one for 4dol., and at another time, quite unexpectedly, a satisfactory one for about a shilling.

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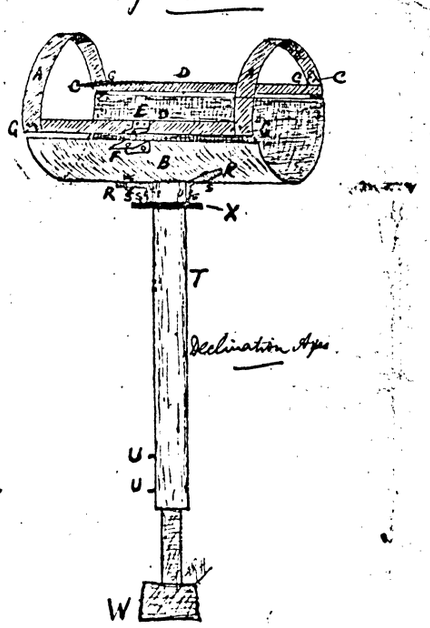
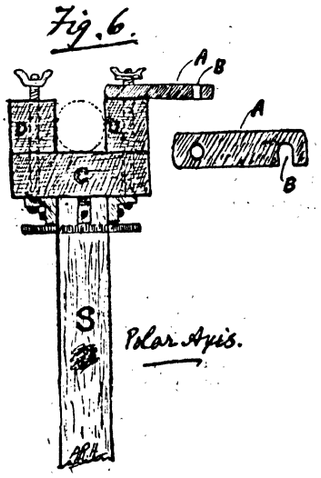
Fig. 5. The Cradle



Declination Axis.

Fig. 6.



Polar Axis.

MIRROR-MAKING.

[60.]—In your issue of December 24, 1909, I described the making of a 12in. speculum, the glass being only ¾in. thick. I silvered it when it had reached the condition described in that letter, and on testing it in the tube, found its performance to be highly imperfect. Everything was confused, and Saturn was a blur. So I reverted to the thicker 12in. glass, and brought it by regrinding and polishing to a surface close to the sphere, but still a little undercorrected. On silvering it I found its performance much better than the other 12in. glass—so much so, in fact, that at times I thought it might not be much improved. That being accomplished, I then took the thinner glass in hand, removed the silver, and placed it on a polisher with the facets evenly graduated with the largest ones in the centre, and the smallest at the circumference. I polished it until the sphere was reached, and then passed, and the parabolic shadow showed at the side of the mirror opposite that from which the knife-edge approached. The image at this point with the eyepiece on both sides of the focus was somewhat confused, and it had nearly (but not quite) definite edges at the principal focal point. At that point there was a slight blurring of the edges. The measuring of the aberration correctly is next to impossible. At least, so it was with me. I got the aberration anywhere from $^{3}/_{32}$in. to ¼in. More definite measurement I could not obtain. The aberration should be about ¼in. But the faint shadow, on the mirror just to the right of the centre, was there beyond doubt, whether the mirror was recently taken off the polisher, and perhaps, therefore, slightly heated, or when it had been lying for many hours untouched by anything. So I placed it in the tube and tested it, unsilvered, and at once I could see that it was a much better piece of workmanship than the thicker glass. The moon's craters were clear-cut beyond question, and Mizar separated as if it were composed of two most disconnected stars. Sirius was very confused, but Castor divided nicely. The moon's brightness, just past the first quarter, may have been a hindrance to correctness of my test. To-night, if possible, I shall test the glass on Saturn. I like a glass to pass three tests before I decide it is satisfactory; they are, the moon, Saturn, and a star. The "workshop test" may be final with some workers, but I would not rely on it. I do not condemn it, but simply say I would not accept it in any sense as conclusive. If I find Saturn stands out clear and perfectly, I shall silver the glass, and then still further correct the thicker 12in. mirror; but if Saturn, after a thorough test, fails, I shall still further correct the glass. I observed somewhere—I think in these columns—that the true test of the perfect parabola on a star is by the in and out of focus tests, that on each side of the focus a star should appear as a perfect disc, with no dissimilarity on either side. This, I question. The in and out of focus tests to me show a circle of light with a black area in the centre, and that black area on being closely inspected resolves itself into the shadow of the diagonal mirror and its three supports. That appearance is the same whether the mirror is perfect or not. A careful consideration and investigation of appearances tells me that when in the tube no test is reliable except that upon the stars or planets.

My experience with pitch and beeswax is as follows, and while I take no sides with other disputants in current controversy, it does seem that the merits of pitch and beeswax have not been considered quite appropriately.

One writer grew angry, another became mirthful, and another threatened, if I remember correctly, to "wax" eloquent on the subject. A polisher that will bring the glass to a fine surface is all that is desired. In fact, anything that will do this evenly will satisfy all needs. How best can this be done? I have had no experience with soft pitch—that is to say, pitch so soft that it very easily receives an impression. With hard pitch I have had at least two unfortunate experiences, and of it I can speak from knowledge. I found at least twice that the hard pitch served not as a polisher, but as a grinder, and that when a glass was becoming polished the hardness of the pitch served to prevent the rouge becoming imbedded in its surface, with the result that the rouge rolled around between speculum and polisher, and caused the glass to lose its polish and become as if it had been replaced for a short time on the tool, and was fine-ground with the finest emery. For a time I was at a loss to understand why this occurred; but by coating the pitch with beeswax I found the grinding to cease and polishing to resume. Subsequently I had the same experience with the beeswax, and found that the reason was just the same—the beeswax had become very hard, and had become a grinding and not a polishing tool. So I added a little turpentine to the beeswax, thus softening it slightly, and on applying the softened beeswax to the polisher it worked satisfactorily. An application of turpentine to the pitch would operate similarly, I presume. To polish with a polisher so soft that it will actually run seems to be out of the question. The difference in hardness between a polisher that will polish properly, and one that will grind instead of polish, is so slight, that only a careful examination can distinguish between them. In testing my 12in. mirror last night, it being still unsilvered, it could bear very easily a power of 270; while on even the moon a power of 585 was very indistinct.

A night or two ago I was permitted for a moment or two to look through an "ultra-microscope." A drop of a solution of sugar and water, in which the sugar is supposed to be completely dissolved in the water, was placed under the instrument, which is of very high power, and with a brilliant illumination in the field. Particles of the sugar were observed each one nearly being surrounded by a small diffraction ring. This is probably a close approach to the molecule being actually visible to the human sight.

Mr. Ellison, in one of his letters, says he has devised a method of polishing whereby he can completely control and change the figure of the glass without changing the polisher's form. Would he tell us how he does this?

A. R. Hassard, B.C.L.

9, North-street, Toronto, Canada, Jan. 20.

SATURN'S OUTER RING: TO MR. MERLIN —EXPLANATION.

[538.]—Mr. Merlin ("E.M.," December 10) gives no scientific explanation, as I hoped he would have done, how he is able to see Saturn's outer dusky ring so frequently with his mirror (as mentioned in "E.M.," November 5), when I believe it has not been seen by anyone since November, 1908, and Professor Barnard, in "Monthly Notices," says he can *not* see it with the 40in. Yerkes. As this is a question of light-grasp, some reasons might have been given. Professor Lowell writes ("Mars," 1904) "that it is easy to see what we expect to see" (are determined to see). There is no difference of opinion between M. Jarry Desloges, M. Fournier, and myself, as Mr. Merlin seems to think, and apparently desires. I think Mr. Merlin cannot have read M. Jarry Desloges' book with care, as he would have seen that there is no mention of the large refractor being stopped down on September 5 and 7, 1907, when the outer ring was sighted. The occasions when it was stopped down, owing to indifferent definition, is clearly stated as July 23 and August 26, 1907. It is also clearly stated that the largest aperture gave minute points of light the best. I do not understand if M. Jarry Desloges saw the outer ring, or whether it was only M. Fournier "who sees the faintest lines at the limit of visibility the best." On September 5—the first occasion it was perceived—it was thought an error was made, quoting the exact words, "Prise pour une erreur de mise au point," and on September 11 it could not be seen. "Nous le recherchames à nouveau, mais quoique les images fûssent assez bonnes, ni mon collaborateur ni moi nous ne pûmes le distinguer." I do not know of any other occasion when it was again seen by these eminent observers. Therefore, this ring being frequently caught now by Mr. Merlin is certainly very remarkable, especially as the definition at Volo is often so indifferent that Mr. Merlin tells us that his 8.5 mirror has to be stopped down for planetary details to 7.6in.—a fact commented on by Mr. Wickham, also by "Amateur" ("E.M.," April 10, letter 248). The latter considered Mr. Merlin's mirror must be defective.

To show that M. Jarry Desloges and I are of the same opinion, I quote the following sentence from his book: "Avec l'ouverture de 37cm. (14.8in.) visibilité des petits corps lumineux, avec ouverture de 21cm. (8.4in.) invisibilité des très faibles corps lumineux." I venture to think that if I had stated that I saw a very faint object frequently with 7.6in. which has not been seen by any observer since November, 1908, and could not be seen by the eagle-eyed Professor Barnard with the 40in. Yerkes, I should have been told that I was one of those included by Mr. Merlin (in his letter to "E.M.") "who did not stick at trifles."

Camberley. H. Watson (Col.)

SPECULUM-MAKING.

[539.]—I began work on a 10½in. glass before having acquainted myself with the first principles of speculum-making, and kept working in advance of valuable instruction I was receiving from Mr. Hassard, Mr. Mellish, and Mr. Prahl. I had never heard of the "E.M." up to this time, much less having read it.

My friend kept along with me in the work. Up to the time we decided to silver, I believed that as I had gone so far independent of any professional services, that I was equal to the occasion of silvering; but my friend felt differently about it, and enlisted the services of one said to know something about it. The appearance of the mirror did not indicate as much, however, when it came back. Of one thing I am convinced, and that is, that an amateur is not qualified to determine the figure of his glass from the Foucault shadow-test alone. I was led to believe by the shadows as they appeared on my glass—and I tested time and again—that the figure was a parabola as near as I could understand it, when in reality, on subsequent test, it was badly turned at the edge, and had too great a depression at the centre. I had no ocular at the time to examine the image with, and did not sufficiently understand the zonal test to apply that. To clap the climax, when assembling my telescope, I found my "flat" was imperfect, and my adjustments bad. I had blundered through with such haste, hoping to complete a workable instrument for use on the first warm nights of spring, that I had all but made a failure of it. Valuable time was being lost, so I arranged with Mr. Mellish to figure and correct the glass. He found the figure, as I mentioned before, badly turned at the edge, and a hole in the centre; but between edge and centre very good.

In my long attempt at polishing, and use of polishers of all shapes, I attempted to use the straight stroke that is recommended for all beginners, and, it may be, for all others, either long or short, as the circumstances require; but I could never attain to anything like a regular figure, using an exclusive straight stroke. I did get so that I could do nearly anything with

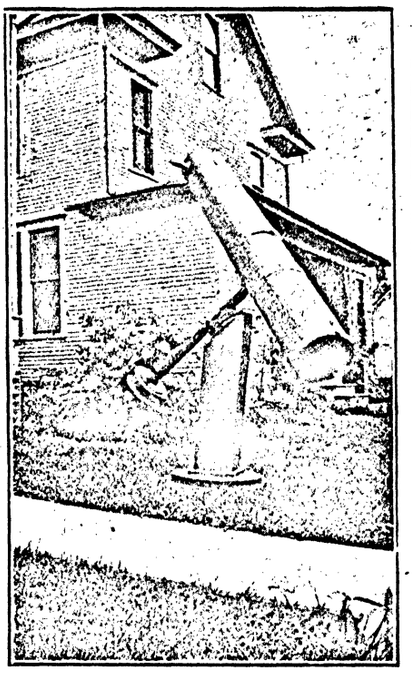


Fig. 1.

the curve, using a circular spiral stroke over a plain polisher (that is to say, polishers not moulded into every fantastic shape under the sun, with each facet of a different size). Will someone suggest why I have failed to get results with the straight strokes in polishing?

I am baffled with Saturn's moons. I feel pretty well satisfied that I have seen five, but

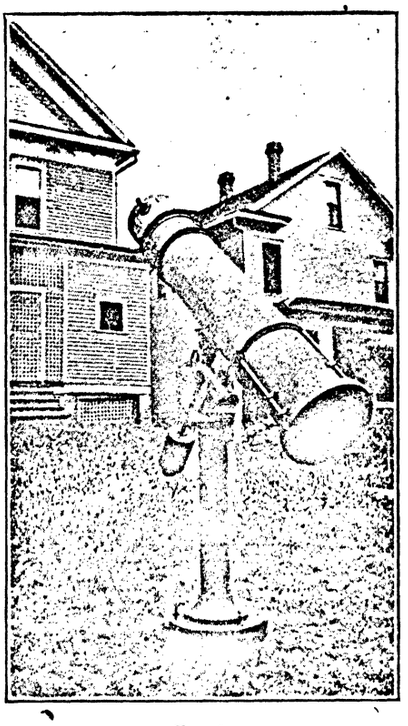


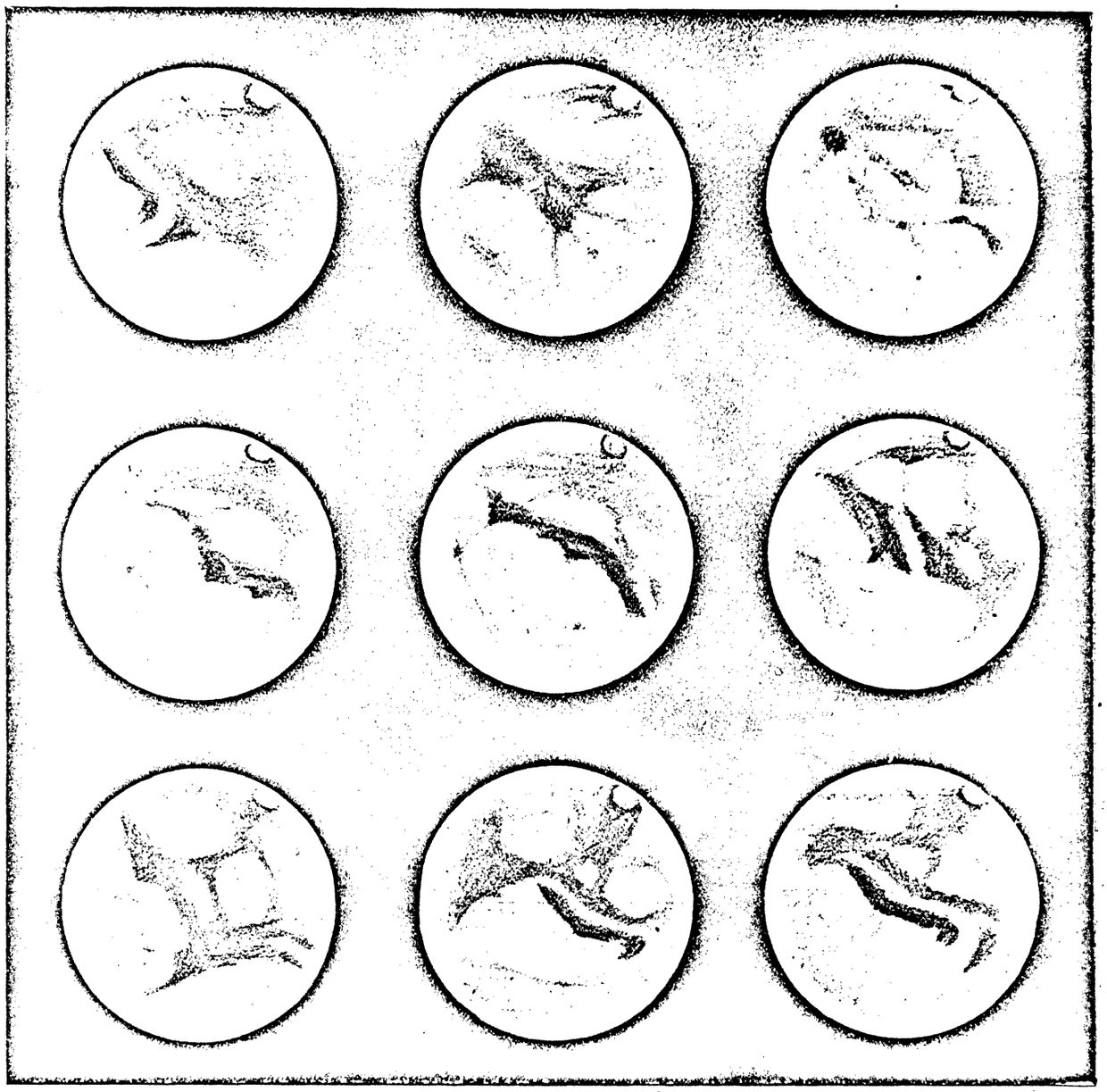
Fig. 2.

am never absolutely sure of but four. I have observed Saturn on only three consecutive nights, of which I have made sketches. One or two outer points of light do not seem to change their positions, as I think they should. Later, I hope to send some sketches of both Saturn and Mars. The photographs are of my telescopes. No. 1 I abandoned long since, by reason of its wrong construction of polar and declination axes; No. 2 I am using now.

Decatur, Ill. Leo Holcomb.

MY NEW TELESCOPE.

