CHAPTER 4

PRACTICAL USES OF INFRARED PHOTOGRAPHY

4.1 Infrared Rays in General Landscapes Photography and some Applications.

In 1890 O.N. Rood published curves showing the high reflectivity of leaves in the extreme red.

In 1911 R.W. Wood was the first photographer who had used the special film and liquid filter for the spectroscopy of extreme red.

In 1924 W.H. Wright made the first long-distance photographs which showed the superiority of the infrared in penetrating atmospheric haze.

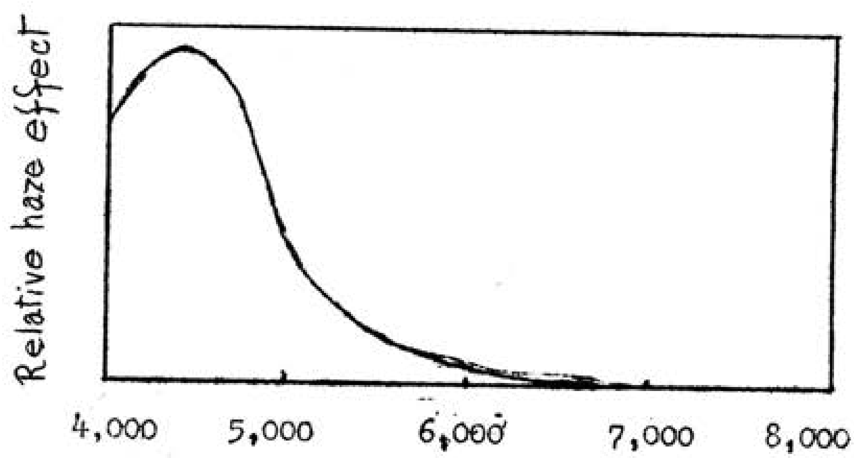


Fig.4.1 Curve showing relation between haze and wavelength.

Few years later M.Hugon made the long-distance photograph. He used the film which was sensitized in 5,700 A and 8,300 A wave - lengths. He concluded that the objects at a distance of 200 km. appeared quite clearly and some occasion when the visibility was 40 km, it was increased only to about 60 km.

N.M.Mohler repeated and extended the determinations of Hulburt the results agreed with those of Hulburt and showed good agreement with Harrison's calculation.

In 1934 W.Clark studied the possibility of increasing visibility through fog at sea using infrared photography, the results agreed essentially with those of Hulburt and Mohler.

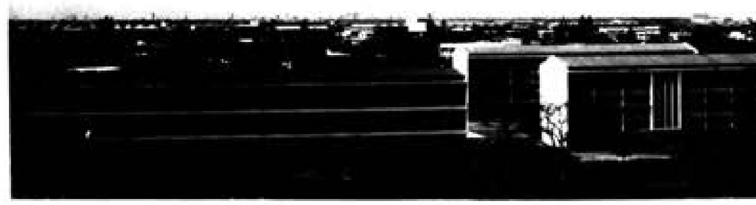
4.1.1 Landscape Infrared Photography.

The acknowledgement of infrared radiation and visible radiation often are reflected and transmitted quite differently by common objects. For example, chlorophyll in live green foliage and grass absorbs a large percentage of the visible radiation which falls upon it but absorbs little of the invisible infrared radiation. This radiation is reflected almost entirely by the leaf and blade structure, and therefore is recorded by means of the infrared sensitive material. Then foliage and grass should appear white in an infrared photograph. The objects in which do not reflect strongly in the infrared will appear dark. Many types of soil, rocks, and sand also have high infrared reflectivity, hence their infrared photographs should appear lighter. Ordinary photographic materials render blue sky relatively light, that is, there is little infrared radiation is present in blue sky, then the infrared materials should render it dark.

The following are landscape photographs:-

L1

L3



L2

L4

No. L - 1, L - 3 are ordinary photographs. Distant scenes at horizon are not sharply rendered as No. L - 2, L - 4, the infrared photographs.

