the ASTROGRAPH



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THE ASTROGRAPH



VOLUME V No. 2

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COVER PHOTOGRAPH

M8 and M20 Area

Photographer	John Sanford
Telescope	105mm Nikkor
Exposure	15 Minutes
F No.	2.8
Film	Tri-X Pan

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BASICS OF ASTROPHOTOGRAPHY

Prime Focus and Eyepiece Projection

Photographic techniques for astrophotography fall into two catagories: (1) Prime Focus and (2) Projection.

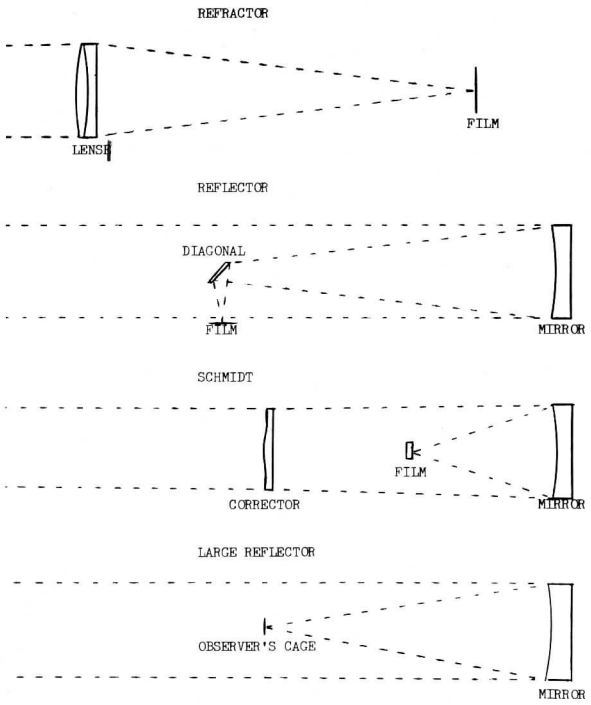
Prime Focus astrophotography is the technique of placing the film directly at the focal plane of an objective element (either a lens or mirror). Other than a flat mirror or a field corrector, there is no optical element between the objective and film.

Projection astrophotography involves the use of either a negative optical element (Negative Projection) or a positive optical element (Positive Projection). The most common negative projection optical system is the Cassegrainian or Maksutov telescope. Both utilize a negative reflective optical element. The least common type involves the use of a negative lens between the objective and film. When the negative optical element is placed in the converging rays from an objective, it decreases the original convergence and makes the original objective element appear to be further away from the film, just as objects when viewed through a negative lens appear to be further away. The effect of both negative optical elements is to increase the effective focal length as seen by the film.

The most common type of positive projection is Eyepiece Projection: i.e., an eyepiece is used as the projecting optical element. Actually any positive lens may be used including a concave mirror as in the case of the Gregorian optical system. When a positive lens is placed between the focal plane and film, it transfers the image from the focal plane of the objective to the film plane much as in the same way a slide projector projects the image of a slide onto a viewing screen. This projection may involve magnification or demagnification depending on the ratio of the distance between the focal plane and lens and the lens and the film plane. Ratios greater than one cause demagnification, less than one cause magnification and equal to one cause no magnification.

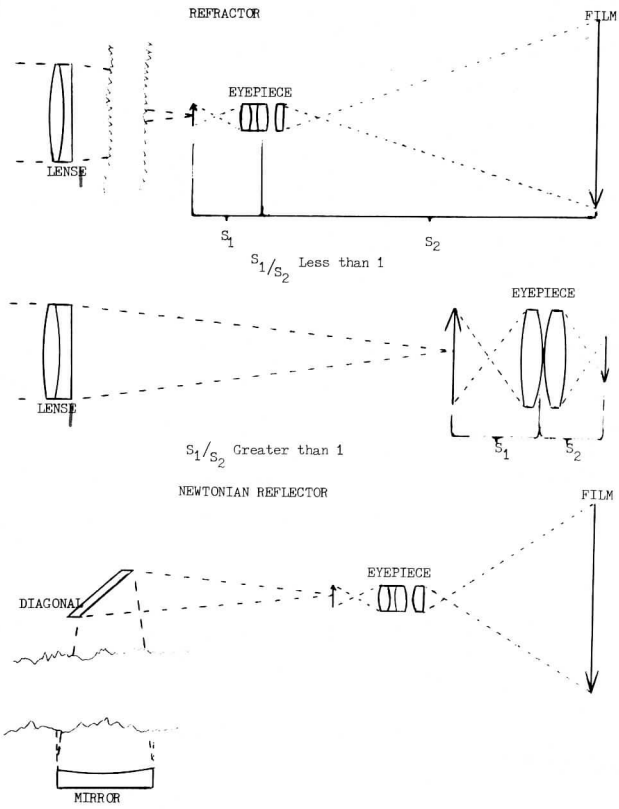
When photographing celestial objects, the moon or planets, the photographic techniques previously discussed have specific advantages and disadvantages, depending on the object being photographed.

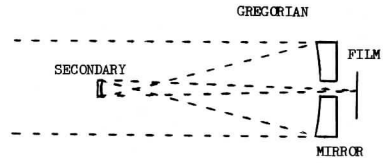
PRIME FOCUS



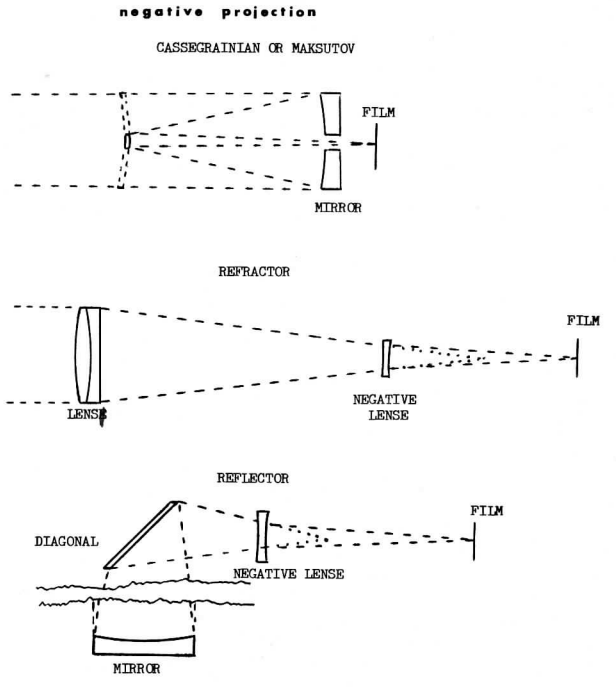
EYEPIECE PROJECTION

positive projection





negative projection



In general good focal ratios for celestial photographs vary from F/2.5 to F/6. Instruments having focal ratios of F/3 and smaller are usually highly corrected lenses or Schmidt telescopes which utilize a corrector lense to increase the useful field.

The one exception to using the Prime Focus technique in celestial photography is when the object is small and bright, and resolution is a prime consideration as in the case of double stars, small nebula, or star clusters. In these cases negative or positive projection may be used with magnifications of two to three times being helpful. Negative projection has somewhat limited useful field, usually less than 15 arc minutes, while positive projection, requiring a long focal length eyepiece (about one inch focal length) and long projection distances, has useful fields of 30 arc minutes or greater. Theoretically the exposure time for stars should not vary if a projection system is used because stars are point sources and have diffraction disks which are smaller than film grain sizes. In practice atmospheric turbulence, the quality of the projecting optics, and significant amounts of magnification, will tend to make stars act more like extended objects than point sources. Thus exposures of five times for a two times projection and ten times for a three times projection will be common for galaxies and nebulae, and somewhat less exposures for double stars and star clusters.