[540.]—Having something that may be helpful to communicate, I venture once more to invade your columns. I thought my trouble with the 15in. reflecting telescope were to be ascribed to imperfections in the atmosphere, perhaps flexure, but have now discovered that the sole fault is in the curve. As much is to be learned from failure sometimes as from success so I venture to narrate some of my recent tribulations. As I had thought the atmosphere was responsible for the defects in the 15in., and none of the wise men had anything to say by way of correction, I decided to make a new telescope of 12in. aperture, but with a focal length of one to about nine. So I secured my glass, and ground a mirror on the tool which had been used with the 15in., having first cut the tool down to 12in. in diameter. The tool was very thin—not over ¼in. thick. Down to the fine-grinding I did the work with the mirror on top, but when it came to the fine-grinding I placed the mirror beneath and the tool on top. Here I met with a mishap in grinding with emeries insufficiently fine, and when it came to the polishing, I found I had a curve closely approaching the sphere, but highly imperfect as regards the removal of fine pits. So I reverted to the fine-grinding again, and made a blunder that was very grievous indeed. The mirror, face up, was lying on a projection where it was not possible to travel around it, and I had to grind wholly from one side. And although I tried to be careful, when the polishing was proceeding, I found that there were two elevations on opposite sides of the mirror, where apparently the grinding had not been as effective as on the other parts of the mirror. In fact, the mirror's face was not a surface of revolution, and when I tested the mirror in the tube the result was most disappointing. Even the moon refused to show itself with any distinctness, and the edges were multiplied most confusingly. So I laid aside mirror and tool, but might mention first that as the sun was not shining much when testing time came, I reduced the focal length to about 93in. Then I procured some new glass, two pieces, each ¾in. thick, and one (for the mirror) 12¼in. in diameter, the other being about 11¼in. in diameter for the tool. These I ground, and made the mirror 108in. in focal length. I took care this time to get the fine-grinding properly done, and made no effort to hurry from one grade of fineness of emery or carborundum to a still finer grade. The reason I mention both emery and carborundum is because I used whichever happened to be convenient. I usually use No. 30 carborundum for the rough-grinding until the mirror is nearly at the proper depth, but after that either is used according as it happens to be convenient. Of course, the carborundum is preferable, since it cuts much faster, but the emery is by no means cast aside. Sometimes I am out of a particular grade of carborundum, and its absence is frequently replaced by the emery. The thickness of the tool prevented its bending in any manner whatever, and I secured a surface that was excellent for polishing. During all of the last three or four grades of fine-grinding the strokes were very short, not exceeding an inch or so, and often I whirled the mirror round on the tool, letting it move slightly over all parts of the circumference of the tool, thus bringing the surface to the highest perfection for polishing. Then I proceeded to polish with a polisher made with facets of even size all over; but finding the polish appearing more noticeably at the edge than the centre, I used very long strokes, and kept the mirror overhanging the tool by nearly one-half its diameter. The strokes were 8in. 10in., and 12in. in length. The earlier testing showed the surface to be like Fig. 1—a section of which, highly exaggerated, appears at Fig. 2—and a continuation of the treatment without change brought the mirror gradually on through Figures 3 and 5, with the exaggerated sections as appear respectively in Figures 4 and 6. Then I changed the polisher and cut it away as appears by the diagram Fig. 9, and before long had the mirror resembling Figs. 7 and 8. It will be seen that there is a slight elevation at the centre of the mirror, and too great a depression at the edges. How would the English mirror makers now have finished the mirror? For, in examining the image on the mirror with an evepiece at the centre of curvature, I found the image of a hole that was about $^{1}/_{32}$in. in diameter to present the appearance shown in Figure 14, showing that the image was apparently doubled. This at first I



4336 is betwixt us and M 8. The clearness of the stars on Dr. Roberts's photograph is incompatible with their being either involved in the nebula or beyond it. Here I agree with Sir John Herschel and Dr. Roberts, and conclude the opposite opinion expressed by the other two writers results in the one case from a too-cursory examination, and, in the other, from the character of the photograph on which the opinion was based.

If change should take place in this nebula, it appears to me it is likely to be in connection with the dark spaces. Either they may close up or widen out; become obliterated, or new ones appear. The evidence will have to be photographic; but many photographs will have to be taken, and their evidence most strictly examined, before admission as proof; because differences of plate, development, modes of printing, exposure, and instrument, cause photographs to be most deceptive witnesses. But in one thing they are satisfactory: they can be examined by any number of people without any question of varying conditions; so that any pretensions to the discovery of geometrical problems, or systems of water-ways, or new rings, can be at once tested, and so are not likely to be made. A.

COMETS' TAILS—THE SUN AND TERRESTRIAL METEOROLOGY.

[536.]—Mr. C. Robinson's letter (No. 521) can hardly have been written with due regard to our records of cometary appearances. To speak of "undisturbed contour" of these mysterious celestial wanderers is to entirely fail to take cognisance of the very contrary phenomena exhibited by so recent a comet as Comet Moore-house during September and October last year. Biela's Comet is with justification credited to have broken into separate portions before the observers' eyes, while comets Brooks and Rordame also showed tremendous disturbance of their outline. The idea of comets' tails being set stiffly straight is also erroneous, or at least exaggerated. As often as not the tails partake of sweet, yet pronounced curvature, which they could not possibly do if the tails' *raison d'être* was an optical phenomenon, such as proposed by Mr. Robinson's friend. These very curvatures prove that the tails are composed of ponderable matter, however attenuated, and, according to Bredichin's theory, this curvature is the more pronounced the greater the atomic weight of the element which gives rise to this or that portion of a multiple comet-tail (vide Comet Donati, 1858). Comet-tails may *appear* to be perfectly straight and radially set with regard to the sun's centre when the plane of the earth's orbit, laid through the sun's centre, coincides with such a plane laid through the comet's head *and* tail, to the extent of the latter's full length.

In view of the recent increased attention given to the synchronism of exceptional terrestrial meteorological conditions and the sun's synodic rotation period, I hope that readers of the "E.M." will remember what I have observed and argued in this respect in your columns for a long time past on my own responsibility, and that they will give me due credit for having anticipated what comes later on, but is given more prominence to. Albert Alfred Buss.

MARS.

[537.]—I enclose a few drawings of Mars, made from sketches of the planet as it appeared to me during the recent opposition. I used a 10½in. reflector, powers 200, 300, and 400. As the instrument is not driven by clockwork, I did not use a micrometer. The positions of the markings are, therefore, not accurately drawn to scale.

1. Shows the Sabæus Sinus as it appeared to me on September 22, 23h., local time (Central Standard time).

2. Mare Erythræum, Sept. 19, 23h. 50m. The southern part of the *mare* seemed slightly reddish in tint. The same region in the next presentation appeared to be darker in the eastern portion, and dark green or blue in colour, with a suggestion of the reddish tint in the central part, south of the Stagnum Pegaseum.

3. Solis Lacus, Sept. 14, 23h. 30m. Nectar seemed rather broad—perhaps double—being nearly as wide as the Solis Lacus. I caught two glimpses of Nectar and the Solis Lacus on Nov. 21, 18h., with a 3in. refractor.

4. Mare Sirenum, Oct. 12, 21h. 40m.

5. Mare Cimmerium, Oct. 10, 22h. 30m.

6. Hesperia, Oct. 6, 23h. 10m.

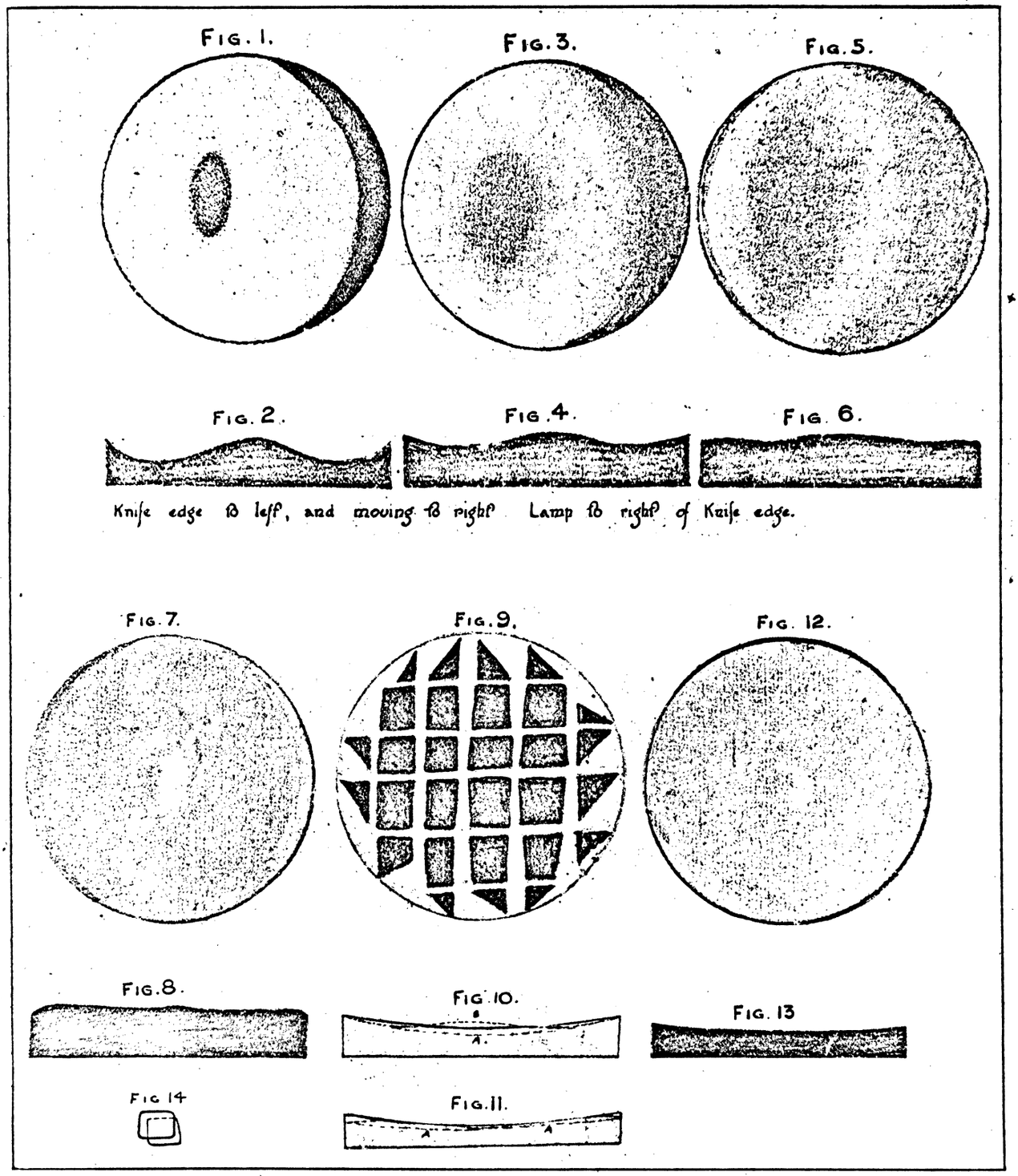
7. Syrtis Major, Sept. 30, 22h. 20m.

8. Æria, Sept. 28, 24h.

9. Icarii Luci, Sept. 29, 1h. The brilliant line bordering the southern extremity of Æria may have been the effect of contrast.

Latimer J. Wilson.

803, Shelby-avenue, Nashville, Tenn., U.S.A.



attributed to flexure, but a further polishing showed it to disappear, when the mirror resembled Figs. 12 and 13. I think that doubling of the image is caused by there being two curves on the mirror—one caused, perhaps, by the inner portion, and the other caused by the "turned back" portion near the mirror's circumference. When the two curves became united in one, the duplication of the image disappeared. I left the mirror as shown in Fig. 12 (13), with still the slightest approach to an elevation in the centre, but with the outer edge apparently wholly gone, and tested the mirror in the tube. The tube was the old 15in. mirror's tube, and I had to lengthen the eyepiece by about 12in., which, of course, was unsatisfactory. But the result was very satisfying. Saturn stood out very plainly, and the moon, just past full, gleamed brightly and with its edges clearly cut and quite single—no doubling of any image whatever. Sunspots looked well, too. I made no test on stars, because with the moon shining so brightly, and with the imperfections in the eyepiece adapter, because of its great length, their distinctness would not have been observable. I am making a new tube, the same as that used in the 15in., for this mirror, and expect it to be in use before long. At the same time, I have commenced to regrind the other 12in. on the tool used for grinding the one already finished; but in order to lengthen the focus I have the tool on top, and am making the strokes quite long, and may proceed and finish it before yet I am done.

I wanted to say something about Figs. 10 and 11, but fear I have already said about sufficient for one letter. And I wished, too, to say something about testing, but shall content myself with briefly saying that elaborate mechanism for testing is wholly unnecessary. The aberration of a mirror when tested at centre of curvature with an artificial star is always double the excavation. Nine divided by the focal length in inches equals the depth of the excavation. Eighteen divided by the focal length in inches equals the aberration. In my case the aberration is ¼in. That length is very easy to estimate without any special mechanism. All I use is a common one-foot rule, divided into sixteenths of inches. But even that is not necessary for amateurs. A mirror anywhere between the sphere and the parabola will do nearly all an amateur requires. Indeed, even less than the sphere (although near it) will work wonders.

Toronto. A. R. Hassard, Barrister.

GLASS MIRROR MATTERS.

[541.]—David Booth (letter 495) is about right when he says that beeswax and turps cause turned-down edges on mirrors. I have tried everything under the sun for the last 20 years. You cannot beat good pitch. I should say that amateurs who use beeswax or any other wax will get "waxy," and spoil their mirrors

with a very bad turned-down edge; also a very uneven curve.

Here is a very simple hint to soften the surface of pitch-tool. First, be sure and have your pitch-tool to the exact curve of mirror, and use hard pitch; then pour on tool a little turps. Be sure and cover pitch-tool with turps; then warm surface of tool and restamp curve again with mirror; cover with rouge and water.

Mortlake. H. N. Irving.

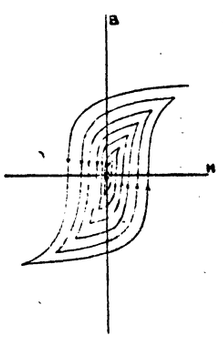
RING SHADOW PROBLEM.

[542.]—With reference to my letter of a fortnight ago. Since I have read other correspondents' replies in later numbers of the "E.M." I see that the whole of my work is erroneous, because I have commenced by writing tan. θ where I should have written sin. θ. With this correction, my formulæ are reliable; but all the results I gave in that letter are incorrect. I regret, Sir, that I have wasted your space, and possibly Mr. Whitmell's time, with inaccurate work; but I do not intend to add to my offences by attempting excuses or explanations. C. J. Westland.

Christchurch, New Zealand, Nov. 3.

DEMAGNETISING A WATCH.

[543.]—Mr. Hollis (letter 455, page 419) expressed his desire for the principle on which a watch is made non-magnetic. Perhaps the following, although it lacks definite proof, may be of service to him. We may treat it as an example of demagnetising a small magnet, since the treatment will be general with all the magnets induced in the watch. Further, in this small magnet we will consider one axis in its plane of rotation. During its first rotation between the poles of the powerful magnet, the axis will revolve into the direction of the field, and its induction will be increased to its maximum value, which value, since the inducing field is very strong, will depend finally upon the permeability of the magnet. As the magnet revolves on, the inducing field along the particular axis we are considering becomes less, and finally zero when perpendicular with the axis. It then reverses and increases in the



opposite direction to a maximum value again, and so on. If we plot the induction, along the axis, against the inducing field, we obtain the well known curve of magnetic hysteresis. This curve would remain constant so long as the magnet spun in the same spot; but on slowly removing it out of the field, the curve would diminish in area, and finally disappear at the origin. Such a curve is indicated by diagram. In other words, the induction would become zero, and the magnet demagnetised in the plane of rotation. It seems from this that the watch should be treated twice, the spinning being performed on a different axis each time.

A. T. Arnall.

THE CHEAPEST LIGHT.

[544.]—My letter in your issue of November 5, describing the Blanchard High-Pressure Paraffin Lamp, has caused me a good deal of correspondence, and as it is impossible for me to answer all the questions through the post, I will try to give readers of "Ours" a few further particulars. Let me first of all state that I am not connected wtih the sale of any lamp, and I cannot therefore undertake to reply to questions regarding price, etc. Further, the "Blanchard" is not the only make of this type of lamp on the market. There is the "Wells" lamp, which works on exactly the same principle, but is fitted with an upright burner. The general design of the Wells lamp will be gathered from the illustration (Fig. 1). On the front of the oil-container will be noticed a little dial; this dial shows at a glance how much oil is in the container. I think this little fitting

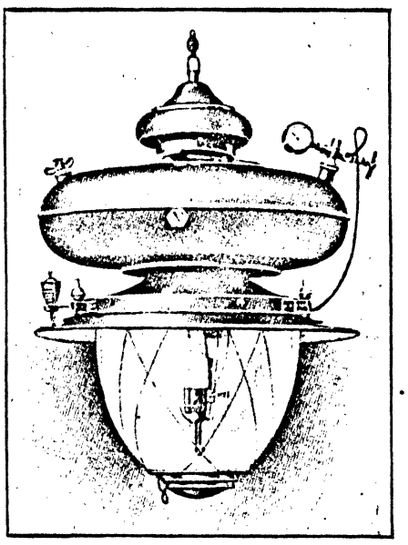


FIG. 1.

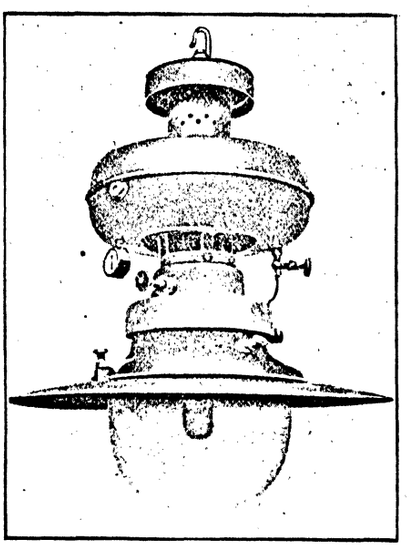


FIG. 2.

might be adopted on all paraffin lamps having metal containers.

One correspondent wished to know if he could obtain a very powerful single lamp for the front of his shop. I wonder if Fig. 2 would suit

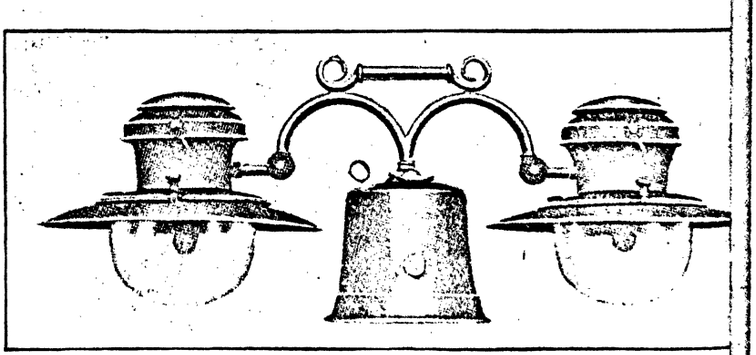


FIG. 4.

him. It gives 1,500 candle-power, and weighs over 70lb. when full, besides being over a yard in length, and over 2ft. wide. I think he would want something in the nature of a small crane to get it up. I certainly should not like the job of putting it up with a pair of flimsy steps.