L-5

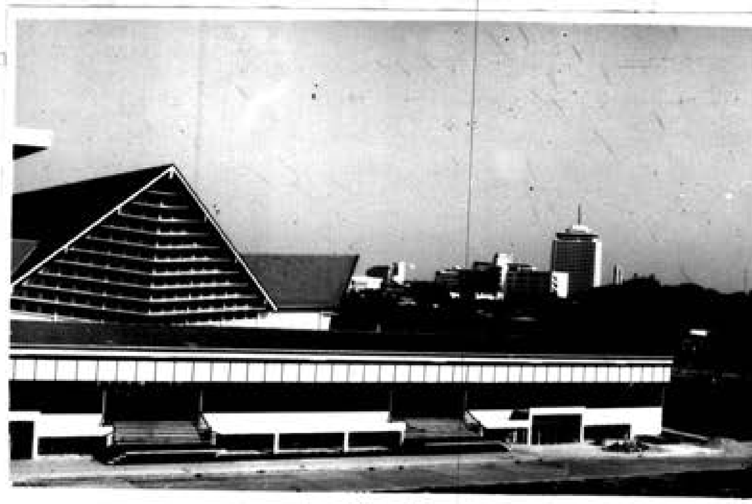
L-6

No.L-5 is an ordinary photograph.

No.L-6 is an infrared photograph showing white clouds against dark sky and a prominent scenes of distant subjects.

No. L - 7 is an ordinary photograph with structural lines not sharply defined compared with No. L - 8 and No.L - 9, the infrared photographs.

No. L - 10 is an ordinary photograph.



L - 10

No. L - 11 is also an ordinary photograph but filter No. 29 is used over camera lens, showing darker sky and [illegible] lighter shadows.

L - 11

No. L - 12 is an infrared photograph showing darker sky, darker shadows and white leaves and grasses.

L - 12

4.1.2 Fog and Haze Penetration.

When a distant scene is photographed with the usual photographic material, object details are often obscured by haze even when a filter is used. Consider the folloing ordinary photographs of a distant scene, then compare them to infrared photographs of the same scene.

See page 54.

No.H-1 is an ordinary photograph of distant scenes.

No.H-2 is an infrared photograph of the same scenes as No.H-1, A mountain at about 50 km away appears against dark sky and white clouds.

No.H-3 is also an ordinary photograph of Bangsaen sea side taken at the same time as No.H-4, an infrared photograph. The distant island scene appears against dark sky, black water and white leaves.

See page 55.

No.H-5 is the same scene as No.H-1 and No.H-6 is the same scene as No.H-2.

See page 56.

No.H-7 and H-9 are ordinary photographs of light scenes. The plates visibility are shorter than No.H-8 and No.H-10 the infrared photographs.

See page 57.

No.H-11 is an ordinary photograph taken through a heavy fog scene of 50 meters visibility.

No.H-12 is the same scene as No.H-11 with a poorer visibility.

H - 1

H3

H - 2

H - 4

(See page 53)

H - 5

H - 6

(See page 53)

H - 7

H - 9

H - 8

H - 10

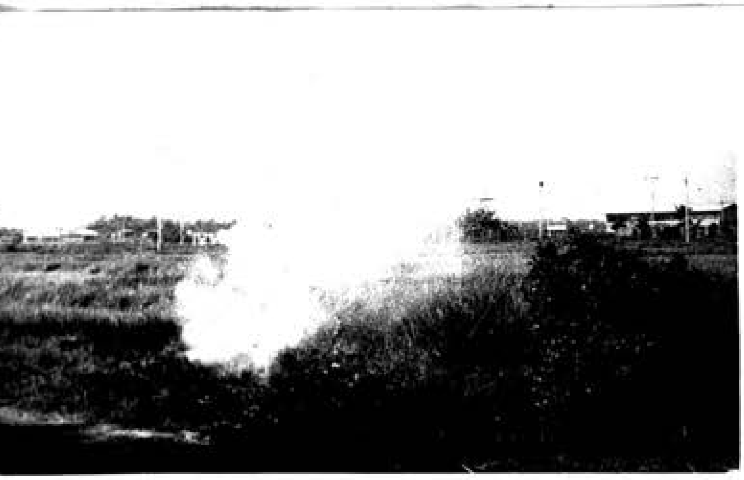
(See page 53)

H - 11

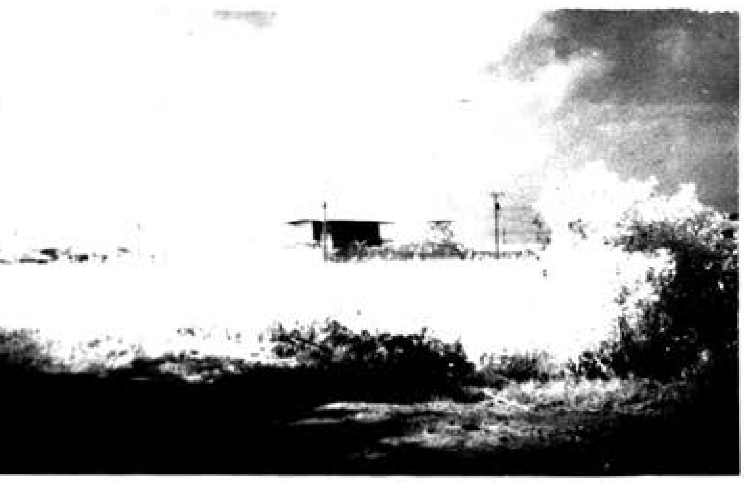
H - 12

(See page 53)

H - 13



H - 15



H - 14

H - 16

No. H - 13 is an ordinary photograph taken through light smoke.