ABOVE: An excellent example of positive projection photography by H. F. Zeh. He used an 8 inch reflector and 8mm projecting eyepiece to yield a F valve of 133. This 3 second exposure on Double X film was taken December 13, 1971





ABOVE: Orion Nebula, M42, taken at the prime focus of a 6 inch F/6 reflector by Eugene Harlan. One hour exposure on 103a-E, $3\frac{1}{4}$ x $4\frac{1}{4}$ plate.

LEFT: 7x enlargement of region of M42 of the above photograph.

In celestial photography most objects have diameters of many minutes of arc and the resolution afforded at prime focus is sufficient. However, in the case of Lunar and Planetary photography where resolutions of a few arc seconds or less are required, normal fine grain film is not capable of resolving what the objective of most small telescopes are capable of resolving. When using a fine grain film with a resolution of 100 line pairs per millimeter (lp/mm), a focal length of 80 inches is required in order to be capable of resolving one arc second. This is a theoretical calculation based on a one to one match between film and image scale, and the 100 lp/mm resolutic of the film is measured at 100 per cent contrast. In practice, a factor of 2 or 3 is required in film resolution over image scale and contrasts of 20% to 5% are common in planetary detail. Thus even the 4 to 5 factor magnification increase of most commercially available Cassegrainians is not sufficient to resolve planetary detail. In general, with most 6 inch or larger telescopes, an effective focal length of 500 inches or longer is required. For a 6 inch F/8 this would require a projection system with a magnification factor of at least 10.5; for a 12 inch F/6, a factor of at least 7. Normal negative lenses, Cassigrainians, and Gregorians do not provide these focal lengths. This is why almost all high resolution Lunar and Planetary work utilizing commercial and home built telescopes is done with eyepiece projection.

Celestial photography involves galaxies, nebula and star clusters. For such objects, extended exposures will bring out detail when could not be visually observed through the same instrument. Because of the dimness of such extended sources as galaxies and nebula, the focal ratio is of major concern, since the exposure is proportional to the square of the focal ratio. An exposure of 20 minutes at F/3 would comparatively require an exposure of at least 80 minutes at F/6. Actually, the exposure at F/6 would require more than 80 minutes in order to get the same film density as at F/3 because the density build up of the film is not proportional (linear) with the Logarithm of the exposure. This is known as resiprocity failure of photographic emulsion and usually occurs with exposures of less than one second to one minute depending on the type of film.

Because of such factors as exposure being proportional to $(\text{focal ratio})^2$ and resiprocity failure, the focal ratio must be kept to a minimum in celestial photography. This is the reason that the Prime Focus technique is almost always used. It utilizes the focal ratio of the objective while the projection techniques are used to increase the focal ratio of the objective. The one exception, in the case of Positive Projection, is when a rather large condensing lense is used to decrease the focal ratio of the objective. This is seldom used, but has been used with large refractors having large focal ratios, such as F/15. This type of projection has two serious disadvantages: (1) the absorption of the projecting lense elements and (2) the projecting lense must be rather large if a sizeable field is to be photographed.

Robert Price

LETTERS

Gentlemen:

I have just received my first copy of the ASTROGRAPH, and I am impressed with the quality of your magazine. If possible I would like to obtain the back issues for Vol. III and IV....

C. R. Hammond

On behalf of the ASTROGRAPH and its staff, we thank you for your kind compliments. We were fortunate in our choice of printers for this expanded version of the publication. He may be one of the most expensive in the area, but I feel the quality of the printing is well worth the additional cost.



ABOVE: M51 by Eugene Harlan, using his 6 inch F/6 refractor. Exposure was 60 minutes on a 103a-E, $3\frac{1}{4}$" x $4\frac{1}{4}$" plate.

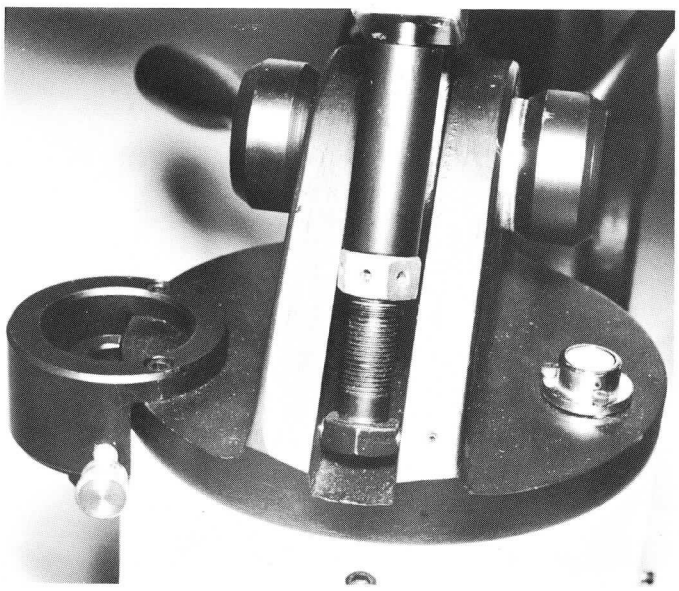
We have had several requests for back issue. The ASTROGRAPH was published monthly as a three paged mimeographed magazine with one page of photo offsets from July 1962 (Vol. 1 #1) to June 1966 (Vol. IV #12). The subscription rate was $2.00 per year. We will make an inventory of the issues we have and publish a list of available issues in our next publication. After viewing the ASTROGRAPH in its current format, the ASTROGRAPH Vol. 1 through Vol. IV would certainly be a disappointment. We are using some of the better photographs that appeared in Vol. I-IV where appropriate in forthcoming issues.

Currently we are receiving such excellent photographs from contributors that it is difficult to image that photographs taken today should be so much better than those taken 5-10 years ago, even though the equipment and film are essentially the same. An excellent example of this is the group of photographs taken by Mr. Howard Zeh illustrating the article on Martian photography. The improvement over the years is typical of the improvement in photography in general.