Another oft-repeated question is, "Will the lamps burn outside?" That is exactly what most of the models are constructed for; they will burn in the strongest wind, a shows a Wells lamp mounted on a fitted with a winch for raising and lo lamp. This is for lighting streets, ya works, or any other purpose where illumination of a particular space is

By far the larger number of corr

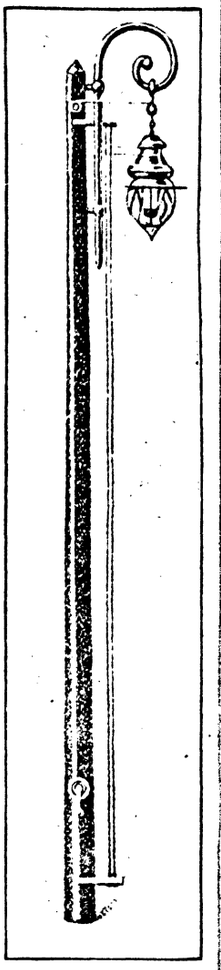


FIG. 3.

were inquiring for a lamp suitable illumination, and it seems a pity choice here is so limited. The first in my letter of Nov. 5, and the ac illustration (Fig. 4) seem to be the o at present made for interior lighting of them suffer from the same defec it would require a pair of steps t tinguish, or fill the lamp in a h room, as it would obviously be question to fit a raising and low in the rooms of most houses. I th makers could supply us with a table with a burner of moderate candle- having a globe correctly tinted to pleasing light, and a removable when used for reading, it should f sale. I would lay particular import

Eng. Mechanic June 18. 1909.

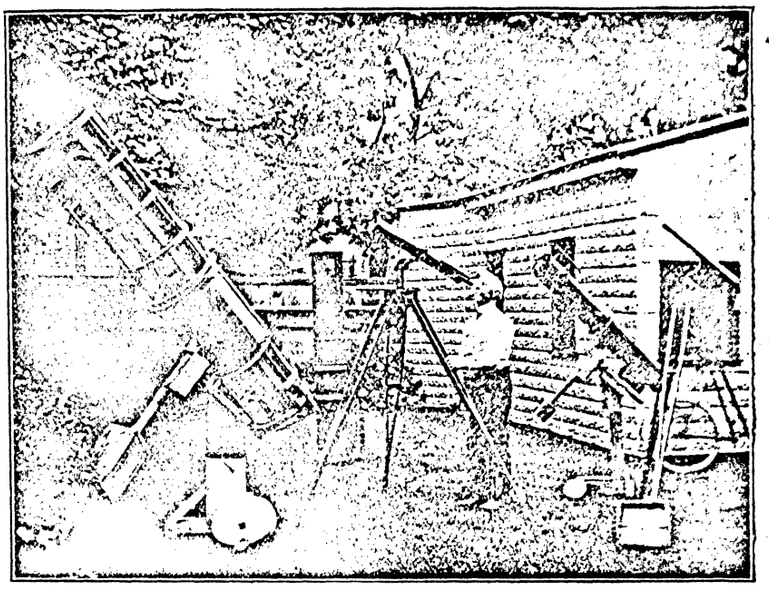
LENSES AND LENS-MAKING.

[436.]—Permit me to say that Mr. Ellison's explanation was pleasing to read, and, as I have profited by what he frequently has said, I hope he may have found a little of interest in my writings. His letter is the first intimation he has given that he has had experience in lens-making. I wish he would treat your readers to some comprehensive papers on that subject. Lens-making is a department in which few excel, and those who do are not as industrious in communicating their knowledge to the public as the mirror-makers have been. A reason may be that not as many are interested in lens-working as in mirror-working. Still, the interest is easily aroused, and, when once aroused, is permanently retained. Somewhere I read that in making eyepieces, the two lenses of the eyepiece should be separated a distance equal to half the sum of the focal lengths of the two lenses employed. I have been experimenting, and find that half, and sometimes a quarter, of this distance has great advantages. The result of these experiments, which are in no sense complete, has left me without any rule whatever. A good paper on this subject from Mr. Ellison's pen would be very welcome.

Thinking that a description of the mounting of my 15in. mirror would be interesting, or perhaps useful, I shall briefly give it. First, I procured twenty ordinary wooden barrel-hoops from a barrel manufacturer. These hoops were not made up; but hoops taken from an old barrel can have their ends separated and be used quite successfully. Ten of them I bent into hoops having an inside diameter of 17in., and secured the ends by nails. Then I procured ten pieces of pinewood—each piece ¼in. thick, 2in. wide, and 10ft. long—and made a cylinder of them and the barrel-hoops, the cylinder being 10ft. long and 17in. inside diameter. The hoops were separated from one another by 1ft., except at the end where the mirror would be, in which case the separation was 2ft. In other words, beginning at the speculum end, the hoops were placed, first, one at the end, then one 2ft. from the end, then one 3ft. from the end, and so on, the last one being 10ft. from the end. The hoops were all inside of the 10ft. strips of wood referred to above. The cylinder made in this manner will be found insufficiently rigid; but the necessary rigidity can be secured by binding the other ten hoops around the cylinder in the same positions with reference to the ends that were occupied by the first or inside hoops. It might be well to have the ten strips project 4in. or 5in. beyond the hoops at the speculum end of the tube. Then the speculum and cell can be pushed up a little way into the tube, and the projections can serve as feet for the tube to stand on, without any weight coming on the cell. The 2ft. stretch which is without hoops can be strengthened by parts of hoops halfway between the hoops that are 2ft. apart, so long as two apertures on opposite sides of the tube are left for the removal of the speculum-cover. The strips of wood should be left a little further asunder at those parts, as the cover will require considerable room. The strips which are required to be used for sustaining the mirror and cell may be reinforced by other strips nailed to them. The circumference of the tube at the point where it will revolve in the cradle should be sheeted around with thin galvanised iron, in order to enable the tube to revolve with ease. My cradle is 2ft. in length, and the sheeted part of the tube extends 2ft. to correspond with the cradle's length. The remainder of the tube may or may not be closed in. Oilcloth will do to cover it. Mine is left open. The remainder of the mounting follows quite closely the mounting described by me in your issue of February 5, 1909. A flange is made of gauge 20 sheet iron projecting about 2in. around the tube at the point where the part of the tube remote from the mirror rests on the end of the cradle. This prevents the tube slipping through the cradle. That flange is secured to the tube by a couple of extra hoops. Its presence enables the cradle to be loosened a little to allow the tube to be revolved. This is the lightest in weight kind of tube that can possibly be devised, and is very convenient besides. The total cost of my 15in. mirror, tube, and mountings is about 30s.

The light-gathering power of this instrument is wonderful. The moon and Jupiter are almost inconceivably wonderful sights. The instrument is considerably more difficult to manage than a 6in. reflector, but is a most useful addition to the observatory. It seems to me that not much advantage is gained by an amateur observer in proceeding beyond a 15in. aperture. That aperture can keep him busy the rest of his life.

A. R. Hassard, B.C.L., Barrister, etc.
9, North-st., Toronto, Canada, June 7, 1909.



MY TELESCOPES.

[202.]—Enclosed is a photograph showing my telescopes. There are a 2in. and a 4in. refractor, and a 6in. and a 15in. reflector, mounted, while standing erect is the tube of the 9½in. reflector, which I also use. The view shows my father standing looking through the 4in. refractor. Most of your instrument-makers seem to produce instruments of unrivalled excellence, so it will not be very interesting to them to know that mine are by no means perfect. The 6in. reflector performs splendidly; I resilvered it the night before last. It had retained its former coat since last New Year's, but the coat was not very good originally, so I resilvered it. With powers up to about 320 the moon looks very interesting, while with powers a little lower, it is very good indeed. Last night the air was steady and the sky was clear, and with power of about 80 the moon was very white, and the terminator glittered like a ridge of broken ice. Saturn, not far away, was clear, and its satellite Titan was easy to hold in view. Its other satellites were not discernible, partly because of the nearness of the moon, and partly, I suppose, because of the aperture. I think in the 6in., with its old coat of silver, I have glimpsed two or three other satellites of Saturn. Possibly I am not a very good observer; but I can make out no definite markings on Mars. I can see quite distinctly a dark central area on the planet, but cannot attempt to give it outline. My 15in. reflector is not doing very good work. There seems to be a kind of wavering secondary image around the principal image; this I noticed chiefly in the case of Saturn. I did think that there might be some defect in the centring of the mirrors, and found that a re-adjustment effected a slight improvement, but not sufficient. I may make a further attempt at readjustment. It may, too, be flexure, because the mirror is only about one and one-eight inches thick; but for a number of reasons, which seem to be safe, I am rather prepared to discard the flexure theory. Of course, I may be wrong, but shall look into the matter carefully before concluding. I have a splendid coating of silver on the 15in. The weight, or counterpoise, of the 15in. is made very simply. A square wooden box made of pine boards 1in. thick, 15in. long, and about 7in. wide, is made, and through one end of it is bored a hole about 3in. in diameter. Through this hole a piece of oak, cylindrical in shape, and large enough to enter the hole, and about 3ft. or 3ft. 6in. long, is inserted, until it passes up even with the other end of the box, which is open. Then the box is filled with concrete, made of cement one part, sand two or three parts, well mixed up with water. In a couple of days it will have set, and the whole will make a most effective and rather inexpensive weight. The projecting end of the oak stick enters the equatorial axis, and is held there by two set-screws or bolts. I made the smaller weight for the 6in. in the same manner, except that the cement in that case is enclosed in a tin can—one that held paint, I think it was. The square box at the foot of the tripod belonging to the 2in. refractor is the dish in which I have been in the habit of silvering the 9½in. mirror. I have made a larger dish of wood, lines with wax for the 15in. The 6in. I silvered in a table-dish belonging to my sister. A little bichromate of potash in solution readily cleared it to her satisfaction again.

Last night, about 8.55, I saw Mars occulted by the moon. I was away from home at the time—in fact, on the deck of a steamboat, and witnessed it with the naked eye. Several of us watched the occultation, or, at least, traced the planet up very close to the edge of the moon. A radiance round the moon seemed at last to merge the planet in its brightness; but when last that I could say that I could distinctly define the planet, it was very close to the edge of the moon. There was some motion of the boat, of course; but the water was quite calm, and it is just possible that I actually saw the occultation, but would not care to say that I actually did. The moon has been very bright during the past few nights; but on Monday night the atmosphere seemed to boil in front of the moon, so much so that the 6in. readily showed about all that could be seen. With larger apertures the moon danced most unsatisfactorily, and waves of air roved over and around it constantly.

A. R. Hassard, B.C.L., Barrister, etc.
9, North-street, Toronto, Canada, Sept. 2.

base (except unity), and multiplying it by itself continuously, a series of powers are obtained, n^1, n^2, n^3, n^4, n^5, and so on, which are shown upon our slide-rule by equal spaces. The nearer this number (n) is to unity the smaller will be our spaces, and the larger the number the greater the spaces. We may also consider the case of unity itself divided or multiplied continuously, and this appears to offer a more convenient form for comparison with astronomical phenomena, one-eighth, one-quarter, one-half, one, two, four, eight revolutions about the sun; of the moon, or of the earth on its axis, are upon the slide-rule shown represented successively one after the other by an equal space. If, then, in place of multiplying continuously by two we choose some other number as base which is but slightly in excess of unity ($n + x$, or its reciprocal, $1/n + x$), we have a natural base which can be applied with precision.

These would only become *true* logarithms according to our definition given above when x was demonstrated to be an *integral* power of n.

To take a simple instance, let n = the mean sidereal day, $n + x$ = mean solar day; then, when $n = 1$, $n + x = 366.25 / 365.25$ = (according to Herschel, "Outlines Ast." § 911) 1.00273791. Here at once we have an approximate base which does not differ far from the base known as E (2.71828).

It may be argued, with justice, that the attempt has been made above to transplant on to astronomical phenomena a logarithmic base which is not natural to them. Referring to a mass of papers I have on the subject, I offer the following as one single example which needs further elucidation by others whose mathematics is more extensive than my own.

Number.	Period.	Com. log.
1. 3,232.57 M. S. days..	= rev. ☽ apogee =	3.5095
2. 27.321 M. S. days..	= rev. Moon .. =	1.4365
3. 4,332.8 M. S. days..	= rev. Jupiter.. =	3.6367
4. 366.25 sidereal days	= year ..... =	2.5637
Log. difference between 1 and 2	.....	2.0730
" " " 3 and 4	.....	1.0730
" sum of 2 and 3	.....	5.0732
" " 1 and 4	.....	6.0732

It will be noticed that 2 is the reciprocal of 4 (and add to this that 29.53 is the log. of 365.25). Another and, perhaps, better example of the natural logarithmic phenomena of the planetary motions may be obtained from the following:—

6,965 sid. revs. ☽..	= 190,295.37 M. S. days
6,444 lunations....	= 190,295.11 M. S. days
521 years.....	= 190,295.25 M. S. days
549 syn. rev. ☽ ☌	= 190,294.38 M. S. days
28 rev. ☽ ☌....	= 190,214.94 M. S. days
521 years.....	= 190,816.25 sidereal days

(It will be noticed that 10 lunations has become a logarithm to three places of figures.)

$$521 + 28 = 549, \quad 521 + 6{,}444 = 6{,}965,$$
$$190{,}294 \div 7 \text{ (4 revs. ☽ ☌)} = 27{,}184.8.$$

It therefore follows that in 27182.818 M.S. days, about one-seventh of the above figures may be taken as accurate, and the above figures appear to bring about an eclipse of the moon in almost the same place on the Ecliptic every 521 years. It will be interesting to learn *in which part* of the Ecliptic there is the most alteration in this period.

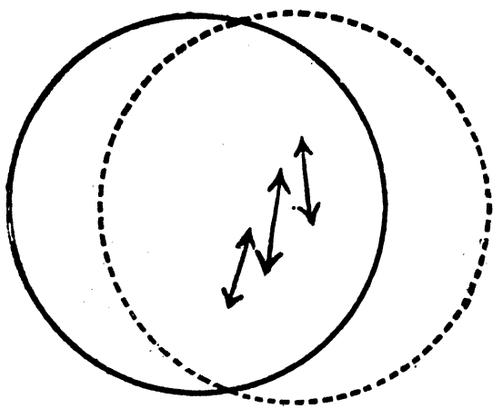
Before I finally close, I should like to mention that the above problem plays no little part in that of determining the actinity of light. I think I am safe in saying that the one problem is inherently inseparable from the other.

English Mechanic.

GRINDING SPECULA.

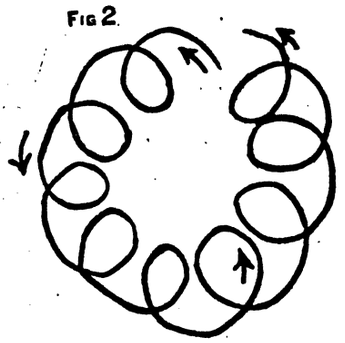
[153.]—When I first made my 15in. reflecting telescope, its focal length was 120in., or 8in. focal length to 1in. of aperture. It required a tube 10ft. long, and in practice this proved quite unwieldy. Most of the time the observer required to be standing on boxes or other supports; and, in addition, the vibration was quite excessive. Upon reflection, it seemed wise to reduce the focal length, and about seven weeks ago I proceeded to accomplish this. The tool on which I had ground the speculum was still available, and I began the reconstruction of the glass. I procured half a pound of each of No. 30, No. 80, and No. 120 carborundum, and a pound of flour grade. I used the entire pound of No. 30, and but a small quantity of the other grades. The washings I saved, and kept carefully the fine white dust which accumulated occasionally on the surfaces of the glasses. This was used at the finishing of the fine grinding. The coarse regrinding and fine grinding were accomplished in about seven or eight hours, and upon test the focal length appeared to be close upon 96in. This makes the proportion of aperture to focal length as one to six and two-fifths. The great 60in. mirror recently ground at Mount Wilson solar observatory has a focal length of 299in., the proportions being as one to five. There was nothing very noticeable about the regrinding that seemed to be of much importance, except that I finished with scarcely a scratch on the surface. I could read fairly large print through the glass with the ground surface remote from the printing, and the ground surface when complete would reflect the light of a coal-oil lamp at an angle of about 20°. Then I proceeded to polish the mirror, making the polisher as I have frequently described in this journal, and coating its surface liberally with beeswax. Here is a partial history of the polishing. On Monday, July 5, 1909, I began it at about 9.10 p.m. After ten minutes of polishing, using short, straight strokes, a slight polish appeared all around the outer circumference of about 1½in. It was necessary to quit work then, and on Tuesday, July 6, I began about 6.45 a.m., and in fifteen minutes, after 1,000 or 1,200 double strokes, a good polish was visible in the outer 2½in. of the speculum. Twelve hundred double strokes more increased that polish about 1in., and the test indicated a slightly mounded centre, although this was hard to tell, because of the large area that remained unpolished in the centre. At 8 a.m. I ceased work. That same evening I worked from 7 to 8.30 p.m. I first gave the mirror 1,500 double

FIG 1



Dotted Line Represents Mirror; Heavy Line Outlines the Polisher.

FIG 2.



strokes, and found the polish around the circumference becoming excellent, but not going in any further. Then I made a change in the method of polishing. I made the strokes as in Figure 1, the mirror always overhanging the polisher by a good one-third, and the strokes being in the direction of the arrows. Figure 2 then shows the actual path of the mirror's circumference around the polisher, the circumference travelling in the direction of the arrows. These spiral movements I gave to the number first of 100, then 100 double straight strokes, then 500 more straight strokes, then 100 double spiral strokes, and then tested. This time the centre was found to be taking the polish; so, feeling sure that the cause of the central polish was in the spiral strokes, I gave the mirror 1,000 more double spiral strokes, as illustrated, and found the centre becoming improved and growing clearer. The test indicated a close approach to the sphere with a raised edge of about 1in. in extent. These strokes were all short—about 1½in. long—and the finish of the fine grinding was done with strokes of about the same length. On Wednesday, July 7, I worked from 7.30 until about 8.45 a.m., giving the mirror during that time about 3,000 double spiral strokes. This brought the polish into within a couple of inches of the centre, and the test showed a 1in. elevation at the circumference and a mound in the centre gradually sloping out towards the outer part. I should have said that about one hour of the polishing just mentioned was done in the evening. The next morning, Thursday morning, July 8, saw me working from 7 until 8 o'clock. The strokes were still all spiral, the overhanging part now being reduced to about a quarter of the diameter of the mirror. I gave the mirror about 3,000 double strokes, and the test showed the mirror to be not far from the sphere; the shadows were all very delicate, and the central hitherto unpolished part was becoming clear. The outer edge was still raised, and seemed to be growing worse, for its focus was about 3in. shorter than the remainder of the mirror. Apart from that, the focal lengths of the mirror were nearly right, the outer part having a focal measurement of about ¼in. longer than the inner part of the mirror. This does not take into consideration the extreme centre, for a hill remained there until nearly the end. For a mirror of this aperture and focal length the aberration is about a thid of an inch—a little less than this, .29, is about the correct measurement—that is to say, the rays from the centre of the mirror should be about .29 of an inch shorter than the rays from the circumference, and the slope of the intermediate part should be gradual. That evening I worked about half an hour, giving the mirror about 1,000 double spiral strokes; the centre was then nearly clear. One hour the following night effected an improvement of the surface with 2,000 double strokes, all spiral. On Friday and Saturday, July 9 and 10, I gave the mirror about 7,500 double strokes, all spiral, long before which was done the centre was clear, and the surface otherwise was becoming quite fine. There were still a number of tiny specks to be polished out, and the test indicated the mirror to be slightly oblate spheroid in surface. This about completed the polishing, although some further work took out the minute specks; and then I had some trouble with rings. They seemed to come in without any reason, and there was no rhyme about them, I am sure. They were not very deep, but whenever they appeared I chipped away the polisher in places where they seemed to fix their habitation, and in odd hours and half-hours of time I had the mirror about done on the evening of the last day of July. There are still some shadows on the surface that ought not to be there, but they are not very dangerous, and the test shows a fair approach to the parabolic surface. The history of the figuring I did not commit to writing as it proceeded, and while I had nearly every kind of ring on the surface of the mirror before it was done, still they were not very deep or high, and the result leaves a mirror with a good surface. With the unsilvered mirror I could see in rather poor air Gamma Arietis as a quite widely separated double, although this is not much of a test. I shall silver the mirror soon, and shall then be able better to test its performance. The glass is only 1¼in. thick, but I have no sign of flexure whatever. Draper's 1in. mirror of 15½in. aperture did show marked flexure, but his mirror was supported in rather a curious manner. The support by means of two ¾in. or 1in. boards nailed cross-grained is not likely to result in much trouble from flexure.