No. H - 14 is an infrared photograph with the same scene as No.H-13

No. H - 15 is an ordinary photograph taken through a dustmscene.

No. H - 16 is an infrared photograph of the same scene showing no difference.

4.1.3 Moon light scene in daylight.

The above infrared landscape photographs are characterized as follows; the sky is rendered almost black, clouds and land are white, shadows are dark but often show considerable details, grass and leaves appear very light as if covered with snow. Photographs taken by infrared in sunlight and then printed slightly darker than normal are looked like they were taken in moon light. This effect have been applied in professional motion picture.

See page 60.

No.M-1 is an ordinary photograph.

No.M-2 and M-3 are the infrared photographs taken at the same time as No.M-1. No.M-2 was developed darker than No.M-3 which make it looks like to be taken in moon light.

See page 61

No.M-4 is an ordinary photograph.

No.M-5 is an infrared photograph of the same scene showing moon light scene.

No.M-6 is another moon light scene.

M - 1

M - 2

M - 3

(See page 59)

M - 4

M - 5

M - 6

(See page 59)

4.1.4 Infrared in Architectural Photography.

From the above landscape infrared photographs, the sky is rendered almost black, shadows are dark but show more details, distant details are rendered with remarkable clearity. These effects can be applied with architectural photography, inwhich ordinary architectural photographs cannot show structural lines sharply against white sky background.

Consider the following architectural photographs:-

See page 63.

No.Ac-1 is an ordinary photograph taken against white sky. All structural lines and paintings are not so sharply defined as No.Ac-3 an infrar ed photograph.

No.Ac-2 is an ordinary photograph using infrared film without filter, showing darker sky.

See page 64.

No.Ac-4, Ac-6 are ordinary photographs.

No.Ac-5 and Ac-7 are infrared photographs. Structural lines of the building are sharper than ordinary photographs.

See page 65.

No.Ac-8 is an ordinary photograph. No.Ac-9 is also an ordinary p photograph taken through filter No.29F showing darker sky.

No.Ac-10 is another ordinary photograph using IR-135 film.

No.Ac-11 is an infrared photograph showing sharper structural lines.

Ac - 1

Ac - 2

Ac - 3

(See page 62)