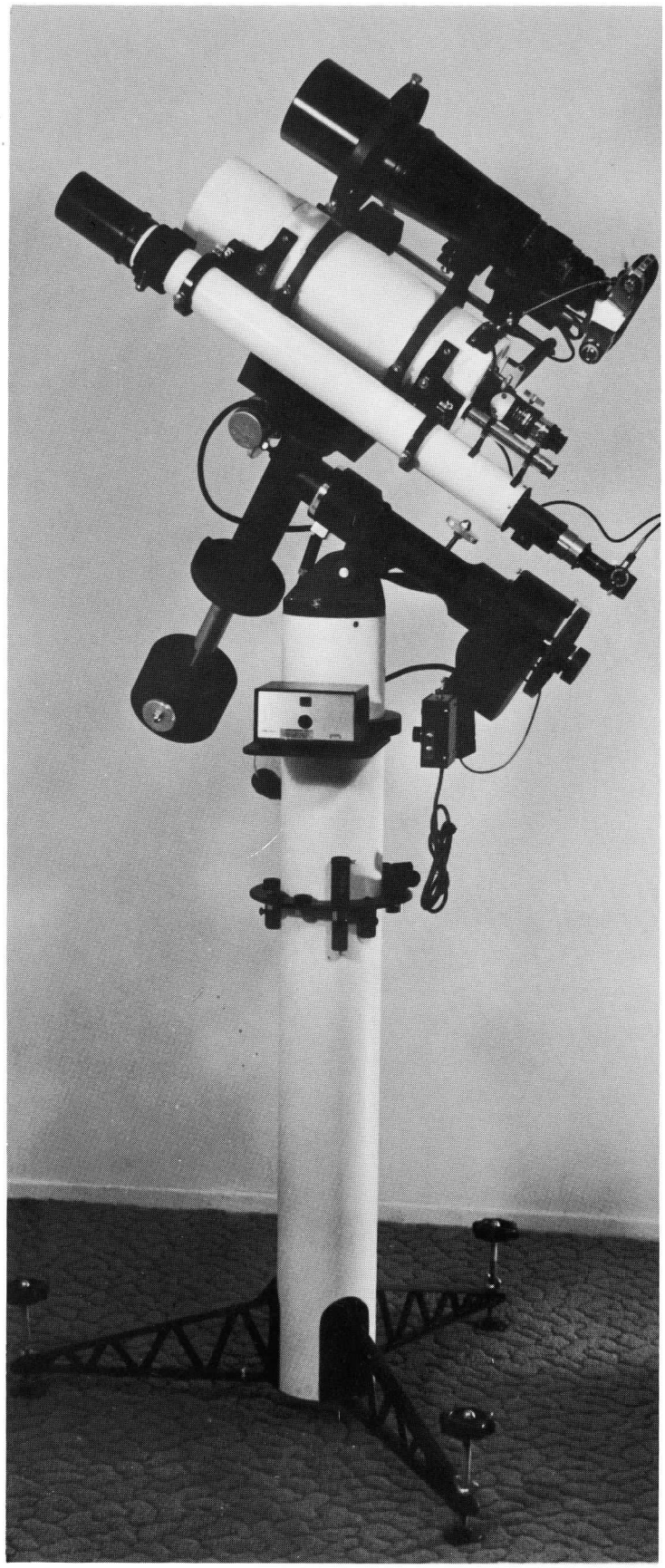
Editor's note: I wish to apologize for the typos in the last issue. I was able to borrow an IBM typewriter and have the first article retyped. Because of the rush to get the first issue out to you, I forgot to proof the article. Note the difference in type between the first column (the IBM typewriter) and the second column on Page 10 of the last issue. Your opinions of which type you prefer as a reader are welcome as well as opinions on the 50% reduction of the picture captions in the last issue as opposed to the 2/3 reduction in this issue. The type you are reading is a 75% reduction of the standard typewriter.

BELOW: Mr. Townsend's 500mm F.L. F/4.5 Takumar telephoto lense and mounting brackets. The Takumar lense is a Cooke-Triplet Optical Configuration with built-in extender lense. The rear lense mounting bracket features a novel ball and cone contact arrangement that can swivel and tie-down. The front bracket is the standard ring type with three spring loaded radial alignment screws and tie-down wing nuts. Mr. Townsend's statement is that "the Takumar lense mount works well, and other amateurs are advised to incorporate similar designed into the mounting of their long focus commercial camera lenses.