With this reduction of focal length to 8ft. from 10ft., I have been enabled to cut off 2ft. from the length of the tube, and it is now only 8ft. long, and is very handy and much more convenient than it was before. I have enlarged my flat mirror, and it is now 2½in. by 3½in. in area

expectedly appear is that rouge, however moist, cannot but have a tendency to accumulate more in some places than in others, and although all kinds of motions are given to the mirror and polisher to attempt to avoid this, still it frequently does occur. However, we silvered the mirror as it was, and Mr. Wallace has been using it ever since. There are a few very tiny stray appendages to bright stars; but nothing to give any troublesome annoyance. The instrument containing this mirror will give very gratifying performances. With powers up to about 175, the moon looked excellent. We had at hand on a night when we tried the instrument one higher power eyepiece; but it was not possible to use it then. Mr. Wallace is very satisfied at the result of his first endeavours, and is proposing to make a machine for grinding, polishing, and figuring a mirror of 12in. in diameter.

Saturn presents splendid views these nights, although the atmosphere has been very unsteady, and occasionally moist. On the 4th inst. I could hold in the 9½in. three satellites, and possibly a fourth. Japetus (if visible) was lost in a multitude of other stars. The air that night was far from perfect, and the city lights were not helpful.

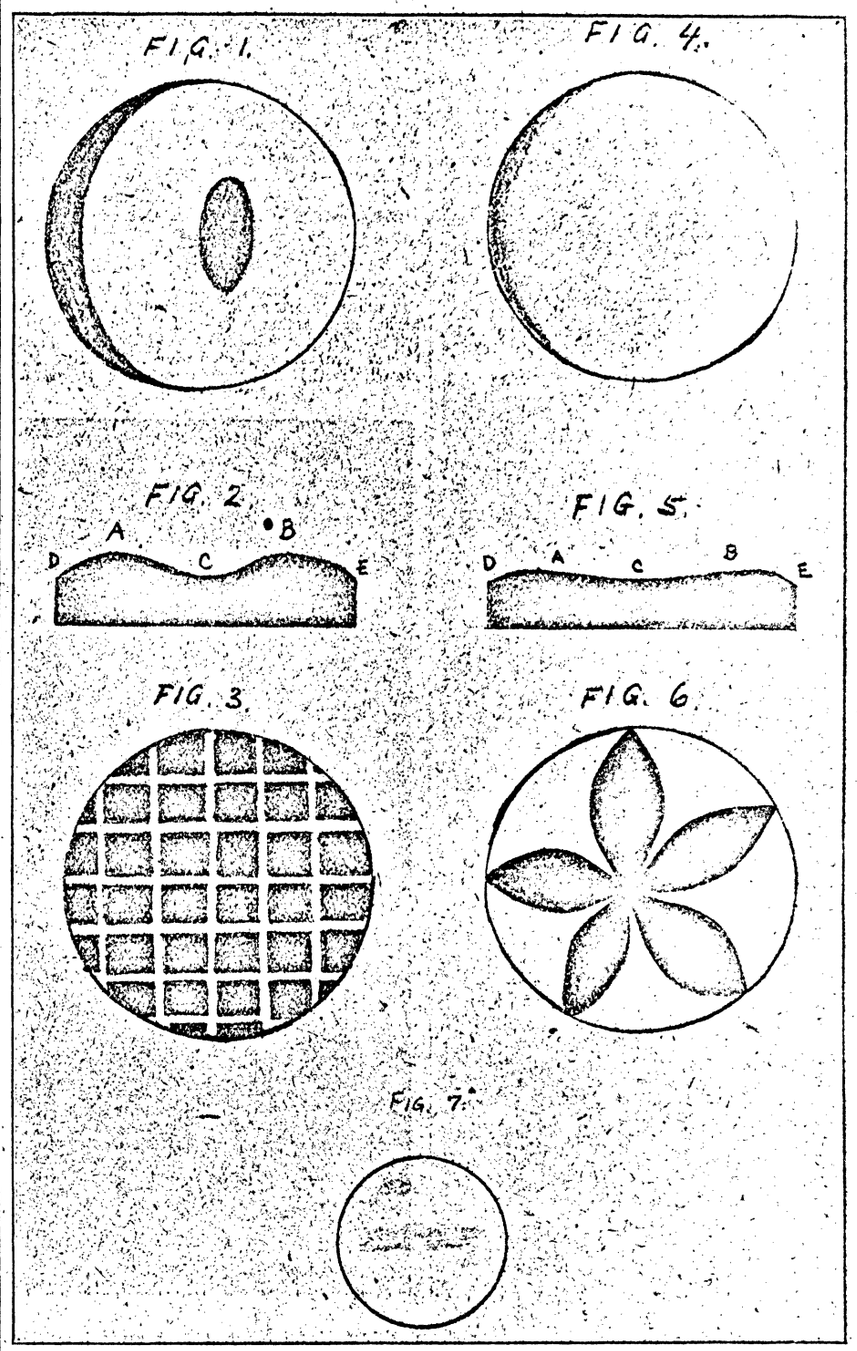
Mars last night presented the appearance shown in Fig. 7. That was at 11.30 p.m.

On Saturday afternoon, Sept. 26, 1909, at 5 p.m., I saw two rainbows, one inside the other, and removed from it by a considerable distance. The violet was at the inside of the one rainbow, and on the outside of the other. The larger one had a diameter of about 90° of sky; the smaller one about 60°.

A. R. Hassard, B.C.L., Barrister.
9, North-street, Toronto, Canada, Oct. 8.

A SEVEN-INCH REFLECTOR.

[331.]—It seems, from the few inquiries now being made regarding the manufacture of mirrors for reflecting telescopes, that all inquirers have been supplied with wisdom, and that most manufacturing astronomers have learned how to construct their instruments. There may be a few left who are a little too timid to ask for information. For any who desire a little addition to their knowledge, I venture to describe briefly how a friend, Mr. R. M. Wallace, of this city, and I made for him a 7in. reflector. Many amateurs suggest beginning with a 6in.; but a 7in. is not much more trouble to make than a 6in., and it is about one-third more effective than the 6in. Consequently, we decided on making the 7in. instrument. I procured the two pieces of glass, the tool being ¼in. in thickness, and the mirror ⅜in. It would have been as well, or a little better possibly, to have had it a little thicker; but never having been bothered with flexure, I decided on ⅜in. as a safe thickness. The tool I had made ½in. smaller in circumference than the mirror. I did the grinding with carborundum in about 2½ or 3 hours, and brought the mirror to a very fine surface, at which light would reflect at an angle of about 20°. The principal point in the grinding is to get rid of the small holes in the glass. A few stray holes often take more time to get rid of than the rest of the grinding. I watched the glass carefully in proceeding from fineness to greater fineness of carborundum, and exterminated the very last of the small holes, and secured a finish which left little to be desired. The last finishing of the fine-grinding was done with the white dust taken off the surfaces of the tool and the mirror, and brought to the required fineness by water in the customary way. Then I handed the mirror over to Mr. Wallace to polish and correct. He had never had any experience with mirrors whatever, although he has ground by hand many lenses in his spare moments—one lens being 6in. in diameter, and almost flawless. He made a polisher like Fig. 3, except that it was considerably larger than the mirror, being possibly about 9in. in diameter, while the mirror was but 7in. The polisher was made of ordinary pitch, and the surface was coated well with beeswax. About four hours brought the mirror to a very good polish, although around the edge was not so well polished as the central part; still, the central 6in. were very good. The focal length, I might mention, is 66in. The test showed the mirror to be quite hyperbolic, and although some may criticise the accompanying drawings, and say, as has been said before, that the shadows are too dark, there is no mistaking the fact that the shadows were not only dark, but as black as the night the Plague of Darkness fell on Egypt. Fig. 1 shows the mirror as it then appeared under the Foucault test; and Fig. 2 shows the faults in the mirror requiring correction. The mounds A and B (Fig. 2) required reduction until they were nearly (but not quite) down to the levels of C, D, and E. The mirror, it will be seen, required great action at the spots A and B, midway between the centre and the circumference, but no action at C, D, and E. This was accomplished by making the polisher to resemble Fig. 6, in which will be observed the centre of the five leaves is slightly removed from the centre of the polisher. This is to prevent rings appearing on the surface of the mirror. Just as at the close of the fine-grinding, so now, the movement of the mirror over the polisher was in very short, but straight, strokes, and in about four or five hours the surface of the mirror was brought to such a condition that under test it appeared as in Fig. 4, a section of which appears at Fig. 5. It will be seen that further correction at A and B was necessary to make the mirror perfectly spherical. But, as often occurs, a mirror with a surface like Fig. 4 will change without apparent reason and become covered with rings or other irregularities, and as Mr. Wallace was anxious to begin using the glass as soon as possible, we decided to cease work upon it. Others may not, but I do, pronounce a mirror showing the features reproduced in Fig. 4 to be a fairly good mirror. Let it not be understood that my voice is for less than perfection; but many cannot spare the time for attaining perfection, and others have not the skill, and even the best of us, in aiming at perfection, will often come far below it. If the mirror, having reached the degree of perfection shown in Fig. 4, had been polished further, it might have become perfect or have acquired rings which might have taken weeks to eliminate, and the chances are much in favour of the rings. A great reason why the rings un-



and is elliptical in shape. It is about 7ft. from the surface of the mirror. It takes in the whole image of the sun.

Dr. Blacklock's letter containing some comments on a recent letter of mine published in this paper was quite interesting. I have a number of old volumes of the "E.M.," and some of his letters written about thirty years ago have been quite helpful. A series of his letters on testing mirrors were perused by me about a year ago with much interest. One thing about him I do not like, and that is his long silences. Sometimes for years he says scarcely anything. I regard this as a great misfortune when he has all the learning that a wide experience can give. He generally has something to say that is not mere repetition.

A simple test in connection with the silvering may be helpful. When all is ready except the addition of the reducing solution, I put a little of the other liquid in a small vessel, usually an ordinary saucer, and take a small piece of glass and proceed to silver it. Generally this small piece of glass is a flat mirror, which may be wanting a new coat of silver, but any small piece of glass will do. Proceed to silver it by laying it face-down in the saucer—usually the saucer is concaved sufficiently to enable this to be done by merely immersing the piece of glass, which will touch at its corners or edge only—and into the ammoniated nitrate of silver solution pour a few drops of the reducing solution. Either the small mirror will become coated with silver or it will not. If not, search for the trouble, and rectify it; if it will, then the large mirror may be proceeded with to completion.

A. R. Hassard, B.C.L., Barrister-at-Law.
9, North-street, Toronto, Canada, Aug. 18.

OBJECT-GLASS WORKING—TELESCOPE-MAKING.

[154.]—Like "O. P.," p. 376, No. 2304, I have spent some years specula-working by hand and machine, and now have a desire to try my hand at a lens. Although I cannot claim longer than 14 years as a regular subscriber to "Ours," its value is so patent that I have always added any back volumes that have come my way, with the result that I have about 45 vols., and amongst them those very interesting articles by "Prismatique." What I would like to know is this—Would the formulæ given in those articles for the radii of the curves of an o.g. be sufficient for sizes up to, say, 3in.? I have procured several pairs of discs from Chance, the refractive indices for D of which are hard crown 1.5156, dense flint 1.6191, and for V 60.3 and 36.2 respectively. Perhaps Mr. Linscott, or some other kind expert, would give curves suitable for these glasses, say, the proportions approximately as given by "Prismatique." I have no doubt your valued correspondent, Mr. Linscott, would know where to find "Prismatique's" article, but I am writing this away from my volumes of "Ours," and cannot give references to those articles. I have had some tools cast, and was just about to turn them up, but have decided to wait in hopes of getting some reliable data, as when once the tools are well formed, it seems a pity to have to alter them. I have constructed a grinding bench to run off my lathe worked by water-wheel, so hope to spend many a quiet hour at this interesting hobby. I find some say the tools should be—for finishing—the same size as the glasses;—is this the opinion of later workers?

If the same contributors would favour us with a few hints on the mounting, it would be a great help. I have a 4in. centre screw-cutting lathe, and would like to know methods adopted of chucking the fine tube lengths for the eyepieces, the methods derived from experience, of working the cells, and setting the lenses. Thanking your kind contributors in anticipation from far-away New Zealand. N. Z.

"A.'s" LETTERS—MIRROR-MAKING.

[155.]—The May numbers of the dear old "E.M." are just to hand, and out here, in New Zealand, they are eagerly looked for, and the first perusal of each (monthly) part is one of the events held in joyful anticipation. I would like to add my small quota in appreciation of "A.'s" letters, which have given great pleasure, and profit, to many in these parts, and I quite agree with Mr. Longbottom (264), and I am sure, from what I have heard from several readers in different parts of New Zealand, that if "A." collected his letters later into book-form, they would be valued by a very large number of readers who would, as Mr. Longbottom says, like to put them amongst the few books to which they love to turn.

I have been much interested in the letters on mirror-working from Messrs. Mellish and A. R. Hassard, and would feel like suggesting to the latter gentleman a more extended search in the back numbers of the "E.M." before he says, at any rate, of "Ours," that "an extensive perusal . . . . fails to give much information that is of assistance." It seems to me that in the articles by Wassall, Blacklock, Ainslie, and others, there is sufficient to put anyone on the right way to make good mirrors if these works are properly studied. I have done a little at it myself, having ground and polished nearly a dozen in all, ranging from 6—14in. diam. I have never yet got quite a perfect mirror, but all of them are very close. On 12in. I have used a power of 600 on Mars, and as one who was at the eyepiece said, "It is like a map," and as such, it was sharp all over, and the areas of the various parts bounded by good, clean divisions. I have been greatly indebted to another valuable correspondent of "Ours." I refer to Mr. C. A. Lowe, whose good-nature led him to write me privately quite a compendium on the subject.

As Mr. Ellison rightly observes, Mr. Hassard's sketches show altogether too heavy shadows for good mirrors of the focal lengths given. My experience leads me to look for just a faint blur on the surface-edge and central, or rather to one side of centre, not anything nearly so hard as shown on p. 303 in the April 30 issue. There is one point I noted in these sketches—in Fig. 7. The mirror appears to have approached fairly closely to a good figure, but has a rather heavy dig-in at the edge as the shadow here—moving against the screen or shutter at "*h*" proves this part to be of much shorter radius, and yet Mr. H. tells us he is about to cut away the outer portion of his polisher. What I would do here would be to work a very short stroke with the full-sized polisher which would rub down the edge slightly, but one requires to watch this carefully, as it may easily turn to a flat-edge, or the dreaded "turn-down." While on this sub-subject I would like to draw attention to the dearth of information available on the testing of mirrors in the telescope tube, and on the stars. "Prismatique," in his admirable articles on the working of the object-glass, refers us to the star test, and to the diffraction rings as being the searching test for each zone; but I do not remember one amongst all those who have written on the subject, describing clearly the in-and-out of focus appearances seen as a result of testing on a bright star. Many there are who write of perfect round points of stars, and what they have divided, but none have drawn the diffraction rings as seen on one or both sides of the true focal point. It would be interesting if several of your valued correspondents would do this. I was very glad indeed to see our old correspondent, Dr. Woolsey Blacklock's letter in No. 2305. I wish we saw more of him. I have got my larger discs from Messrs. Chance, of Birmingham, who make discs of good, clean metal ground flat each side and roughly to a circle at very moderate prices. Can any of your readers inform me whether washed carborundum can be bought in London? But there, I forget—this is a matter for the inquiry column. N. Z.

THE WEATHER IN AUGUST.

[156.]—Rainfall and temperature at my meteorological stations were:—

RAINFALL.

Station.	Total Fall.	Greatest Fall in 24 hours.	Number of Rain days.
Clapham Park....	1.64in.	0.44in.*	10
Tunbridge Wells..	2.80in.	0.78in.†	11
Stow-on-the-Wold	2.75in.	0.85in.§	14

*17th and 24th. †17th, 0.74 on the 24th. §17th.

TEMPERATURE.

Station.	Max.	Min.	Dates.
Tunbridge Wells..	81°	43°	12th & 3rd
Stow-on-the-Wold	79°	41°	12th & 22nd

At Clapham Park from the 2nd to the 15th there was an absolute drought; but this, the only fine fortnight of a wretched summer, was broken both at Stow and Tunbridge Wells by small intermediate falls. F.R.Met.Soc.

ELECTRIC TIME TRANSMITTERS.

[157.]—In reply to "Timer's letter (No. 120), as the writer had always closely followed the progress of electric clocks, he in consequence was enabled to be ahead of him, having met with a transmitter which effected the automatic battery warning, and which could not stop on contact, the year previous to that mentioned by him. The patent number of this transmitter is 24620/1904. A warning bell, designed by the same makers, was discussed at some length in these pages during the following summer, and, judging from the correspondence, created a deal of interest.

May I say how surprised I am to note "Timer's" rash statement regarding the total number of parts of the make of transmitter described in your issue of the 30th? I am well acquainted with the make he refers to, and can count well above 100 separate and distinct parts. The magnet-mounting and armature, for instance, contain over thirty distinct and separate parts, which at once absorbs the greater part of the number stated by him.

There are two home transmitters in operation at Plymouth which I have had an opportunity of inspecting, and I do not see any marked difference in the number of parts contained in them and the make of subsequent date referred to by "Timer." The number of moving parts is identical. W. Plymouth.