Ac - 4

Ac - 5

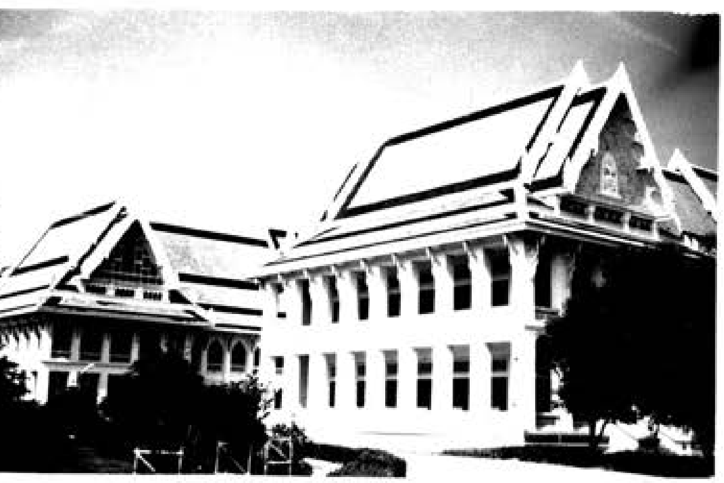
Ac - 6

Ac - 7

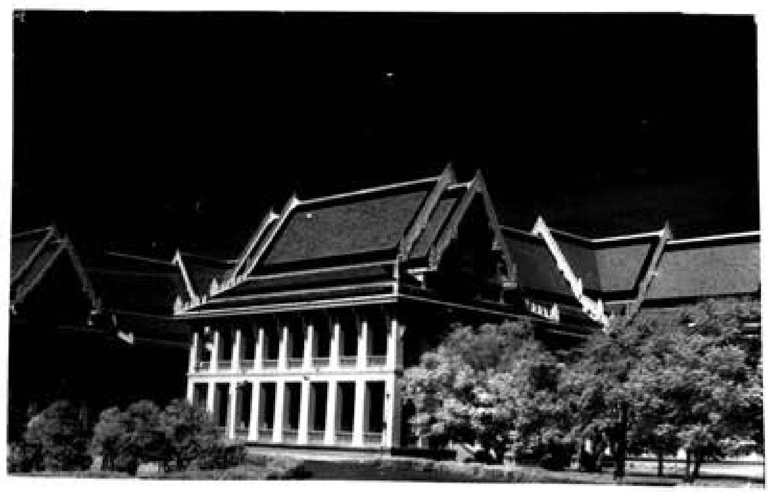
(See page 62)

Ac - 8

Ac - 10



Ac - 9



Ac - 11

(See page 62)

4.1.5 High Altitude Aerial Photography.

From the result of Landscape infrared photographs, it is noticable that bodies of water are rendered very dark in sharp contrast to land on a clear day; fields and wooded areas are rendered very light; cities are rendered darker than fields. For this reason, in very high-altitude infrared pictures, cities should appear as dark patches surrounded by lighter country.

In aerial photography a special camera prorerly mounted in airplane is needed , to ensure the desired field of view and to minimize vibration. Aerial infrared roll films are used, because it is much lighter than plates. Further more it can be change much more rapidly so that series of pictures can be taken in quick succession. Since the aerial camera is moving in relation to the subject to be photographed, the exposure must be kept short so that blurring of the image can be avoided. The exposure time depends on the speed of aerial film, speed of the airplane and its height.

There are several types of aerial photographs, the two main kinds are "verticals" in which the camera is pointed vertically downwards and "obliques" in which case the camera is deliberately pointed at an angle to the vertical.

The following photographs are the result of aerial photography;-
See page 67,68.

No, Ar-1, Ar-2, Ar-3, Ar-4, Ar-5 are the ordinary aerial photographs taken at the altitude of 700 feet.

No.Ar-6, Ar-7, Ar-8, Ar-9 and Ar-10 are the infrared aerial photographs taken at the same altitude. These obliques aerial infrared photographs are rendered clearer and sharper than ordinary photographs.

Ar - 1

Ar - 6

Ar - 2

Ar - 7

Ar - 3

Ar - 8

(See page 66)

Ar - 4

Ar - 9

Ar - 5

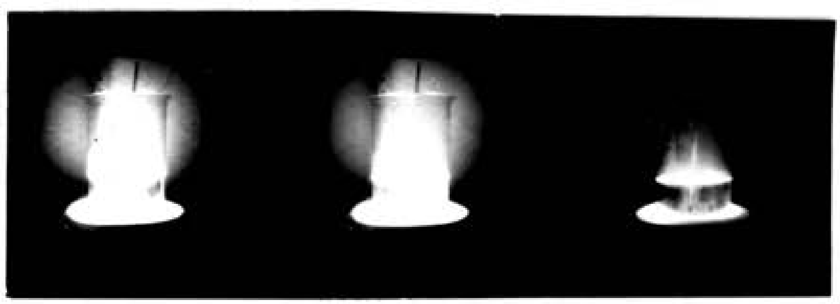
Ar - 10

(See page 66)

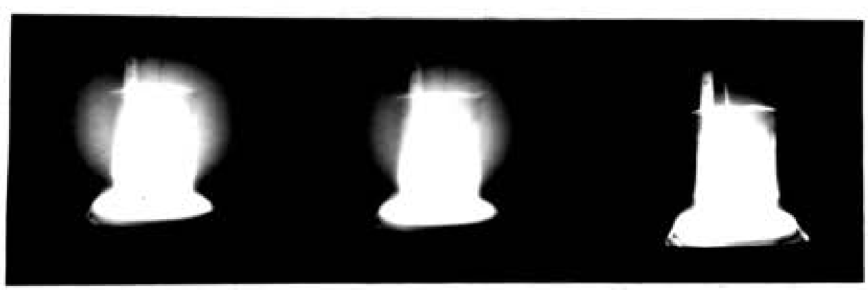
4.1.6 Infrared photography in the study of heat distribution of hot bodies.

In ordinary photography, reflecting or emitting light from an object is photographed and the negative gives a record of the distribution of brightness over the surface. The actual brightness at different points can be measured. In the same manner infrared radiation emitted by a hot object is recorded on an infrared-sensitive film. The distribution of infrared emissivity which is related to the temperature of the surface, forms the subject of photographic thermometry.