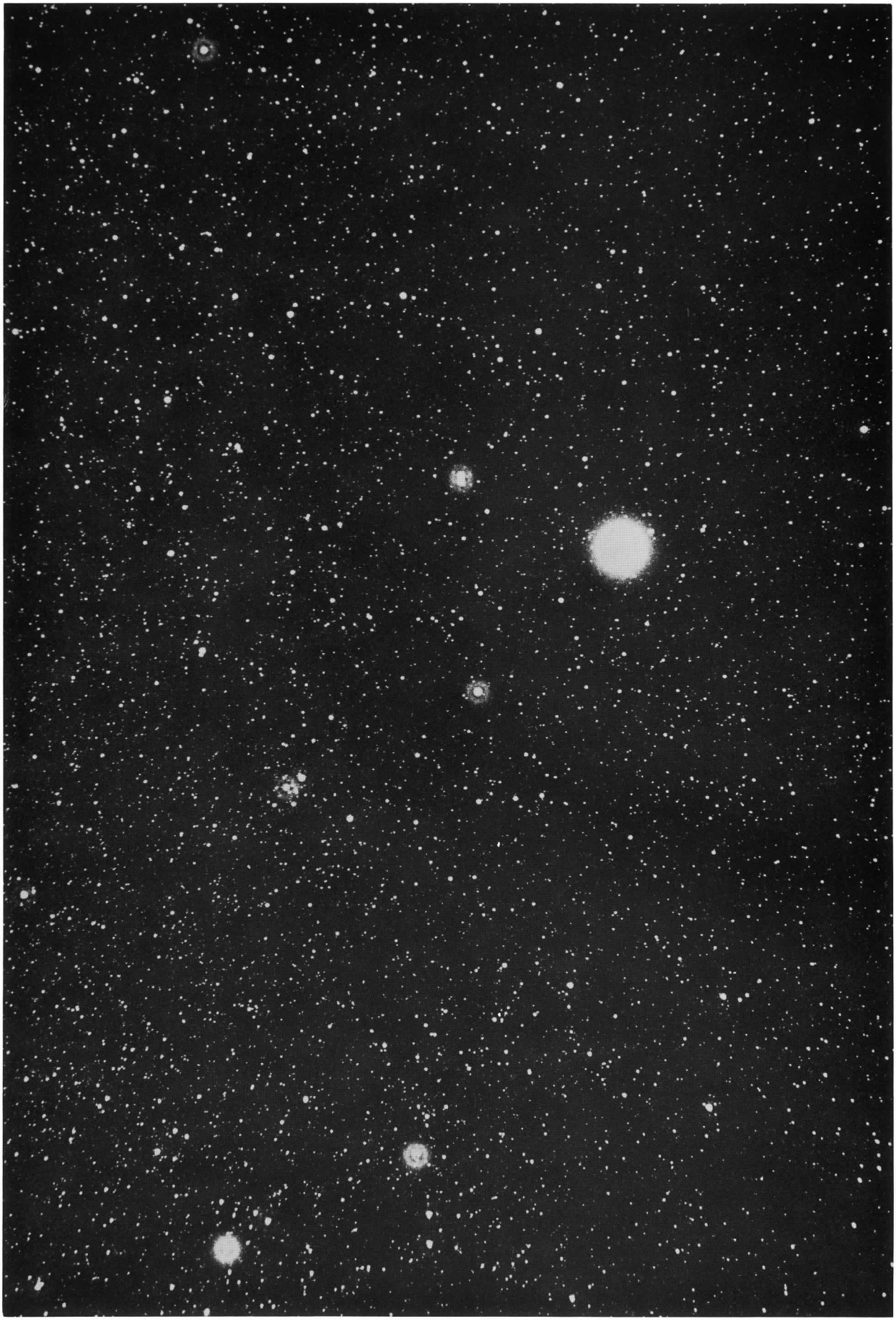




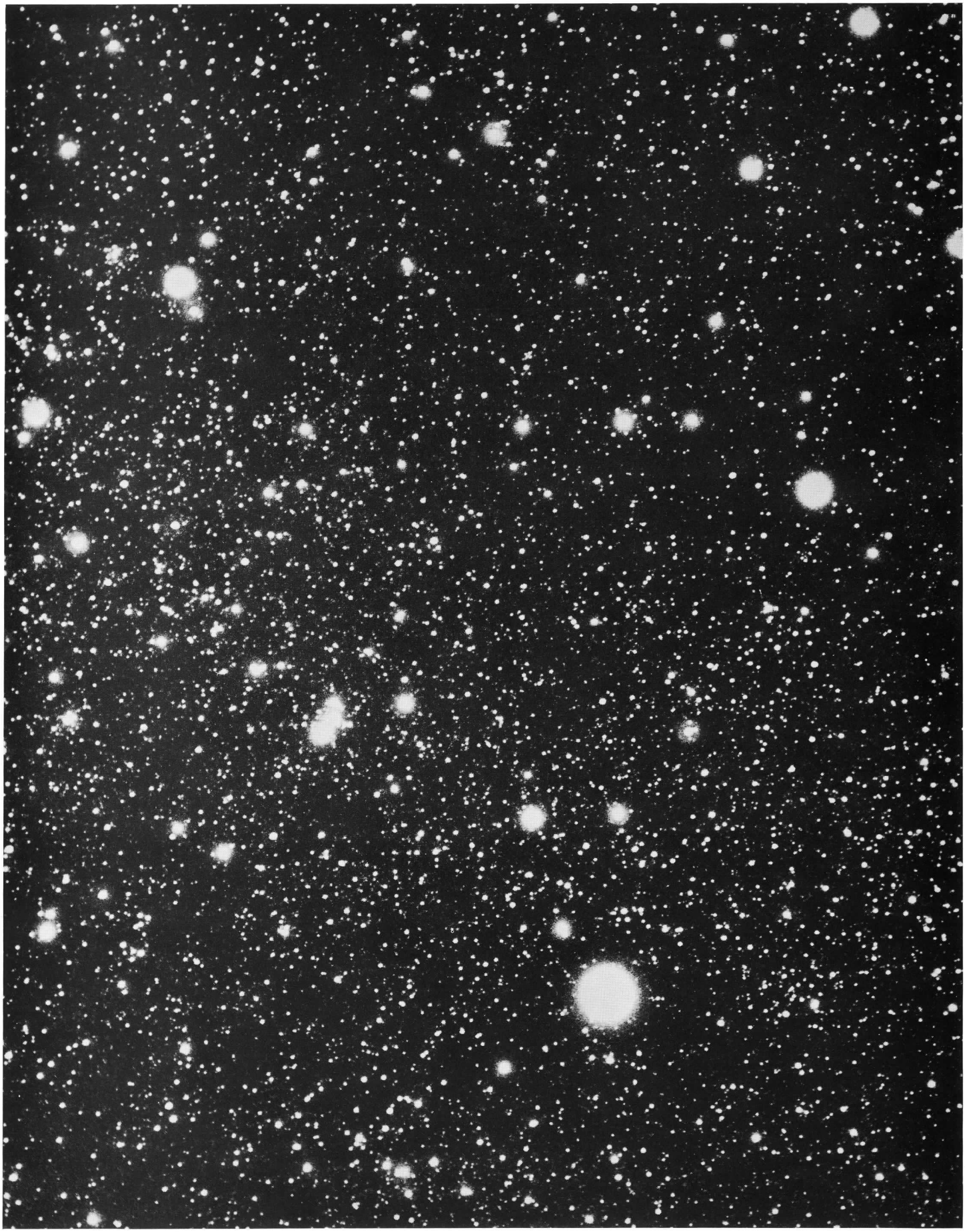
ABOVE: Closeup of equatorial Head of Custom Photo-Visual System. It features Quick-Cock Handles, Bubble level, Azimuth Adjust, and Elevation Adjustment custom designed.



ABOVE: Mr. Charles Townsend's custom Photo-Visual Patrol System. Uppermost is a 500mm F.L. F/4.5 Takumar telephoto lense. Center 5 inch aperture Gregory-Maksutov, visual and guiding telescope. Lower 2.4 inch guide telescope. The extra heavy duty mount has all electric guiding controls (DC or AC).



ABOVE: Constellation Lyra by Mr. Townsend. Exposure was 15 minutes using a 135mm F.L. F/2.8 Lentar telephoto lense stopped down to F/3.5. Film was 103a-F developer in D-19 for 4 minutes at 68°F.



ABOVE: Bright star Ksora (δ Cassiopeia) and surrounding area by Mr. Charles Townsend. His 25 minute exposure was taken on August 4, 1973 with a 500 mm F.L. F/4.5 Takumar telephoto lense stopped down to F/5.6. Film used was 103a-F developed in D-19 for 4 minutes @ 68°F. Taken from Mount Pinos.

MARTIAN PHOTOGRAPHY

Mars is approaching a favorable opposition for photography. Opposition will occur on October 25 when Mars will be 21 arc seconds in diameter. This opposition is especially favorable because Mars will be placed high on the ecliptic (+10° in declination). In addition the author has found the best seeing conditions occur in the Spring and Fall. September, October and November are usually good months for seeing.

There are several distinct advantages and disadvantages when photographing Mars as compared with photographing such planets as Jupiter and Saturn. Of major advantage is Mars' brightness (per unit area). It is more than six times brighter than Jupiter and sixteen times brighter than Saturn. Thus a focal ratio twice as long as would be used on Jupiter, would require 2/3 the exposure. Or One could use a film one sixth as fast and the same exposure and focal ratio for finer grain.

Or one could use the same photographic set up for Jupiter but decrease the exposure by 1/6 to minimize atmospheric turbulence.

Because Mars is about half the diameter of Jupiter, the astrophotographer should consider either using a longer EFL or using finer grain film. These two methods are especially recommended as opposed to decreasing exposure time because Mars' altitude should minimize atmospheric turbulence. In considering what EFL to use, the following table gives the diameter on the negative and enlargement necessary to equal 1/2 inch.

EFL Inches	Image Diameter (21 arc secs. Planetary image Inches)	Enlargement Necessary (For $\frac{1}{2}$ inch dia. print)
240	.025	20x
480	.05	10x
960	.10	5x
1440	.15	3.3x
1920	.20	2.5x

As an example using a 10 inch reflector and 960 inch EFL would give an F value of F/96. Mars' brightness, normalized in unites to fit the formula T (exposure time) equals the square of the F# divided by the product of the brightness and film speed in ASA, is 160. Thus at F/92 using Tri-X at 400 ASA would necessitate an exposure of .14 seconds (try 1/5 second). A finer grain film with an ASA of 25 would require an exposure of 2.3 seconds. The 4x enlargement necessary with the 960 inch EFL should not produce very much grain with either Tri-X or slower speed film.

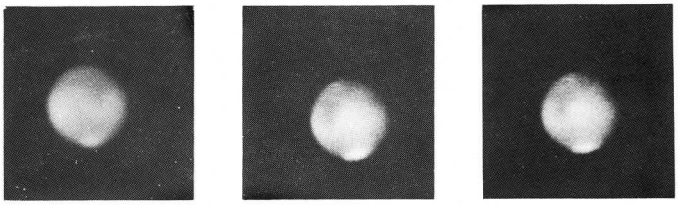
Because longer EFL is usually utilized when photographing Mars both atmospheric turbulence and any instabilities in the mounting or clock drive will show up in proportion to the increase in EFL.

Although the contrast in surface markings are usually small, they do not appear to be any more difficult to photograph than the low contrast details on Jupiter.

The features on Mars have one advantage over those on Jupiter. They can be enhansed by using film that is sensitive to or filters that only allow through the red half of the visual spectrum. Thus Kodak Spectra-graphic films type E & F are nicely suited for Martian photography.