[158.]—Being interested in the above, and familiar with the type described in your issue of April 30, I was surprised to see in "Timer's letter (No. 120) that the total number of parts, counting all screws and washers, in the instrument referred to by him did not exceed fifty. My curiosity prompted me to make reference to an illustration taken from a recent price-list, and I could easily distinguish more than twice that number. I trust that "Timer" will excuse me for pointing out this error.

C. W. S. Banbury.

A CURIOUS TRIAL.

[159.]—As one of the "others," I am afraid I cannot follow "Treadle's" explanations. In the first case, supposing the weights used came along from some town in the South; the gold-dust, when weighed the second time, would be weighed with similar weights, which is equivalent to using the same weights. Then, in the case of a weighing machine being used, if weights of any sort were used in counterpoise, their very small loss, or gain, would not be negligible, as it would act in proportion to the (relatively) large loss, or gain, of the gold. For an explanation—as far as I can see—the spring balance is the only chance.

The newspaper-cutting is certainly interesting, and, I can assure "Treadle" that the weak point is very unlikely to strike one, unless by chance. I readily believe what he says about the leg-pulling. Jaybird.

FIVE-FIGURE LOGARITHMS.

[160.]—Several months ago there was some correspondence in the pages of "Ours" with regard to five-figure logarithm tables. I do not remember those of Dr. Gausz being mentioned. I found that the book was unprocurable in the United Kingdom, and had to send to the United States for a copy, through a well-known bookseller in the Strand. It is a favourite log-book there, and is very complete, having the trigonometrical functions of angles for the first and last degrees of the quadrant to single seconds, with p.p. for decimals; to 10", with p.p. for single seconds, for the next and previous 6°; and to minutes, with p.p. for seconds, for the remainder. The price is the absurdly small one of 1s. 9d. net in London. It is a German book, and the "Vorwort zur Sechsten Auflage" is dated 1895, though the title-page is dated 1908.

H. C. L.

STEAM CARS.

[161.]—If "Faber" (letter 106) is the same that used to contribute to "Ours" some eight or nine years ago, then I am very pleased to again see his name in the "E.M."

I was conversant with the engine "Faber" mentions some time ago, before the details were published in the technical journals. The design in general is good, and although little effective work can be done by the steam after leaving the h.p. cylinder and undergoing such an enormous expansion, the l.p. cylinders act as powerful allies to the condenser, and if, as in the White steam car, when running on the level, a vacuum is obtained in the condenser, the l.p. cylinder would contribute a considerable amount of power. So long as four h.p. cylinders are retained, the idea of compounding an engine of the Serpollet type (for that is what the Lowca engine really is) is a good one. I have often thought of adding a pair of l.p. cylinders to a Serpollet engine, to see what results would be given, but have never had the time. The power given by this engine is interesting to "Faber," no doubt, as I believe that he brought the first 5H.P. Serpollet car to this country, and the four cylinders of this car were practically the same size as the Lowca engine—viz., 50mm.

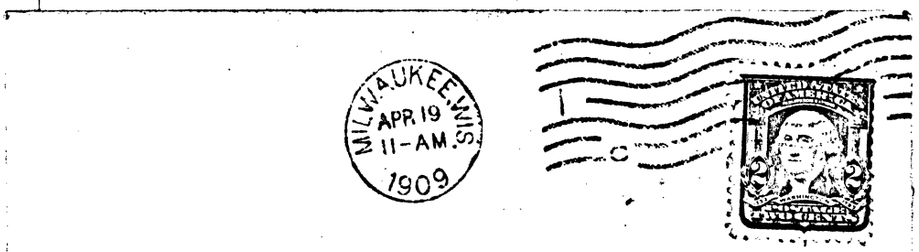
170

MAY 3 1909

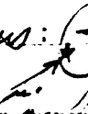
Milwaukee April 29 1909.

Dear Mr. Hazard:

Your letter found my mirror at the 3 minute emery. It looks too good to go back to rough-grinding. Fine emery has but little effect. What would be your reason for shortening the focus? So far as I can see, it would make the instrument lighter, somewhat easier to manage, that's all. As it is now, it will take high powers more easily than if it had a short focus, although I am afraid this does not count for much, as the air will seldom be steady with so large an aperture, even with the low powers. (I just went down to turn off the 3 minute emery) I wanted 10 feet, and have a few inches over 11. Some of my friends were overjoyed when they heard of this. They say that it will make the instrument appear more like a giant telescope than ever. It will be pretty high up I know. Still, eleven feet is not so bad. Consider Mr. Ellis's 8½ inch which has a focus of 8 feet. He never off the ground all the time using his. I done the roughing with 2 lbs. No. 30 carborundum in 4 to 5 hours. I don't know how many hours I have been at it. I was too interested in the work to keep track of the time



Mr. A. R. Hazard,
Confederation Life Building,
Toronto, Canada.

After I have used the 60 minute emery I'll begin polishing. I'll make the polisher of a wooden disk, so that I won't have to pour the pitch on the tool, which is only ¼ in. thick. I just finished a ½ in. eyepiece for Van Sco Holcomb, who has a 10 in. mirror. I make the best grade only, instead of making two kinds, as I have been doing. My price for an eyepiece is now $3.50. I don't know how the eyepieces of the other makers are, Brashear, Bausch & Lomb, and others, but I know how mine are, and I don't see how any eyepiece can be better. When Mr. Mellish was here, we put on the ⅖ in. giving power 160 and we separated the double star γ Coronæ without difficulty. The stars are 0".9 apart. I have also separated the double star μ² Bootis with the same power, the two stars being only 0".7 apart, thus:  Try them with your telescopes. My 8 in. showed μ² Bootis and the clusters 13 M, 92 M, and 5 M splendidly showing seperate stars in the clusters very distinctly. In fact, my 8 in. now suits me very well, so I'll take my time with the 14 in. It has one scratch on it, and about 6 pits are

distributed over the surface; the scratch is about 1 in. long and looks like a white hair lying on the glass. I'm glad it's no worse. The glass is just 1½ in. thick and exactly 14 inches in diameter. I will be well satisfied with 13½ in. aperture of perfect curve. Does your curve go clear to the edge? (My cell (the mirror's) will be made of hardwood boards 2 in. wide, 7/8 thick, glued and screwed together, and then cut circular. A friend of mine has a band-saw, and he has agreed to do this for me.  I am going to make it as you described it, so that it will go inside the tube.

A wrecking concern in Chicago wants $10 for a smoke-stack 16 in. diameter, 15 ft. long, 14 gauge. I don't want it.

I am sending some of my lenses. The reason I make them meniscus is that they are then more achromatic than a double or plano-convex. Also they have a flatter field.

Anything will do for a finder if it has cross-wires in the eyepiece. My 8 in. finder is a 2 in. achromatic, 12 in. focus, and a nice little thing it is. It magnifies 12 diameters.

Dear Mr. Hazard. April. 17. 1909.

[in margin] gelund! Are you out of writing paper? I am already hunting every clear bit of paper 4 letterwriting. Sure I'll use the margins of newspapers to write letters on. Many thanks for the history of your 15 inch. It is very interesting and contains many valuable pointers. far too good for those over the sea, Mr. Ellison in particular, who should keep his thoughts more 2 himself. My 14 in. hasn't materialized yet. My friend received a postal from the glass company that has the order stating the disk broke during edging. I have made a [illegible] ground the edge, and it is [illegible] I have also ground a 7 in. mirror for [illegible] time and

I will perhaps make a 3in. finder, of 18in. focus for the 14 inch. It is not neccessary to have so large a one, but I have the objective, all that's needed is to change the front curve a little, so as to get the focus shorter.
How will you silver your big one? I have thought of making a circular wooden box 2in. deep, made by sawing out some boards nailed together with the grain crossed, and fastening these down to some more boards, so as to make a shallow box. Have three little blocks set inside for the edge of the mirror to rest on, and then let it go [redacted]. The inside could be coated with plaster of Paris. I am somewhat tired now, so I'll stop, and go to bed. Write soon again, and tell me how the Moon and Jupiter show with your monster.

Very sincerely yours
Arthur Drake

(I forgot the one inch margin.)

I am out of paper.

FORM 71.

MAY 10 1909

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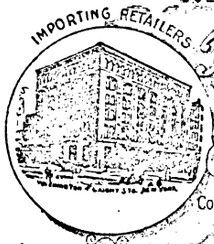

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Mr. A. R. Hassard
Confederation Life Building
Toronto,
Canada

May 7, 1909

Mr. G. K. Hastard
Toronto, Canada

Dear Sir:

I have tried out my glass on Jupiter and the stars, and find that it is imperfect (all this after silvering) and speaking of silvering. my first attemt was a failure, I think due to inexperience in handling the bath and not leaving the speculum in the bath long enough. I used 175 gr. silver the first time, and 200 the last. the second film is very good and strong and the light pash of speculum is every thing that I could wish

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190

The reasons for my failure in reaching the proper curve on speculum. are that I was deciev in the shadow believeing that I had the right appearing shadow as indicating a prabola. I had no suitable eyepiece to test the artificial star at focul point - and this test by the way, in my opinon is indispenceable to an amateur. he cannot be deceived in a true star at the focul point, but can be easily deciseig in shadows appearing on speculum without wide experience

I should have tested speculum on a star before silvering. but I

was to anxious, and my tube was not ready at that time, and also I had no suitable eyepiece. So you see how things go with one when beginning any new undertaking. every thing requires actual experience for perfection.

My glass works very good on the moon. but the moon only. I am going to put it on the polisher again very soon and go forward with the horse hitched at the front of the rig instead of the rear.

Tell me all about how you are getting along with your 15 in.

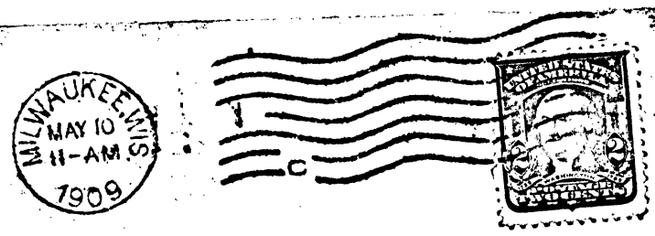
I enjoy speculum making and do not intend to quit with my 10 in.

What is the subscription price of the E M. I want to take it? Write real soon and all about your work.

Very sincerely yours
Leo Foleomy

P.S. I tested speculum after silvering on artificial star with one of Mr Brahls 160 power eyepieces and got this sort of an object at focal point (inside of focus this:) outside-slightly in both cases- this:- I knew then before taking it out-under the blue sky. that every thing was up.

175



Mr. A. R. Hassard,
Confederation Life Bldg.
Toronto, Canada.

Milwaukee, May 10th. 1909.

Dear Mr. Hassard:

I am glad to hear that you have the lenses safe. I didn't send them in my usual way, but my 14 in. demands most of my spare time, so I sent them in a hurry. I ground the largest one out of ordinary plate-glass, to see what kind of a lens it would make. The others are regular optical glass. I hope that you will find some use for them. I also make smaller lenses, which I sell, unmounted, for 50¢ a piece 1/2 in. diameter & under. about to 1/20 in. focus. If you would like to make your own eye-pieces I could furnish the lenses. You ought to use two 1/2 in. focus lenses, combined with the double convex I gave you, and you would have a dandy large-field eyepiece: ◯ for your 5 in; or, they could be somewhat weaker.

I have my tube now, and it is fine. It weighs 77 lb., 22 gauge iron, and is very rigid. Only trouble is, I don't know where to put it. What do you do with your leviathan, when you're through observing? I have almost everything done, the cell, flat-support, and will make a higher post soon. Only the confounded mirror refuses to get finished. It is most obstinate,

Pay tube cost $4.00

the curve is, and I don't know just what to do with it. I inclose a sketch. It is hyperbolic, 12 in. are just splendid with 13 in. aperture a slight haze shows around the artificial star, and 14 in. the full aperture, is useless. What would you do with a curve like this? Does your curve go clear to the edge, or are you using less than 15 in. aperture? This is the first time I am up against it, but, of course the mirror must be made perfect, even if it takes till 1981. I am making the cell like yours, in fact, it is finished and the silvering dish is also done. Calver uses 350 gr. silver on a 12 in. speculum. I'll use 300 on my 14 in. Yes, I still use nitric acid for cleaning the surface, but one time when acid was all I used ~~alcohol~~ alcohol and it worked just the same as if I had used the nitric.

Tell me more about how the Moon and Jupiter look with your big glass. you can't imagine how interested I am. And write soon, tell me what you would do with a curve like my glass has. Getting the proper curve is a most agonizing job.

Very sincerely yours

Arthur Pratt.

Point your telescope at Regulus, in Leo. It has an 8.5 mag. companion, which is double, mags, 8.5, 13. dist. 3"5 tell me if you see it. How does ε Lyrae look now? And 19 Dr, 57 Dr, etc. Accurate work

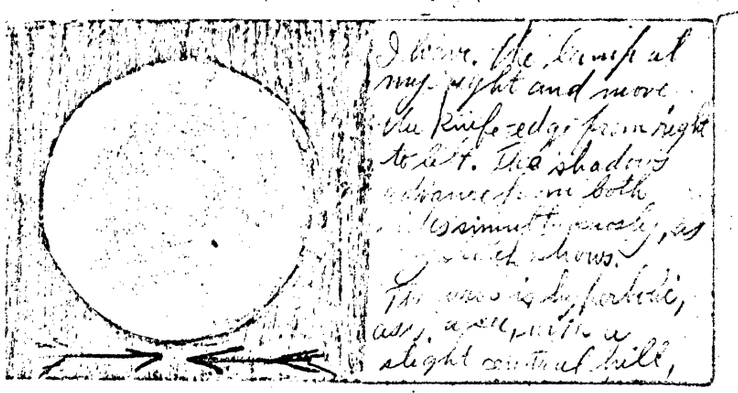
May 12, 1909.

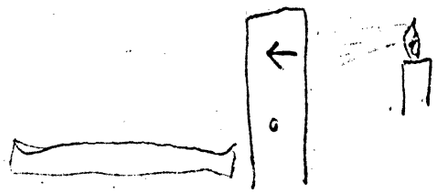
Dear Mr Prahl,

Is it possible that your hyperbola has been caused by the elliptical strokes in the finegrinding? I never have resorted to them. I always kept to the straight strokes, and during the last 3 or 4 grades of the flour emery made the strokes not more than about 1 or 2 inches in length. As you know, I had to go back from nearly a finished polish 4 times; in fact the first time when I had a dandy curve. I have read that a mirror undercorrected is better than one overcorrected, one in which there may be an oblate spheriod but not the hyperbola. I dont think any of my mirrors is hyperbolic. If you will cut off the outer 1 inch of your polisher, and leave it 13 in. in diameter, or indeed 12 inches, with an odd projection running out the full 14 inches so as to keep the full mirror receiving some abrasion, and keep the rouge just barely wet, so that it will be quite hard and a drag to get the mirror to move over the polisher. But be sure the rouge is very free from grit and don't forget the beeswax. That ought to reduce the inner 12 inches and bring them down to the level of the outer inch or two. The nearer dry the rouge is the quicker it will cut, and at the last lap one wants it to cut very rapidly. My mirror is far from perfect, and some time I may go further with it, but at present it satisfies me for work on the moon and Jupiter. The moon is very low and very far around at present, but I'll look at it again soon. The last few nights have been rainy. The double convex lens is very fine. It is 3 in. focal length; would it do if I cut circular some spectacle lenses - 2 or 3 and put them together until they are of 2 or 3 in. focal length combined and then make them all into an eye-piece of about 21/2 or 3 in. focal length? I have used the 8 1/2 in. focal length one for a finder, objective, and it does fine work, or rather will, for it is just finished today. What diameter is your tube? Doesn't mine look large? My sister is on the ladder 2 steps too low to look into it. When I am done observing I put the tube in the outer kitchen; much to my sisters displeasure. Once I had it in the dining room, and "there was a sound "of revelry by night." It may be that my father will enlarge the present telescope house so it can go in. I call the telescope house "the elephant house," since it contains the white elephant. How is your cradle arranged? My axes are only 2 1/2 or 3 in. now, but may be enlarged. How do you figure out all about the eyepieces, the method of placing them, etc? Is not it very delicate the testing in the final work and also the polishing or figuring of the surfaces after the polish is complete?

It looks as if to-night would be fine, so I'll hold this letter until to-morrow, and add to this any observations that I may make to-night.

Sincerely A. R. Hassard,





which, however is only 2 inches in diameter and will be covered by the flat. The trouble is with the edge, and all my polishing hasn't gone effective with. I used several stages, and don't know just what to do now.

Cottage Grove P. 175. May 12, 1909.

Dear Mr Prahl,

Last night was a dandy, but the atmosphere must have been a little moist. And my eye-pieces while good with my 2 inch show a little flare with instruments of higher or larger apertures. Faint stars are a little free from the flares. Jupiter looked well, but it was impossible to get distinct views of his belts. Very late again I tried with the 4 inch refractor, but the belts were very faint. Those who draw Jupiter with a great wealth of detail can see what certainly does not come to my notice. I rather think that the short focus while good for light gathering, is not so good for definition. My great hope is in the planet Saturn. And of course the moon. Last night I looked at Regulus; the comes was very clearly visible with all powers, but the bright light of the bright star alpha was such that all attempts at dividing the smaller one were impossible. Gamma Virginis, - very easy- divided nicely. I see that Webb says the companion to Regulus was divided at Washington. I assume that meant by the 26 inch there, and that would assume it would not be divided by anything smaller. So you cannot expect better results, it would seem. My finder - the objective being from your hands - works nicely, although there is some colour. Do you use your refractors much now? I seldom do. I made the 15 inch very largely for the purpose of looking through it at Saturn. I want to see a number of his moons. The Orion nebula I am also after. But they are friends of later visitation. Does your lathe run by electricity, - if not, how?

I wonder what Mr Mellish is doing. He may be hard at work at his glass. I hope he writes soon. I have all your and all his letters pasted in a book, and they are interesting to look over. I rather think that eye-pieces which are corrected for a 2 inch glass of 24 in. focus would not do on a 15 in glass of 120 in. focus. Am I right?

That being so, I must do something towards providing myself with corrector eyepieces.

I tried to get the cluster in Hercules in the mirror last night, but was too tired when I thought of it to go to the trouble to hunt for it. However I shall get at it soon. There is a little fixing to be done to make the tube steady, but I may get that done to-night.

I am defending a man to-morrow before a Jury for fraud, have another case for manslaughter and another for attempted murder. So my hours are not always at my own disposal.

Write again soon.

Faithfully Yours, A. R. Hassard,

After 5 days, return to

.....John E. Mellish.....

COTTAGE GROVE, WIS.

MAY 15 1909

COTTAGE GROVE MAY 15 1909 6 PM WIS

UNITED STATES TWO CENTS

A. R. Hassard, B.C.L.

Confederation Life Bldg

Toronto,

Ont.

May 12 1909

Dear Friend

I will soon get the 16 in glasses I now have a 6¼ in glass to refigure. and I have been very busy with my camera. I took a photograph of a flash of lightening one morning at 3.15 and it is a very queer thing.

I will get a 1½ in glass, and a 1 in glass to grind it on. I never thought about the weight of a 16 in glass 2½ in thick, it would be 47 pounds I may get my 16 in glass done and mounted in June, I hope so any way.

The nebulae will be splendid sights with such large apertures. I will make the focus of the 16 in. only 10 feet. $\frac{120}{16} = \frac{30}{4} = 7\frac{1}{2}$

I will make a house for the 16 in, and the roof will slide away, I will also have a wind screen to set it at any side the wind blows from.

My but wont Mars be a wonderful sight next fall. I will make the tube solid and make a rotating section on the eye end, it will be turned true, and will work much better than the rotating tube.

It gives me great joy to see how you are going ahead also Mr Prahl is very good at figuring a curve now, and I am comming after. We must keep on and it will shake the world before long.

Some Astronomers are getting interested in our work. I can not find any more comets They will soon come all in a bunch. Mr Hosdick and I are working the sky together, I would never have known him if it had not been for you.

Did you ever look at variables? there is a field where the lights in a city do not bother and Professor Pankhurst of Yerkes is glad to have any one who will follow a few variables. Very respectfully Yours

John C. Hubbell.

$\frac{96}{15} = \frac{32}{5} = 6\frac{2}{5}$

$\frac{108}{12} = 9$

May 13, 1907

Mr. A. R. Hassard
Toronto, Canada

Friend Hassard:

Your letter and picture of your mammoth telescope is at hand. I appreciate the picture very much and enjoyed your kind letter immensely.

You speak words of encouragement that I am grateful for, and to believe that one appreciates you, and feels some interest in your work, is a stimulating influence that is not to be despised. Speaking in my own behalf, I have had no serious symptoms of discouragement, in fact I feel that I am gaining greater interest every day, and have no thought of giving up any part or parcel of any undertaking in the work of telescopic construction and the study of astronomy.

Already I feel that I have been bountifully repaid for my work, time and expense in what little I have seen with my imperfect speculum. With an eyepiece of my own construction of two lenses from a very cheap draw telescope, I am enabled to see things that are almost unbelievable to one never having used a telescope.

I have been observing Jupiter and his moons the past few evenings, and I enclose a little

sketch of how I noticed their different positions on the various evenings. I am confident that if it were clear to night, see the inner one- Fig. 4- on the limb of Jupiter, by acute searching with my low power eyepiece. I am confident I see indications of the belts, and they appear something like this: may 12 10 P.M. ○ I can seperate Mizar an companion

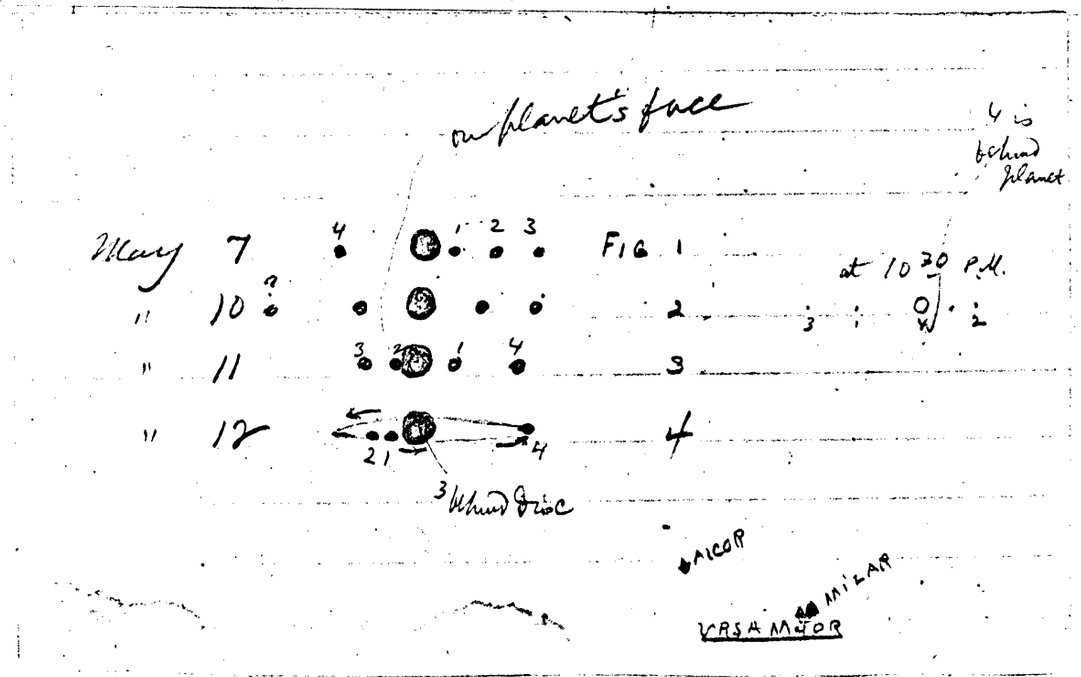
sufficient, that I can see that mizar is a very close double. The glass seems to show smaller stars as very round and clear cut, but the larger ones it seems to show as three cornered, there is considerable stray light around Jupiter unless eyepiece is at most particular position, at which point diameter is reduced and detail brought out. Praesepe is a most beautiful object appearing as though almost mechanically set with the most varied and beautifully colored incandescent lights.

I did not see any thing in Mr. Schalle idea of testing. I followed your instructions and those as given by Mr. Tacault. I understood all the shadows- or mostly all- that appeared on the various occasions, and was able to bring the curve to very near the sphere at any time

but I was determinedly uncertain of my curve after leaving this point. I quit when I satisfied myself I had the parabolic shadow, as near as I was able to judge what that was. I am confident that a high power eyepiece is an aid to the ametuer in connection with the shadow test. My mirror shows practically the same object with the 160 power eyepece on a real star that it does at the focus with artificial star.

I will postpone further particulars untill another letter. I will then attempt to tell you of the surface curves that appeared on my speculum. the character of polisher I used and manner of stroke applied.

I am thinking of sending my speculum to Mr. Mellish for correction. this will give me a perfect glass to use, then I shall begin



work on another of the same size for the experience. what do you think of that idea? In my second attempt at silvering I left mirror in bath fully 15 minutes it shows slight indications of fogging- appearantly in my judgement- that is, if to be correct, it should show bright and transparent like a looking glass; it does not do that, rather it shows more of a milky cast but I think not enough to bother about. the film is firm and solid, and polishing appearantly made no improvement.

Write soon, I am always pleased to hear from you.

Yours most sincerely
Leo Holcomb

Cost of
Ref. #3. 15 in.
reflector

2.45 } glass
.20 }
.20 } wood
.40 }
.10
.50 carbon + Emery
.50
.30 rouge
.25 iron sheet ring
.35 cradle
.10 stove iron
.10 nails
1. axes + 4 screws
.50 bolts screws + hinges
.10 tins for cutter
$7.05
.15 wood for silvering bath
$7.20
.80 silvering
$8.00
brass for diagonal
.50 + for Eyepiece
solder + flux

May 20, 1909.

Dear Mr. Holcomb,

Your letter of the 13th inst. was very interesting. It is encouraging to you to find such good results. From your description, you seem to have a very good mirror, and there is not much need of your sending it anywhere to be improved. You will not get the best results from the eyepiece made of a cheap draw telescope, for I am told that the eyepieces in them are corrected for terrestrial observations, and the rays of light are expected to reach the objective of them not in parallel lines like those of a star, but in converging lines, and such being the case, there will be some effect in consequence upon the eyepiece lenses. But I constantly use one of them, and find it does very useful work. The lenses in that eyepiece will be perhaps 3/4 of an in. apart. Now if you divide the focal length of the mirror in inches (e.g. 80 if such be the case) by the 3/4 you will find the power of the eyepiece. In that case it would be about 106. The belts of Jupiter should show fairly well with that power. Two hundred will do much better. Your drawing of Jupiter's moons was all right except for May 10, when you evidently overlooked satellite No. 3, which was very far out from the planet on the same side as No. 1; the other two satellites being on the other side of the planet. At 10.30 P.M. that same night No. 4 had disappeared behind the planet. On the night of the 11th No. 2 was just emerging from the planet's disc, - you give that in your drawing, as having taken place. A short time before that it was on the face of the planet. Up to the present I have never seen a satellite on Jupiter's disc, perhaps from the fact that our City lights are not very useful in adding to definition. You have Mizar properly shown. We do not call it a close double; there are many much closer, even to the range of your instrument. Try Gamma Virginis; it is more than double as close, Mizar being 14.5" and the latter being 5". Gamma Arietis is 5" but it is not visible just now. Gamma Leonis is 3", and a Herculis 4.7". It is said that an undercorrected mirror is much better than one over corrected; for the mirror once it passes to the hyperbola becomes so turned down at the outer inch or two or more, that the rays from all that area will never focus at any point, but will always keep on diverging, and the use of them is wholly lost. I rather think a sphere for the mirror's surface will do fairly good work; indeed I doubt if some of mine are much more than that. Any two lenses separated a little more than ~~twice their focal~~ 1/2 the sum of their focal lengths will do to some extent as an eyepiece. It is said if the lenses have focal lengths in the proportion of 2 to 3 they will operate much better. Were you able to polish the mirror with rouge after the silvering? Did you use distilled water - did you make the latter?

I shall be glad to hear from you again.

Faithfully Yours,
A.R.Hassard,

P.S. Last night Jupiter's moons were all to the west of the planet. That is a little unusual, occurring I think not more than about once a year or so. Two very small sun spots were visible in the 15 inch this morning. The spots of three or four days ago have disappeared.

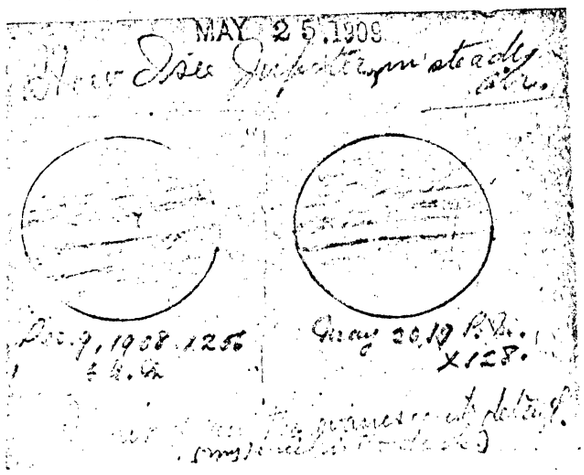
Milwaukee, May 20, 1909.

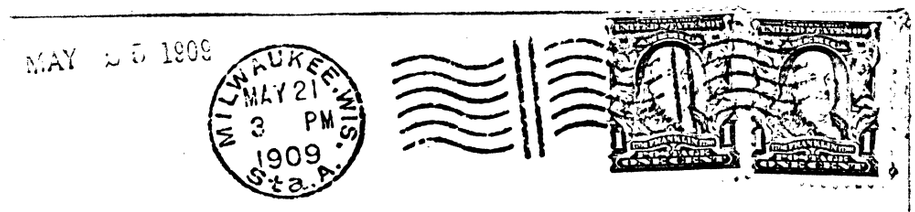
Dear Mr. Hassard:

Are all the objects viewed with your 15 in. surrounded by stray light? If so, you haven't the correct curve. In my 8 in. all 1st mag. stars are surrounded by irradiations, caused by the glass of which the eyepieces are composed. A 1st. mag. has a circle 30" in diameter, smaller stars, none. An eyepiece is good for any telescope whatever its aperture may be. I don't test my eyepieces any more. I can feel, during grinding and polishing if they are coming out right. I only test for spherical abberation, using a microscope. A single lens, you know shows color. If used as an objective

it gives an image in each of the seven colors of the spectrum. I look at each image to see if it shows of equal brightness and plainness in each color. The glass of which spectacle-lenses are made of is no good for optic pieces. I've tried it & gave a very hazy image. Good plate-glass is far better, but best of all is the very best optical glass. My optical glass costs about $8 the lb. in small slabs. If your 15 in. shows no stray light, it cannot show detail. My 8 in. hasn't any, and it shows splendidly. Jupiter is so very distinct, there is no mistaking what I see. And the moon is wonderful. What do you intend doing with your 9½ in. glasses? Try your mirror on γ Coronæ & Boötis. My telescope divides both these stars with power 128. Their distances apart are 4 and 0·7 respectively. I see seven stars in ε Lyræ. Even persons who are not used to telescopes can see them (⁘) The clusters 92 h, 13 h, 3, 5 h are well resolved, power 128.

I have put the 14 in. out of sight. I have no interest in it, & don't know why. Perhaps I'll finish it some time, or grind it to a focus 7 or 8 ft. I can't get over 12 in. good. When I use my 8 in. I sit on a chair, and have to stoop a little when I look straight overhead with it, but 11 ft. above the ground is considerable. I know the air is usually so abominably unsteady with 8 in. that I think the 14 in. would reveal nothing new, except fainter stars. I can





Mr. A. R. Hassard

Confederation

Life Bldg.

Toronto, Canada.

see a 12 mag. star near a large one without difficulty if it isn't too near, viz. Alpha Herculis, mags. 2, 12, dist. 4.8". I see with 100, but 256 showed it very easily. I think I'm a poor speculum maker, but when it comes to figures, I feel at home in that work. I refigured my old 3 in. this week, and I enjoy seeing it now it seems like a new instrument.

Very sincerely yours,

Arthur Brahl.

3-A-140-5m-8-08 19026

MAY 25 1909

City of Cleveland

Department of Public Health and Sanitation

City Chemist.

Cement Lab
City Hall

Mr E. R. Hassard
Toronto Canada.

Dear Mr Hassard:

Enclose you a proof of my telescope. I had success with the telescope last night for the first time with a 2/3" or 130 diameters. The markings on the lighted portion of the moon were splendid. It gave me more than a full view of the moon if the moon were full. I want a low eye piece that will show the moon like a ball Do you think a 1". focus eye piece or 86 diameters will do? I understand that your 9½" Speculum has about the same focus as mine. The highest power I have is a 1/3" focus eye piece. I want a higher power, do you think my speculum will stand a 1/5" or 1/6" focus eye piece? My speculum is hyperbolic, I overcorrected it by mistake. Couldnt see the belts of Jupiter with the hyperbolic mirror. I guess it ought to show the belts no matter what the error is, don't you think so.

Its good that you had luck with the 15" Speculum. Mellish is going to make a 15" too. I ordered the glass for

for him,
~~him ordered~~
and think it will come in two weeks.
The discs are 1/2" and 3/4" thick He wanted
2 1/2" thick glass and made up his mind when
I hinted the weight.

a reporter is chasing me for a blow in his
the newspaper. I desire no publicity but
guess that I will yield as the telescope
in the paper will start many amateurs.

Hoping to hear from you very
soon

Respectfully Yours
David Friedman

May 26, 1909,

Dear Mr. Freedman,,

A little lower power than 86 should be used to see the whole moon at once. If you have used a small draw telescope for a finder, as many of us do, you will remember that you had to cut the eye end of it in two. You then only used one part, and had another part left with two lenses left. Measure the distance between those lenses and in ordinary cases they are about 1 1/4 to 1 1/2 inches apart. That being so, they should be just fine to show the whole moon at one view. Your 1/3 " focus eye piece will give you a power of about 259. That is fairly high for ordinary purposes, but the moon will stand higher. On the moon with my 9 1/2 in. I have used 270 and 415. But they are not very satisfactory. On the 15" these powers make about 400 and 610. The 610 is very ill-defined, and the curve of my mirror is not responsible for that. The 400 is rather fair when seeing is good, but my preference is for 100 or 200. With my 6 inch which I often use the powers are about 30, 55, 110, and 150. Also 250. The three lowest ones are most frequently in use. Around Jupiter with low powers there is always a glare, but it lessens with higher powers, but with the highest powers detail becomes difficult. The best views of Jupiter are with 80 power on a 4 in. refractor, and with 110 on the 6 in. reflector, and with 260 on the 15 inch. Saturn will stand high powers better than Jupiter, and its definition is always better I think than Jupiter. You will enjoy it. You should not be discouraged by the drawings you will find of Jupiter, many of them are as fully detailed as the moon, nearly. But that is a most gigantic error, unless, perhaps, the glass as of great perfection, and even then, I have grave doubts of the reliability of these drawings. I can't commence to recognize the marked amount of detail on Jupiter that other observers draw with such delicacy and it is beginning to dawn on me that much of the detail is imaginary. One observer has sent me two drawings of Jupiter with detail inscribed on its surface, and the drawings with powers 128 and 256 are exactly of the same size and with the same quantity of developed detail on each. The harmony between the two amuses my suspicions of them both. So don't be distressed when all things are not the same as you were soothed into believing. The only thing most people like to examine are the Moon, Jupiter and his moons, Saturn and his system, Mars, and its markings, a few of the wider doubles, the Pleiades, the Orion nebula, the clusters in Cancer, Perseus, and the occultations of stars by the dark limb of the moon; as well as a few other clusters and nebulae. A person wanting much more than that ought to get the mirror figured by an expert; or go to much greater trouble with it. Mr Prahl started on his 14 in. glass, but has given it up. My 15 inch wont be used a great deal; Mars and Saturn will call for its use more than anything else. Don't be discouraged; if you have the ambition, continue with the work, but do lots of observing, and enjoy it, for it is very pleasant indeed. The moon is fine now, and if you will consult the Nautical almanac you will find a list of occultations by the moon, on June 3, Omega 1 Scorpii a 4th mag. star will be occulted at about 9.38 P.M. Write soon again, and if convenient send some photos. Yours c...

May 27, 1909.