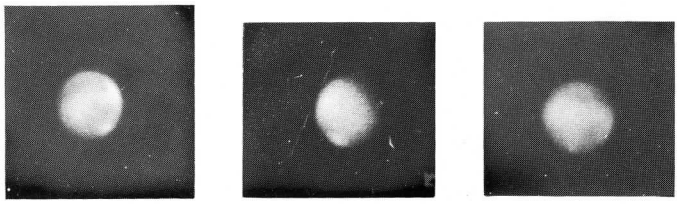
Robert Price

MARS 1963

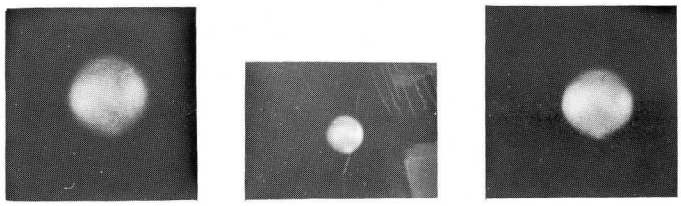


ABOVE LEFT: Mars taken 2/26/63, 1/2 second exposure on KB-14 film developed in Rodinal.
ABOVE CENTER: Mars taken 2/26/63.
ABOVE RIGHT: Mars taken 2/26/63 at about 230° Central Meridian.

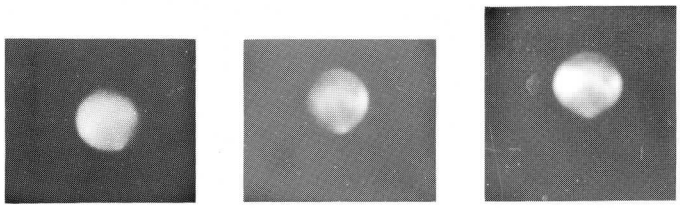
MARS 1965



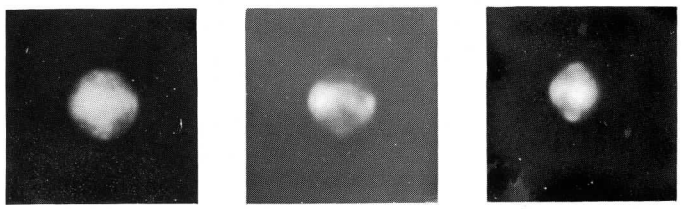
ABOVE LEFT: Mars taken 2/14/65. Positioned at 215° Central Meridian.
ABOVE CENTER: Mars taken 2/28/65, Exposure on IFF film developed in Rodinal.
ABOVE RIGHT: Mars taken 3/12/65, positioned at 0° Central Meridian.



ABOVE LEFT: Mars taken 3/20/65, positioned 250° Central Meridian.
ABOVE CENTER: Mars taken 2/28/65, exposure was $\frac{1}{4}$ second at F/80 on IFF film.
ABOVE RIGHT: Mars taken 3/21/65, positioned 255° Central Meridian.

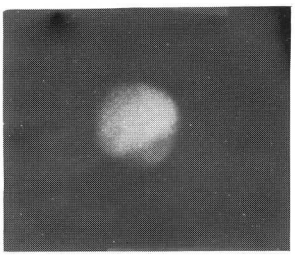


ABOVE LEFT: Mars taken 4/4/65, exposure was 3/4 second at F/80 on KB-14 film developed 2.5 minutes in Rodinal diluted 1 to 75 at 68°F positioned 135° Central Meridian.
ABOVE CENTER AND RIGHT: Mars in vicinity of Syrtis Major. F/80.



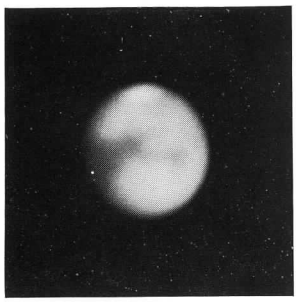
ABOVE: Mars in vicinity of Syrtis Major.

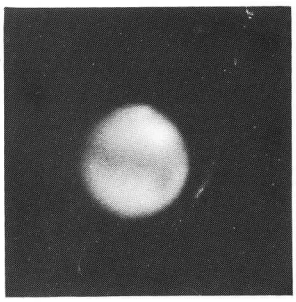
MARS 1969



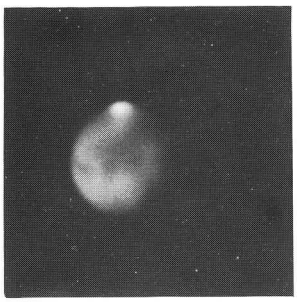
LEFT: Mars taken 6/10/69. 1/2 second exposure at F/80 on KB-14 film.

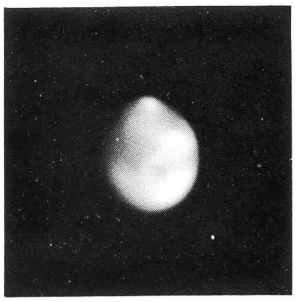
MARS 1971



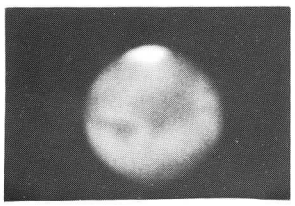


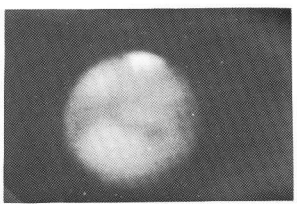
ABOVE LEFT: Mars taken 7/18/71. 3/4 second exposure at F/112 on KB-14 film. ABOVE RIGHT: Mars taken 7/27/71. 1/2 second exposure at F/112 on KB-14 film.





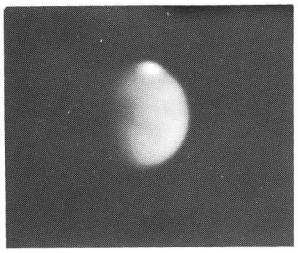
ABOVE LEFT: Mars taken 9/21/71, 5-6 second exposure at F/135 on VTE film (approx. 6.6 ASA).
ABOVE RIGHT: Mars taken 9/23/71, 2 second exposure at F/128 on IV-E film.

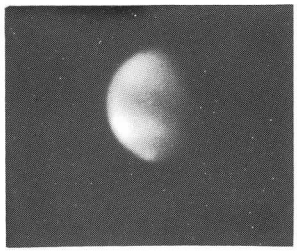


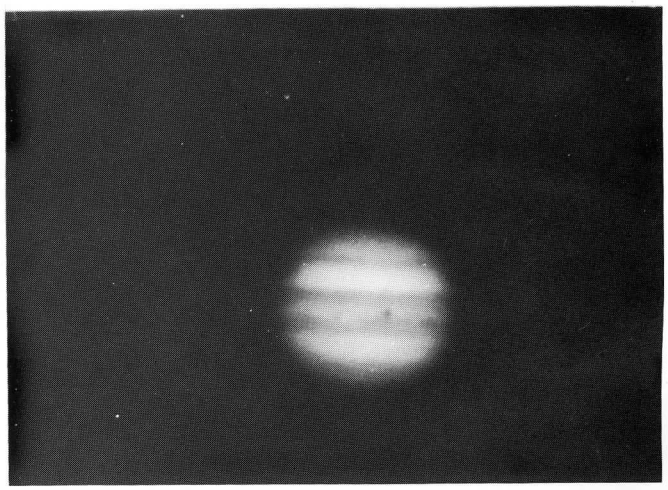


ABOVE LEFT: Mars taken 8/17/71, 2-3 second exposure at F/112 on KB-14 film.
ABOVE RIGHT: Mars taken 8/23/71 at F/135 on IFF film.

MARS 1973







ABOVE: Jupiter photographed on July 17, 1973 by Mr. H. F. Zeh. He used his 9 inch reflector at F/80 for this 3 second exposure on VTE film. Notice the satellite shadow.



ABOVE: Jupiter photographed on August 15, 1973 by Mr. H. F. Zeh. He used his 8 inch reflector at F/104 for this 6 second exposure on VTE film.

SATURN PHOTOGRAPHY

On the morning of October 17, the Moon will occult the planet Saturn for observers along a line north of Northern New York State. This event will occur after dusk for the East Coast, and before dusk for the West Coast.