Dear Mr Prahl,

Please let me write you about one two things. On April 14 you wrote me that your 14 in. glass had not arrived; on April 26 you wrote that it was then at the fine grinding stage, so it is fair to assume that it came some time between those two dates. Just a month has elapsed and you are perfectly discouraged. Where would my mirrors have been had that course been followed here? My first took nearly a year to finish, many days I worked for hours and hours; Mr Mellish told me that his first mirror took ages to complete, -, it seems to me he said it took him about 4 or 500 hours to obtain the proper curve, or was it you? My 15 inch kept me nearly every spare hour from February 1 until the end of April. Four times I had the surface polished; one time the polish was the result of nearly 3 weeks of labour at every spare moment. Then I went back and ground it over again. Do the same you. Go back half way in the fine emery; about 4 or 5 grades back, and make your strokes quite long at first to shorten the focus. Go even back to the beginning of the flour emery, and make your strokes 6 inches long or longer. An hour of this one evening and an hour another evening will reduce the focus down to about the right amount - say - 110 or 115 inches. Once you get it down to below 120 inches the thing is not so unwieldy. It's amazing how unwieldy a few inches additional make it. Then when you strike the 4th grade from the end of the fine emery shorten your stmkes down to 1 inch, not a speck longer. Grind in that way with the last 4 grades, and run each grade through for exactly one hour. It is very tiresome, but divide the work into 4 nights, and take 1 grade and one hour each night. The temptation to rush from one grade to the other, especially when the strokes are so short, is as great as the temptation to go fishing on a fine Sunday afternoon, when the minister's son is going too. Then you will be ready for the polishing. You may find the polish to resist coming on in ~~many~~ places, but follow the former directions I gave, and besides I think that if you heap up the beeswax on the pitch, and have the polisher's surface quite soft you may escape this trouble. Fearfully short stmkes on the polisher will prevent the curve becoming hyperbolic. Don't try the hypereveloidal curve nor any of those curves which are complex. You will succeed, and let me tell you that it is not the high magnification when you get the mirror finished, but the brightness and clearness of the image, which make the instrument "a thing of beauty and a joy forever," as Keats would say. The moon looks wonderful, and Jupiter seems to live away inside of the glass. Go ahead with the work and you will be more than delighted. Keep the curve undercorrected rather than otherwise, and when you get the first faint polish begin to come so that you can diagnose the surface, stop working and tell me what it is like, and I'll write you further and tell you just what to do. Write again soon, - I'm going to "touch" you some day for a pair of lenses that will make a 1 inch focus eyepiece. But be sure and write soon, I'm wonderfully interested, and don't give up. Most sincerely Yours, A. R. Hassard

MAY 28 1909
MAY 28 1909

May 25 1909

A. R. Mason,

Dear Friend,

I just sold an 8½ in speculum to Dr Barnitz, and just got through with Mr Halcombs 10¼ in speculum, when he sent it to me the rays from the central point came to a focus ½ in near the speculum than the rays from the ~~out edge~~ I got the glass perfect clear to ⅛ of an inch from the edge.

I have ordered a 16 in glass 1½ in thick for $4.50/100 and a 16 in glass for the tool ¾ of an inch thick, they will come in about two weeks, mean while I will make the mounting I will have it done by July 1st, I will make the focus 120 inches I think Mr Goodrick is off about the 7 moons of Saturn any 5 in in the world will not show them,

I see you are having very clear skys all the time now, that is fine

I have not seen monthly notices yet for March I will go to Madison soon and see them

Thank you for the photo,

I will make stays to run from the outer end of the axles to the eye end of the tube to hold the tube from vibrating in the wind, I will also make a large movable wind screen.

I think next winter I will make a 24 in telescope I will have to sell the 16 in first, the glass for the 24 in will weigh 100 pounds and will cost about 75 dollars, The 16 in speculum weighs 27 pounds I will have a clock to run my 16 in, I will have a long bar clamped to the polar axis and have a string fastened to from the other end down to the ground where I will have a clock to wind it up Professor Barnard gave me this idea. it will run one hour at a winding Very truly yours John E. Mallish

JUN - 1 1909

MILWAUKEE WIS.
MAY 31
10 30 AM
1909

Asst. A. R. Hassard.
Confederation Life Bldg.
Toronto Canada.

After 5 days, return to
John E. Mallish
COTTAGE GROVE, WIS.

MAY 28 1909
MAY 28 1909

COTTAGE GR...
MAY
26
1909
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A. R. Hassard. B. C. L.
Confederation Life building.
Toronto.
Ont.

18 JUN 3 1909

Milwaukee, May 31. 1909.

Friend Hessard:

No doubt you think that I am utterly discouraged with my glass. But this is not so. I have only put it away for a while and forgotten it completely. I have always done things this way. When I made my 9 in. I began grinding it Aug 2, 1908. I fine-ground it, and then it laid around for some time. At times I didn't know just where I had put it. October 8th I began polishing it and the 12th I had it in working order and was observing Saturn. It seems that I get fresh energy by taking a rest, problems which seemed insurmountable will vanish and the work then progresses finely. When I do take up the 14 in. again I'll finish it.

Just now I am still undecided what to do with it. It is too big an instrument to use for desultory star-gazing and would be almost useless without driving-clock and micrometer, circles, etc. I want something practical, something that will accomplish results, and I know of no more interesting or valuable work than that of celestial photography. This would necessitate a short-focus mirror say 5 or 6 ft. with 14 in. aperture. So I am still rather undecided, I will let it alone. What think you of it? Why do you say "keep the curve undercorrected rather than over"? Why not perfect? If I don't get a perfect curve, one that cannot possibly be improved, I don't want the glass. The way it is now I could use it as a 12 in. it shows no stray light whatever, but 14 in. is what I want and I'll get it.

On the morning of April 14 I wrote to you that the glass basket arrived. It came the same evening. I did the fine-grinding this way. I began with 1 second, then 2, 4, 8, 16, 32, 64 seconds. Then 2, 3, 5 minute, then 6, 8, 10, 12, minute, then 15, 20, 25 minute, 30, 35, 40, minute 45, 50, 60 minute and finished with 90 minutes. No fine emery was used, only the carborundum-slush caused by rough-grinding. I had such a surface that I could see through it, and the polish came on all over in some 4 hours.

I am using the 8in. at present, and it performs very well. I sit on a chair while observing, as my tube is only 54 in. long.

Sunday, the 23d. I began grinding a mirror of 6 1/2 in. diameter. It is onyx-stick-glass and I ground it as an experiment. The focus is 24 in. ground on an iron tool with the curve turned on the surface. All the grinding took 4 hours and then I polished 2 hours. It was then almost complete, only the edge was pitted where it was not polished well. Tested, and found the curve so very perfect that I was afraid to do any more polishing. Silvered and mounted it and it performs splendidly. I will use it for celestial photography.

I have just finished a 1/4" eyepiece for Mr. Mellish. If you want the lenses for a 1/4" eyepiece, I can make them for $1.75.

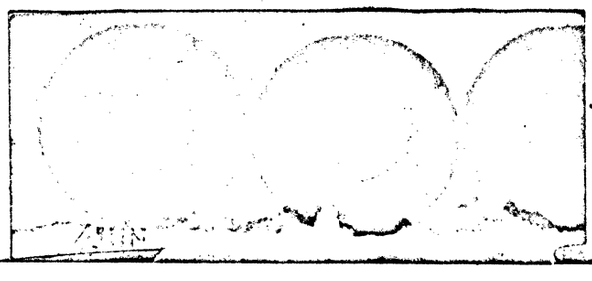
Those that I sent you were only glass disks with a curve on each side. They are untested, and only supposed to be used as magnifiers. I make the lenses for eyepieces finished pieces of work, and my eyepieces show a good sized field without distortion, that is, the field is flat, clear to the edge, without a diaphragm. I just bought a another supply of optical glass. Two disks 1/4 in. thick, almost 1/2 in. square, cost $1.50. The ordinary glass is 11¢ a pound. My glass is from Jena, Germany, and cannot be beat as it transmits to all the rays of light, visible and invisible, admitting, by photographic tests eleven times more light than the best B. & L. optical glass. If you want those lenses, let me know and I will make them before I get started at the 14 in again.

This is decoration day, a holiday, but I must go to work, so I'll close now. Thanks for your very encouraging letter.

Sincerely yours,

Arthur Brad.

I inclose some Sun spot pictures. The first was taken with the 8 in. the 28th. 9 P.M. exposure 1 second. The next I took with my old 6 in. last year. The smallest was taken with the 2 in., 24 in. focus 10 sec. exposure.



Toronto, June 4, 1908.

Dear Friend Holcomb,

I was glad to get your letter. It shows that others have difficul-ties besides myself. I have never seen a transit of Jupiter's moons myself, - somewhere I read very lately that Jupiter is an impossibil-ity with anything under a 6 inch reflector. Still a 10 inch reflector ought to do much. My mirrors don't do perfect work. Sometimes Mr Prahl says his do, and again he seems disappointed. I have read again that this year Jupiter has been very disappointing, not being clear. You will see drawings of Jupiter that seem very perfect, but I think there is much imagination in them. I'd like to see some photographs of him, where the photographer can't aid his imagination. But don't you know that a photograph by even the largest telescopes, Lick, for example, reveals less detail than many contributors to periodicals say that they can see with a 3 or a 2 inch aperture. I think there is more im-agination with Jupiter than with anything in the sky. But wait till Saturn comes round, and you will be agreeably satisfied. For your mir-ror will do very much with him, his belts and moons. I rather think that Mr Mellish may not go far enough in his corrections. My 15 inch which is imperfect does about as good work as the one I had Mr Mellish finish for me. Mellish thinks that the mirror should be nearly flat in its appearance, but this is hardly so. In your case the mirror should show a fair shadow of the parabola, and he said when he began your mirror it had its central rays come to a focus 1/2 in. inside of the outer rays. Now the mirror would be right, in my judgment if they came to a focus 1/4 in. inside the other ones. That is about the right ab-erration, as it is called. Mr Prahl says the right aberration is 1/50 in, that is to say that the focal length of the centre of the mirror should be 1/50 inch shorter than the outer parts. This is not so, I think. The difference should be 1/4 of an inch or thereabouts. But do not be disappointed. I can't use more than about 200 on bright stars with my 15 inch. But with faint stars I can go higher. Don't expect to much. I think the reason for the distortion of Jupiter still is be-cause of the bad seeing there has been on the planet all year. Do you know that some writers have a curious way of writing for hours and say-ing nothing. Mellish & Prahl and others and the Eng. Mech. say or have told me less in weeks of writing than I could tell a person in 2 pages. They talked of length of stroke, and flexure, and aberration and a hundred other things nearly, when all that was wanted was to draw a picture of a mirror, a picture of the places on the polisher that needed cutting away, and a statement that very short strokes so as to cut these places were needed, would have done more than wordy letters meaning nothing. Perhaps your "flat" is imperfect. But if it be of good plate glass, it shouldn't be. Try several and use the best. Silver 4 or 5 "flats" and try which does best work. Tell me how you do your silvering. I can't get my silver to stand a speck of polishing. Perhaps it is because I have not used distilled water. Do you use dis-tilled water? Do you make it or how do you get it? Please let me know. Would you lend me Mr Mellish's diagrams he says he sent you and his letter that he sent describing the figuring? But don't be discouraged. You don't want or expect that your instrument can rival Lick or Yerkes be content with an instrument that will show many of heaven's wonders tolerably well. And you will have my blessing. Write soon again. Send me some photos.

Yours faithfully, A.R.Hassard,

BRANCH STORE, 134 MERCHANT ST., DECATUR, ILL.
USE SMALL STORE STAMP

JUN - 4 1909

June 2, 1909

Mr. A.R. Hassard
Toronto, Canada

Friend Hassard:

I have been cleaning house and taking quarterly Inventory and am some what detained in answering your letter.

I sent my Speculum to Mr. Mellish for correction may 17, and received it back may 25th I have done no observing since writing you last, except to try it Monday night after Mr. Mellish had worked upon it the improvement as I find it under the same conditions as before but little. I cannot use Mr. Prahls ½ in eyepiece which gives a power of 160 on my glass- only on the moon it does better than before with this power on that luminary, but it shows Jupiter only as a glaring ball of light with a somewhat cleaner image- that is; clearer of stray appendages of light. There is practically no improvement on Jupiter and moons. the distortion of image is not so great as before, but still great enough to destroy definition. The improvement is of about the same ratio with my low power- (that I described to you before. it gives a rounder image of the larger stars with this eyepiece than before Mr. Mellish work. for example, Mizar and companion, appeared in the

first instance like this: now a clear separation in the last instance, not so in the first. I feel very much disapointed that I am unable to use high powers. I only have the one of Mr. Brahls which he said he tested on his glass and found it to be fully as good as the one he uses of the same size.

154 MERCHANT ST., DECATUR, ILL. 190

and that with his 8½ in shows Jupiters belts very distinct Mr. Mellish says he tested my glass with powers of 300 and said it would do anything that a 10¼ in made by Brashear would do. in fact he said it would stand powers of 400 but he had nothing higher than 300 to use on it. I feel that Mr. Mellish must be right in his interpretation of the figure and that I am at fault somewhere in the adjusting arrangement of glasses. I have written him fully and feel confident that he will help me out of the dialemma. I will not be satisfied with a glass that will not show Jupiters belts and a transit of her moons across the disk.

I left the silver film or speculum for Mr. Mellish to pass judgement upon, and he says

he never saw a better one. I did not polish that film either. the one I have now is a better film and I put in more than an hour polishing it with the result of removing the foggy cast and leaving a beautifully bright clear hard film without a scratch. it took a brownish cast where polished the brightest and I take it, would be black were the film heavier I did not use rouge I find it will fill a silver film full of scratches. I used the softest Chamois leather clean and bore down pretty hard after getting under good motion. the film will stand all the weight you can put on it this way with no damageing tendencies whatever the light grasp of my speculum and flat is truly fine. I use distilled water obtained ~~obtained~~ from a drug store

Write soon and all about your work.

Yours most sincerely Leo Hleomb.

Oct. 6, 1903.

The Pittsburgh Plate Glass Company,

Pittsburg, Pa.,

U. S. A.,

Dear Sirs,

Could you provide me with a piece of plate glass cut into a disc, the disc being 12 1/4 inches in diameter, and about one and three quarters or two inches in thickness? What would it cost?

Faithfully Yours,

TOOK PHOTO OF COMET

CAMERA ON TELESCOPE.

1910

Exposure for Fifteen Minutes at Observatory—Can be Plainly Seen With Naked Eye.

The first photograph of Halley's comet secured in Toronto was taken at the observatory this morning with a 4x5 camera of three-quarter-inch lens. The exposure lasted from 3.45 to 4 o'clock—fifteen minutes.

From the dome of the observatory the comet could be plainly seen with the naked eye. It rose at 2.43 and was visible till four o'clock, when daylight obscured it. Officials of the observatory followed the comet with the aid of the big telescope.

"But it was distinctly visible to the naked eye," said Mr. Blake, the astronomer. "One can see the comet better through opera glasses, because only a portion can be seen at a time through the telescope. The head of the comet is equal to a star of the second magnitude, but its light is dull. It rises before Venus, and is in line with the streets running east and west.

"To-morrow morning it rises at 2.41. Then we will put a three-inch portrait camera to the telescope."

THROUGH WINDOW.

Mr. A. R. Hassard saw the comet at 3.45 this morning. He had little difficulty in finding it with the naked eye, even through a window partially covered with moisture.

"The nucleus of the comet was very much brighter and more condensed than on Thursday," said Mr. Hassard. "The comet has moved the distance of the diameter of the moon in the direction of the sun. With opera glasses the tail can be seen quite clearly. The star seen last Thursday shining through the tail near the head can still be seen though some distance further back."

JUN 23 1916

To Mr A. K. Hassard
Confederation Life Bldg.

by its photograph taken September 11, 1909.

THE SKY MAP OF HALLEY'S COMET

SHOWING ITS ELLIPTICAL PATH AROUND THE SUN AND THE PLANETS AND THEIR ORBITS. (Copyrighted 1910, by G. R. LOCKWOOD)

EXPLANATION.

The Sky Map of Halley's Comet on the reverse side shows the Solar System which consists of the Sun, its Planets and Halley's Comet which is a part of the Solar System.

It will be noticed that the Sun is the centre and that the various circles outside of the Sun are the orbits of the planets of the Solar System, which of course includes the Earth with its Moon. The distances of the various orbits of the Planets from the Sun are designated by millions of miles. For example, Mercury is 36 million miles from the Sun, and Neptune 2,790 million miles. Following the name of each Planet is the period of time required in its path around the Sun. At the lower part of the map, the velocity of the various Planets is marked in miles per second. Example: the Earth is revolving at the rate of 18½ miles per second.

Halley's Comet moves in an ellipse. It moves around the Sun in the direction that the hands of a clock move, and in the opposite direction to the movement of the Planets. The Comet varies in its velocity. It obtains its greatest speed as it approaches the Sun, about 30 miles a second or 3,000,000 miles a day. It reduces in speed from its highest velocity to about two miles per second at the opposite point of the ellipse.

Halley's Comet takes about 76 years to make its journey of 7,000,000,000 miles around the Sun and back to its far away goal. Its path is an ellipse which extends outside Neptune's Orbit. It was calculated that in April, 1889, Halley's Comet crossed the path of Neptune. Shortly after crossing Jupiter's path, it was discovered on September 11th, 1909, 360,000,000 miles from the Sun. On March 24, 1910, it was directly opposite to the Earth, on the other side of the Sun from the Earth, within the Earth's Orbit and passed from the evening sky to the morning sky. About the middle of April, 1910, it may be seen by the naked eye, in the eastern sky at 5 A. M., and at this time in the morning, it can be seen above the Eastern Horizon for nearly a month.

On April 20th, 1910, it passes the nearest point to the Sun (perihelion) and begins its return journey. On May, 18th it will come between the Earth and the Sun, 13,000,000 miles away from the Earth; its nearest approach to the Earth. The length of the Comet's tail is more than 15 million miles so that the tail will sweep over the Earth itself May 18th. On this day, it will pass back again from the morning to the evening sky, and will be a magnificent object toward the last of May, in the Western sky, just after sunset. At this time, the tail will reach half way to the Zenith, equal to the length of 60 moons edge to edge. The Comet will remain in the evening sky visible to the naked eye from about May 18th until about the 1st of July, 1910.

While approaching the Sun, its tail follows its head; but because the pressure of the light-waves is greater than the attraction of gravity of the Sun after passing its sun-goal, the tail will lead its head.

It last passed nearest to the Sun Nov. 15, 1835, and will probably not return again until 1986, about 76 years hence.

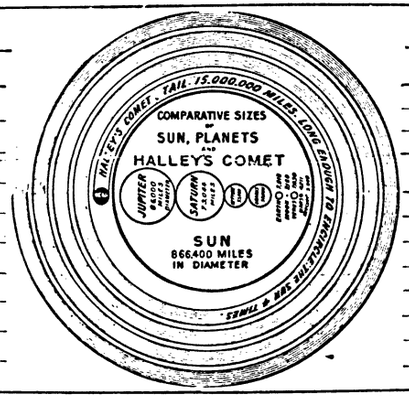
COMETS.

Comets are usually composed of a head and a tail. The head is solid, and reflects the light of the Sun. The tail is gaseous, and is repelled from the Sun by the light-waves. It is fed by a constant flow of particles from the head. Comets usually travel in an elliptical path, and return at regular periods. Some, however, go off in other paths and never return.

NOTE 1.—The orbit of the Earth is divided up into its twelve months, the Earth requiring 12 months to revolve around the Sun, the position of the Earth being located for each month. In the orbit of the Earth the Moon will be eclipsed May 23rd and again November 16th.