Photographic data for the two photographs of the Moon on Page 15 of the last issue is as follows:

TOP PHOTOGRAPH: Region north of the Crater Bullialdus including the Craters Hesiodeus and Hesiodeus A.

BOTTOM PHOTOGRAPH: Crater Gassendi 5/11/65, 1/4 second exposure on Plus-X film at F/80.

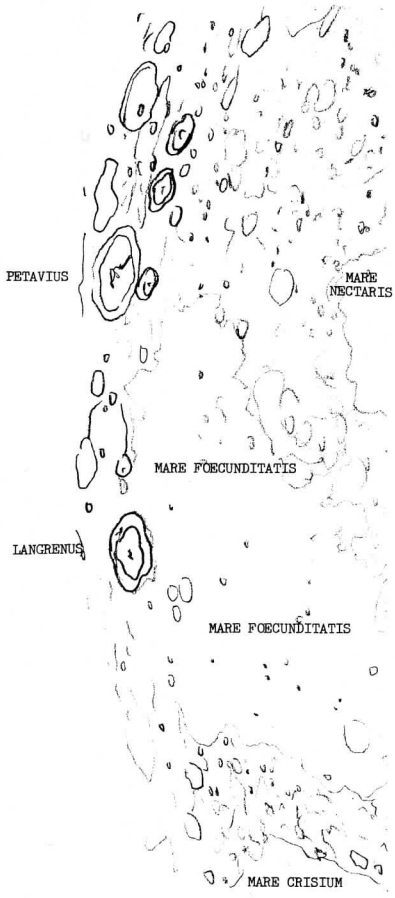
FAR LEFT: Mars taken 8/5/73, 3 second exposure at F/133 on VTE film.
LEFT: Mars taken 8/16/73, 2 second exposure at F/133 on VTE film.

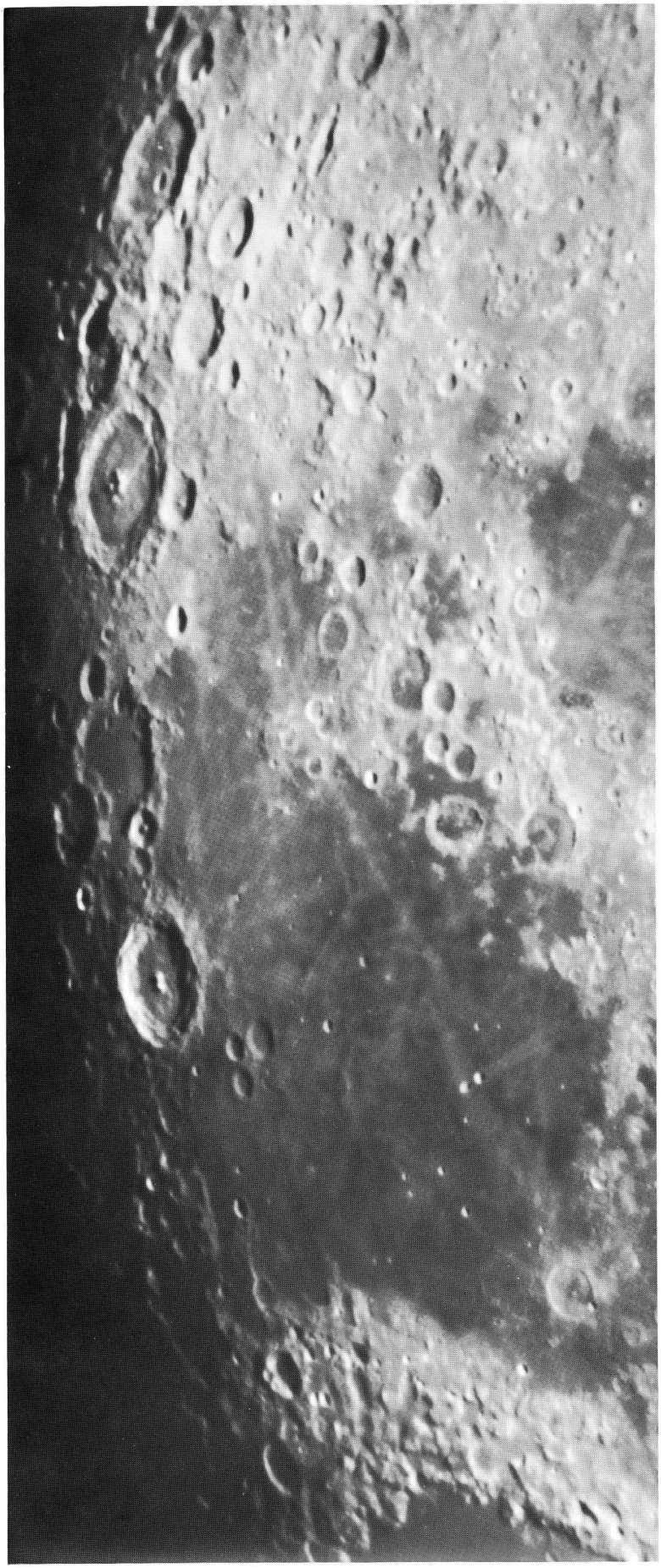
LUNAR PHOTOGRAPHY

The last quarter and Gibbous moon will be in excellent position for photography during October and November. When the moon is about two days past full, the terminator is in the area of the Mare Crisium. This Mare is unique in that it is one of two, the other being the Mare Smythii, which has a well defined shore line. The largest crater in the Mare is Picard which is in the Southwest portion. South of Picard is Lick, while west of Picard is Yerkes. Both these craters have low walls that appear to blend into the Mare.