SOLAR SYSTEM.

NAME	DIAM'TR IN MILES	DISTANCE FROM SUN	TIME AROUND SUN	VELOCITY MILES PER. SECOND
Sun	866,400			
Mercury	3,009	36,000,000	88 Days	29½
Venus	7,630	67,000,000	224 Days	21½
Earth	7,918	93,000,000	One Year	18½
Mars	4,211	142,000,000	Two Years	15
Jupiter	86,000	483,000,000	12 Years	8
Saturn	73,044	836,000,000	29½ Years	6
Uranus	32,000	1,782,000,000	84 Years	4
Neptune	35,000	2,790,000,000	165 Years	3⅓
Moon	2,160	240,000 from Earth		18½



COMETS.

NAME	LAST PASSAGE OF SUN	TIME IN YEARS	REMARKS
Encke	1891	3.30	Path becoming shorter each time
Biela	1859	6.60	Divided in two and disappeared
Halley's	1835	76.37	Path discovered about 1700
MOST BRILLIANT COMETS IN LAST 100 YEARS			
Comet A	1910		The latest comet discovered
Comet	1811		
Comet	1843		Seen in day time
Donati's	1858		Seen in day time
Coggias	1861		
Comet	1880		
Comet B	1881		Changed rapidly
Comet B	1882	800 years	Seen Sept. 17, in daylight. Tail divided and united again

HISTORY OF HALLEY'S COMET

Edmund Halley was born in London, November 8, 1656 and died at Greenwich on January 4, 1742. His father was a soap-boiler yet found it possible to give his son a good education. He was a great friend of Sir Isaac Newton, who disclosed to us the universal law of gravitation.

When 20 years of age, Halley published a paper on the Path of the Planets. He noticed that the great comets of 1531-1607-1682 passed their sun-goal (perihelion) about the same time. So he concluded that they were one and the same Comet, namely The Halley Comet. Having arrived at this conclusion, he busied himself with the path of Halley's Comet, and finally issued the following prophecy, "Wherefore if it should return, according to our prediction, about the year 1758, impartial posterity will not refuse to acknowledge that this was first discovered by an Englishman."

Halley observed an irregularity in the path of the Comet and concluded that the proximity of planets hastened or retarded its passage.

The French Astronomer, Clairout, calculated that the attraction of gravitation with which the Planet Jupiter influenced Halley's Comet held the latter back 518 days and in the same way the Planet Saturn held it back 100 days, and this calculation proved to be correct.

The Comet was sighted on Christmas night 1758, after a journey of nearly 76 years by an Amateur Astronomer, said to be a farmer named Palitzsch who discovered it with a small telescope.

The Halley's Comet passed the Perihelion, March 12, 1759.

On August 6th, 1835, its last appearance was recorded by Dumouchel an Italian at Rome about 77 years after its previous visit in 1758. The Perihelion passage took place November 15, 1835.

Halley's Comet had its first photograph taken in September, 1909, photography not being in use by Astronomers at the Comet's last visit. Prof. Max Wolf, of Heidelberg, has the honor of discovering the Comet by its photograph taken September 12, 1909.

Then powerful telescopes were put upon its track and have been escorting the distinguished visitor ever since. About the middle of April, the unaided eye will bid him welcome, after an absence of 75 years.

When sighted in September, 1909, the Comet was 360,000,000 miles away, between the Orbit of Jupiter and Mars. He has been speeding along at the rate of 2,000,000 miles a day, while approaching the Sun and rounding the Solar Goal in a spurt of 3,000,000 miles a day, at the head of his Elliptical Path.

In all but his last three visits he startled the Earth by his sudden appearance, but these visits have not always been so eagerly awaited. A superstitious age blamed him for every unfortunate event during his stay. Wars, Earthquakes, pestilence and every hurtful event were associated with Halley's Comet. Fearing that his present return might lead to the slaughter of foreigners in China, the Government of China and Foreign Missionary Societies are circulating literature, endeavoring to disperse the darkness of superstition by the light of science.

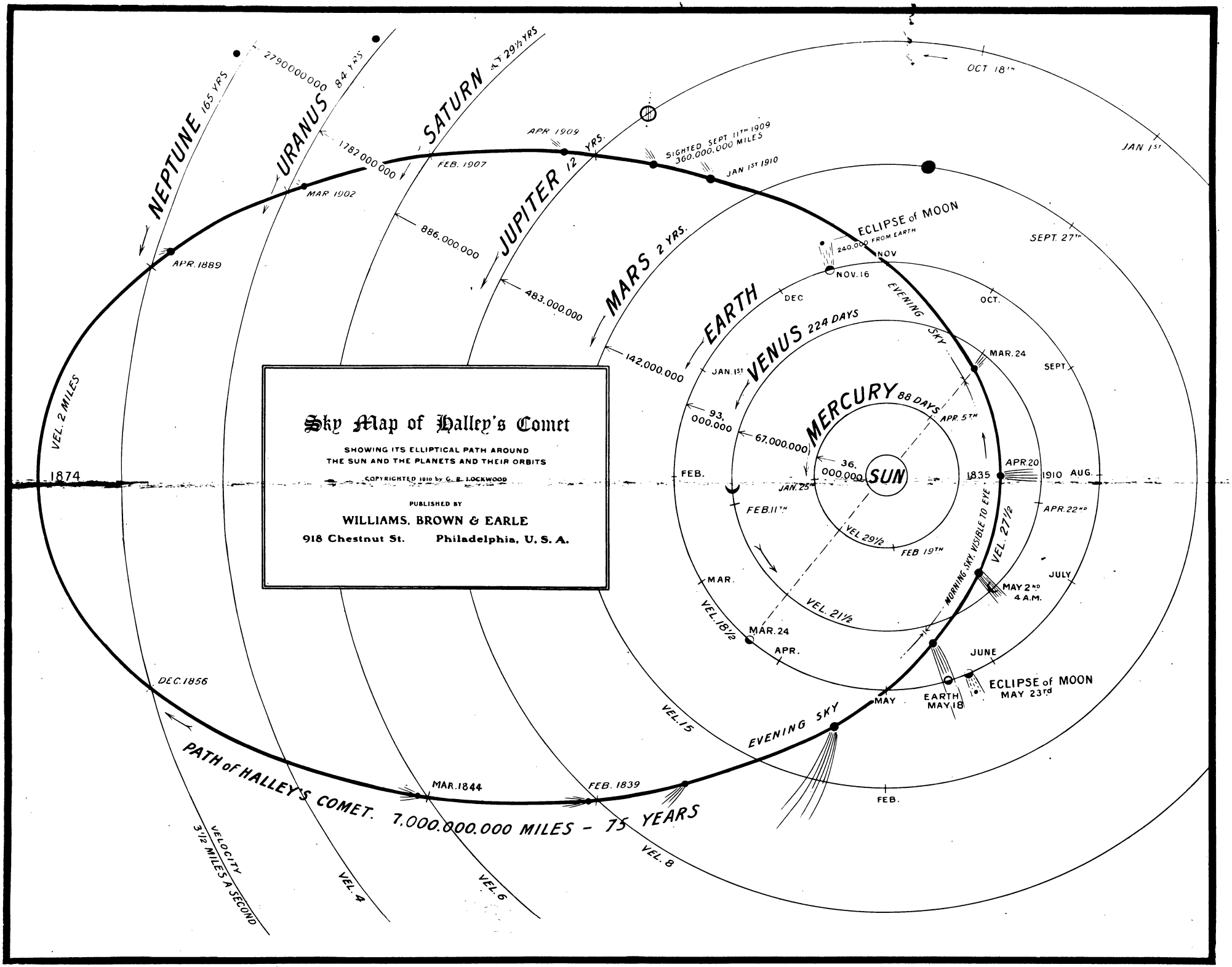
His visits have been recorded as far back as the year 11 B.C. The most reliable records of the early visits of Halley's Comet were made by the Chinese. There is an authentic record of 26 visits which Halley's Comet has paid the Earth, since the first recorded visits 1911 years ago.

Travelling over a path 7,000,000,000 miles in length, Halley's Comet Impresses this scientific age with the infinite reach of Creation and the Glories of the Firmament.

The Comet! Hele on his way,
And singing as he flies;
The whizzing planets shrink before
The spectre of the skies;
Ah! well may regal orbs burn blue,
And satellites turn pale,
Ten million cubic miles of head,
Ten billion leagues of tail!

On, on by whistling sphere of light
He flashes and he flames;
He turns not to the left nor right,
He asks them not their names;
One spurn from his demoniac heel,
Away, away they fly,
Where darkness might be bottled up
And sold for "Tyrian dye."

—OLIVER WENDELL HOLMES


Sky Map of Halley's Comet
SHOWING ITS ELLIPTICAL PATH AROUND
THE SUN AND THE PLANETS AND THEIR ORBITS
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URANUS 84 YRS
SATURN 29½ YRS
JUPITER 12 YRS.
MARS 2 YRS.
EARTH
VENUS 224 DAYS
MERCURY 88 DAYS
SUN
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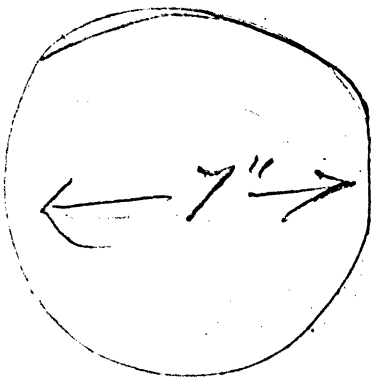
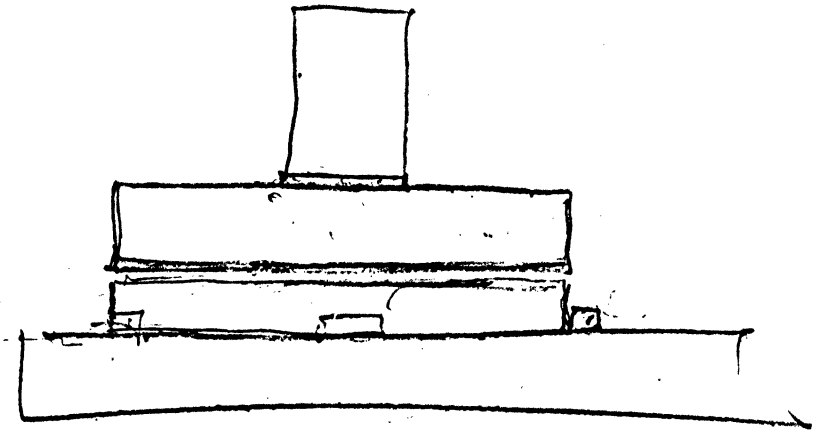
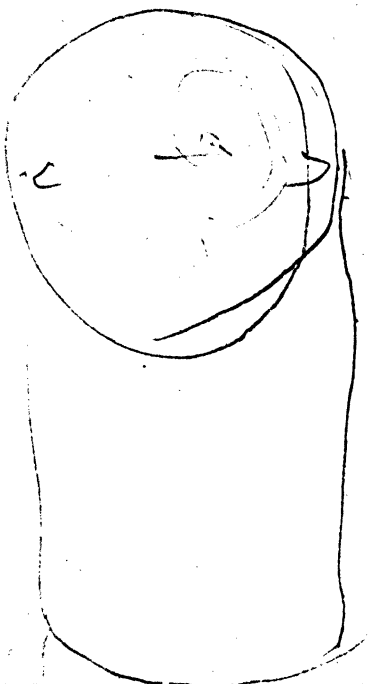
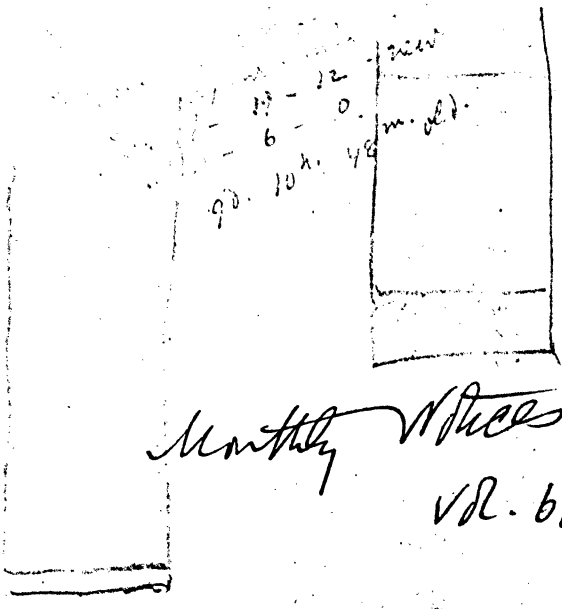
1782000000
886.000.000
483.000.000
142.000.000
93.000.000
67.000.000
36.000.000
PATH of HALLEY'S COMET. 7,000.000.000 MILES - 75 YEARS
VELOCITY 3 1/2 MILES A SECOND
VEL. 2 MILES
VEL. 4
VEL. 6
VEL. 8
VEL. 15
VEL. 18½
VEL. 21½
VEL 29½
VEL. 27½
1874
APR. 1889
DEC. 1856
MAR. 1844
FEB. 1839
FEB. 1907
MAR. 1902
APR. 1909
SIGHTED SEPT 11TH 1909
360.000.000 MILES
JAN 1ST 1910
ECLIPSE of MOON
240.000 FROM EARTH
NOV. 16
JAN. 1ST
JAN. 25TH
FEB. 11TH
FEB 19TH
MAR. 24
APR. 5TH
MAR. 24
APR.
MAY
JUNE
JULY
SEPT
OCT.
NOV
DEC
JAN 1ST
SEPT. 27TH
OCT 18TH
FEB.
1835
APR. 20
1910
AUG.
APR. 22ND
MAY 2ND 4 A.M.
EARTH MAY 18
ECLIPSE of MOON MAY 23rd
EVENING SKY
MORNING SKY. VISIBLE TO EYE


7"







29 Knots = 33.4 miles.
1 " = $1\frac{3}{20}$ "

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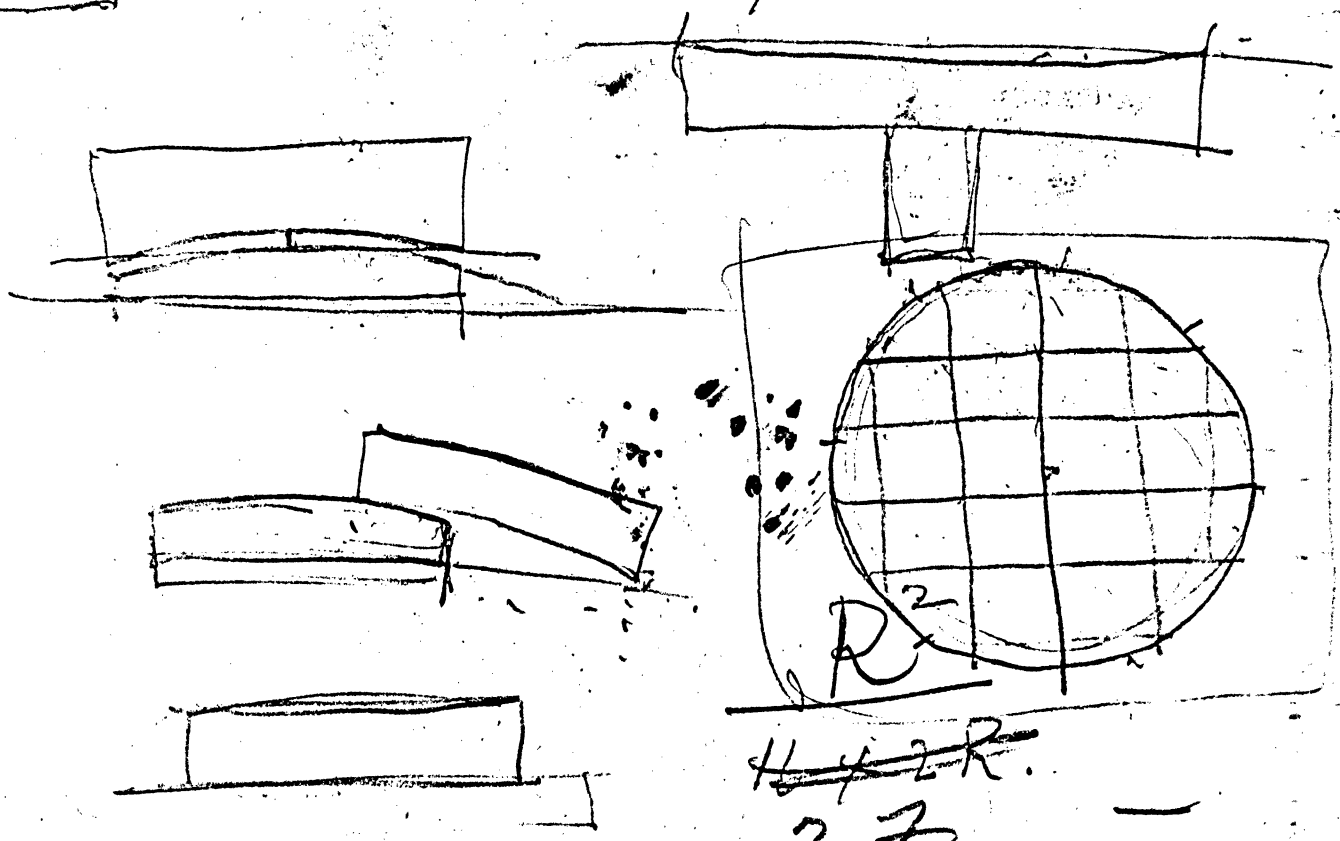
246.



~~H + 2R.~~

247.

Ring nebula in Lyra
Star Cluster in Hercules } p. 13.

4×4^2 7 $3\frac{1}{2} \times 3\frac{1}{2}$

2×9^2 $\frac{2}{7}$

~~18~~ 1

D. Freedman's Lrs - 108.

Figuring. 54.
" very important - 42 -

Time - p52.

Sebliossima 183.

Silvering - 62 74

σ Orionis 85.

J. E. Mellish - 1909.
Jan 27 87
Feb 20 94
Mch 1 97
Apl 11 150
" 22 138
May 12 - 177.
" 25 - 187

13.57 M. - p. 174.

133. 138

A. Prahl. {
148. Apl. 14. 1909.
133. Apl. 25 "
170. Apl. 30. 1909.
174. May 10. "
183. - May 20. 1909.

J. C. Boerthlein
1188 Burrard St.
Vancouver. B.C.

156 - Eng. Mech. Clippings

list of members 95.

Clefts on Moon - 31.

$K^1 K^2$ Tauri - 44.
ε Arietis - 72.

Spencer Lens - 65

blurring of star image - 72.

quantity of $AgNO_3$ - 174.