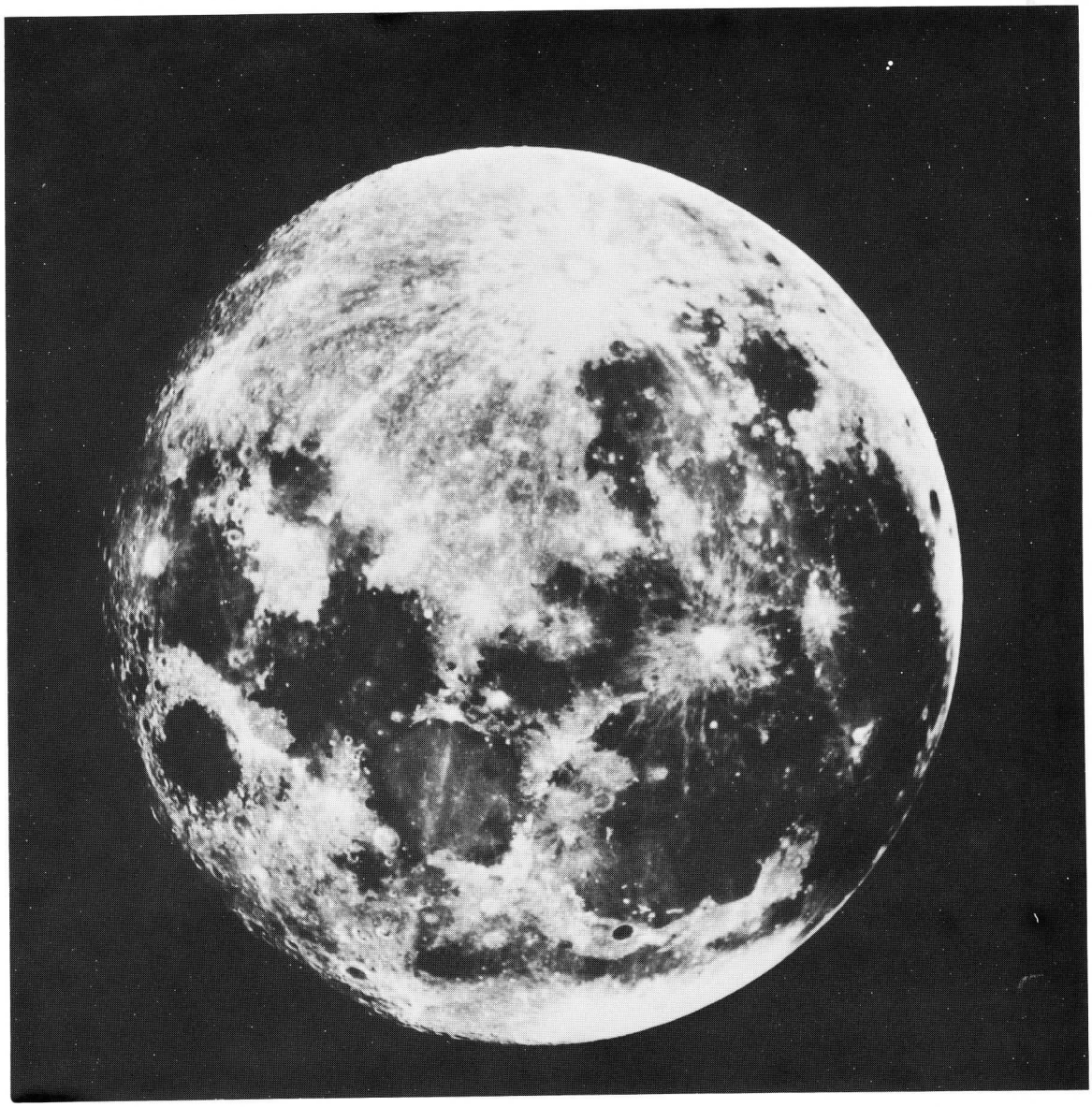
South of the Mare Crisium, along the terminator of the 16 day old moon lie the craters Langrenus, Petauius and Janssen (see Figure 1). If these craters were nearer the center of the moon they would be far more spectacular in appearance, but because they lie close to the edge, the shadows which would show their true nature are shortened because we see them at an oblique angle. Photographs that correct for the angle and show these craters from an overhead aspect are more impressive. Petauius has a unique feature running from the center peak which is in itself unique because of its crater appearance, to the Southwest wall. Janssen has a unique crater, Fabricius, inside and dominating its Northern portion. Fabricius has a horseshoe set of mountains inside the crater between the Northern half of its walls and the center peak. Janssen itself has an interesting depression running from Fabricius south to its southern wall. Janssen is the fourth largest Lunar Mountain walled plains, at 127 miles in diameter.

By the time the Moon is 18 days old the only feature previously described which is visible is Janssen which is in ideal photographic position as are the craters Atlas and Hercules which are North of the Lacus Somniorium. During the 19th and 20th days, the Mare Nectaris region and the craters Theophilos, Cyrillus, Catharina, Fracastorus, and Disccolomni are prominent as is the Mare Serenitatis





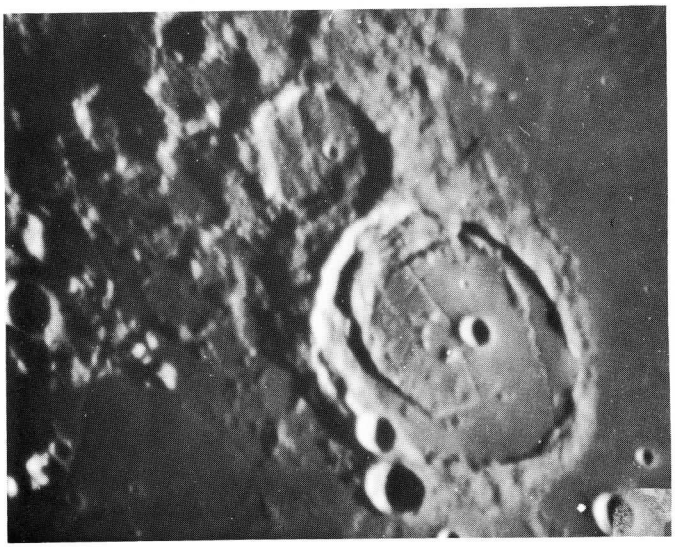
ABOVE: Figure 1. Sixteen day old Moon photographed by John Sanford on 12/22/72. Mr. Sanford used his 8 inch F/10 Celestron working at F/20 via negative projection. Exposure was 1 second on High Contrast copy film developed in D-76. Seeing was rated 4/5.



ABOVE: Fifteen day old moon photographed by Ken Owen on 1/31/72. Mr. Owen used his 10 inch F/6.15 reflector at prime focus for this 1/60 second exposure on High Contrast copy developed in FG-7. A W-14 yellow filter was used. Seeing (0-5) was rated at 4.



ABOVE: Crater Theophilos taken by Eugene Harland in April 1964 using a medium size professional refractor. Exposure was 3 seconds on baked Tri-X film.



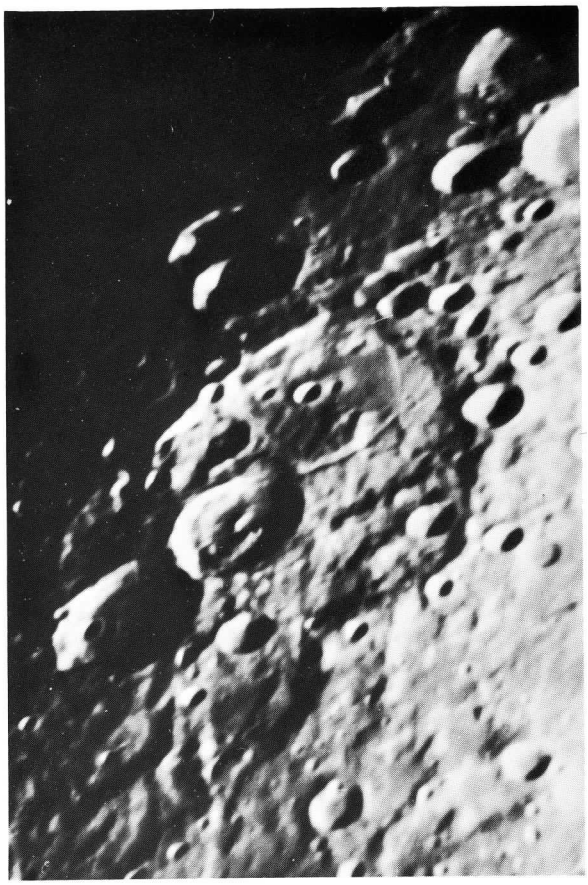
ABOVE: Crater Posidonius photographed in the Summer of 1963 by Eugene Harland who had access to a medium sized professional reflector for this 3 second exposure on baked Tri-X film. Enlargement is 5x.



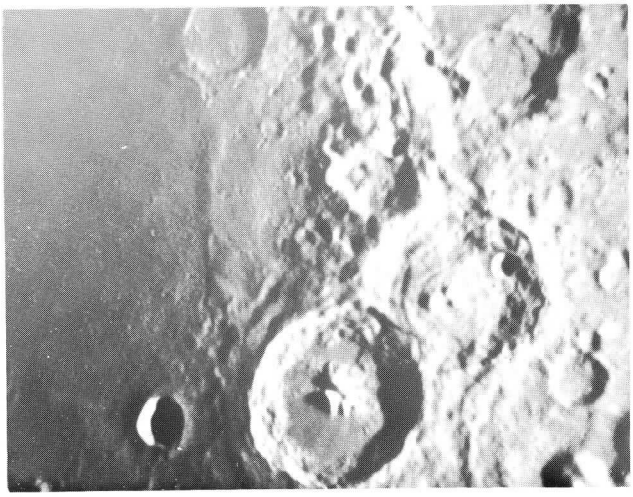
ABOVE: Lunar area of the Caucasus Mountains and craters Eudoxus and Aristoteles. Photographed July 13, 1971 by John Sanford using a 12 inch Ritchey-Chretien F/10 telescope and 2x telextender. Exposure was 1 second on high contrast copy developed in H & W control.

and the craters Posidonius, Burg, Eudoxus and Aristoteles. The western edge of the Mare Nectaris provides a test for high resolution because this area is covered by hundreds of small craters ranging from one to two miles in diameter. Theophilus has a center series of peaks that are as difficult to resolve well as the small craters on the floor of Fracastorus, Beaumont and Catharina. Just Southwest of Mare Nectaris is what appears to be another outer wall, the Altai Scarp. The fine rills on the floor of Posidonius as well as the fine detail around the area of Eudoxus and Aristoteles provide another test for high resolution photography. The Lacus Mortis appears almost like a crater because its Eastern half is not seen clearly as it blends into the Mare Frigoris. Photograph features as the moon approaches 22 days will be continued in the next issue.

Ralph Proctor



ABOVE: Lunar Crater Janssen photographed 11/11/71 by Robert C. Price with his 12.5 inch F/6 reflector working at F/80. Exposure was 1 second on IV-E film developed 6 minutes at 70°F in FG-7 1:15 (9% Sodium Sulphite).



ASTROPHOTOGRAPHY FOR OCTOBER AND NOVEMBER - CASSIOPEIA

Cassiopeia is easily recognized by its "W" shape. This constellation is rich in galactic clusters because the plane of the Milky Way runs through it. One of the most well known galactic clusters is the famous Double Cluster, h Perseus and X Perseus, which actually lies in the constellation Perseus. Both clusters are 36 minutes of arc in diameter and approximately magnitude 4.4 and 4.7 respectively. H Perseus is located at RA 2^h $15^m.5$ decl. +56°55', while X Perseus is located at RA 2^h $18^m.9$ decl. +56°53. They contain 350 and 300 stars respectively. In the Southeastern corner of Cassiopeia lies various diffused nebula with associated galactic clusters (IC 1848 and IC 1805), the nebula IC 1871, the planetary nebula IC 289 (12.3 magnitude and 45x30 arc seconds in diameter), and the galactic cluster 1027. I will try to describe the above mentioned items photographically in the next issue.

IC 1747 (RA 1^h $53^m.8$ decl. +63°04') is a 13th magnitude planetary 13 arc seconds in diameter. The galactic clusters 637 (RA 1^h $38^m.3$ decl +63°47') and 559 (RA 1^h $26^m.1$ decl +58°04') are not readily found on photographs taken with a 12 inch FL. F/2.5 Aero Ektar lense (15 and 30 minute exposures on Tri X developed for six minutes at 75°F in FG-7 diluted 1:3.

The galactic cluster 663 (RA $1^h42^m.6$ decl. +61°01') is a 7.1 magnitude object consisting of 80 stars some 11 minutes in diameter. Photographs with the 12 inch F/2.5 resolve one or two dozen stars. M103 (RA 1^h $29^m.9$ decl. +60°27') is a 7.4 magnitude galactic cluster 5 minutes in diameter which consists of 60 stars. The 12 inch F/2.5 shows 4 stars and a small amount of nebulosity. In Mr. Townsend's photograph on page 8, M103 is located 4 inches from the bottom and $2\frac{1}{2}$ inches from the left hand edge of the photo. In Mr. Townsend's photograph M103 looks like a triple star. The galactic cluster 457 (RA 1^h $15^m.9$ decl. +58°04') resolves into about a dozen stars. It is 10 minutes in diameter and of magnitude 7.5. It consists of about 100 stars. Diffused nebula IC 63 (RA 0^h $56^m.4$ decl. +60°33'), IC 59 (RA 0^h $53^m.7$ decl. +60°48') and 281 (RA 0^h $50^m.4$ decl. +56°19') were not apparent on either the 15 or 30 minute exposures. 281 was just visible on a 15 minute exposure of the area with a 135 mm lense and 103af film. Galactic clusters 103 and 129 are not very apparent as galactic clusters as is the case with clusters 146 and 133 which border the star K Cassiopeia.

Galactic cluster 7790 (RA 23^h $54^m.5$ decl +60°56') is seen as about a dozen of the 25 stars that make up this 7.1 magnitude cluster that is only 6 minutes in diameter. Galactic cluster 7789 located between p and σ Cassiopeia appears as an unresolved mass of stars about 30 minutes in diameter. M52 (RA 23^h $22^m.0$ decl. 461°20') is a 7.3 magnitude galactic cluster 12 minutes in diameter and consisting of some 120 stars. A fifteen minute exposure of the area with the 12 inch F/2.5 reveals a small amount of nebulosity with perhaps 3 or 4 stars resolved. Attempts to recognize the eliptical galaxies 147 (RA $0^h30^m.4$ decl. 48° 14'), 185 (RA $0^h36^m.1$ decl. +48°04') and 278 (RA 0^h $49^m.2$ decl. +47°18') were unsucessful on either the 15 or 30 minute exposures. Recognition may have been hampered by the fact that the area in question was in the extreme corner of the film area. 185 is a 2.2 x 2.2 minute in diameter eliptical of magnitude 10.3.

John Phillips

LEFT: Craters Theophilus (Bottom), Cyrilles (center) and Catharina (Top) photographed 9/9/71 by Robert C. Price with his 12.5 inch F/6 reflector working at F/80. Exposure was 1 second on IV-E film developed in FG-7 for ten minutes at 78°F.



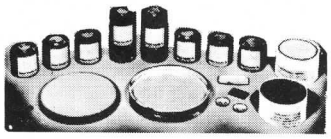
ABOVE: Constellation CASSIOPEIA by John Phillips using a 12 inch F.L. F/2.5 lense. Exposure was 30 minutes on Tri-X Pan, 4" x 5" sheet film developed 6 minutes in FG-7 1:3 at 75°F. Area #1 h and X Perseus; Area #2 NGC 663; Area #3 NGC 581 (M103); Area #4 NGC 457; Area #5 NGC 281; Area #6 NGC 7790.

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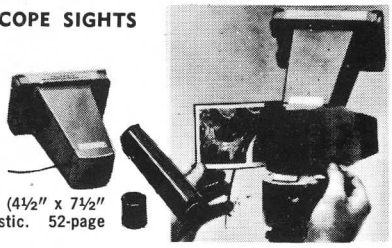


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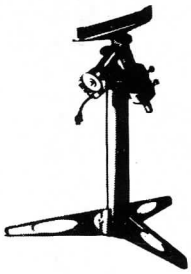
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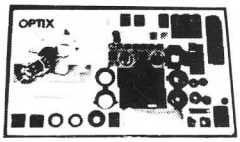
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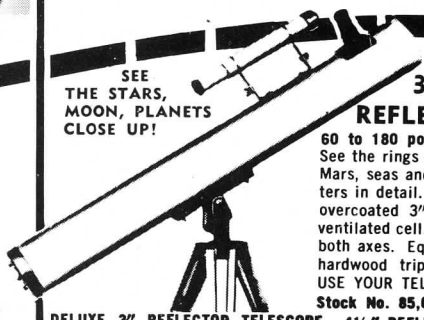




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