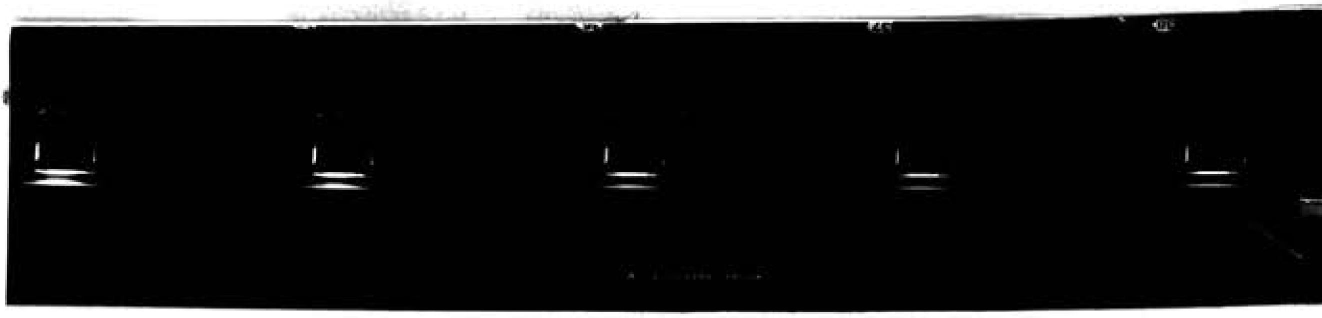
The following photographs are examples of heat distribution of hot bodies:-



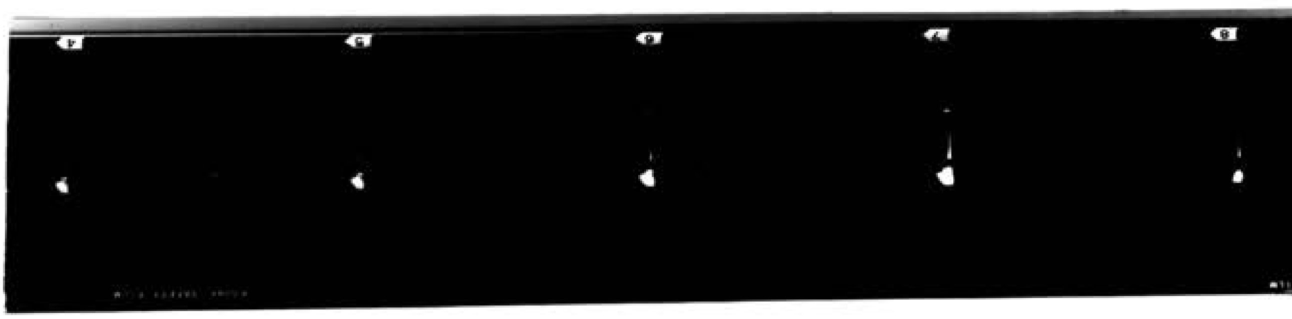
No.1 No.2 No.3



No.4 No.5 No.6



No.7 No.8 No.9 No.10 No.11



No.12 No.13 No.14 No.15 No.16

The above infrared photographs were taken in total darkness. The first strip was taken when the temperature was about 100°C. No.1,2 and 3 the exposure were f/2.8; 128, 64 and 32 seconds respectively. No.4, 5 and 6 the exposure were f/2.8; 128, 64 and 32 seconds respectively.
The second strip is the photographs of an electric oven having temperature inside about 1200°C. These photographs show the heat lost between a cover. No.7,8,9,10 and 11 were taken at f/2.8;16min,8min,4min,and 2minutes respectively.
The third strip is the photographs of a sideview showing that heat flowed downward. No.12, 13, 14, 15 and 16 were taken at f/2.8; 8 min., 16 min., 32 min., 64 min., and 10 minutes respectively.

4.1.7 Documentary and Criminology.[1]

In 1932 Bendikson of Huntington Library and Art Gallery at San Mario,Calif, made the infrared photographs of the censored passage from de Bry's "Collectiones Peregrinatunum." These photographs almost completely eliminated the censorial deletion and clearly revealed the original printing. This led many others to study the application of infrared photography to deciphering of altered documents.

In 1933 L.A. Waters made the infrared photographs of the stock certificate; clearly revealed the original writing. He concluded that the successful will depend on the hind of ink and type of bleach. He could reveal the secret writing by infrared photographs, when the use of ultraviolet failed.

The British Museum used the infrared method for deciphering very early Egyptian texts of about 1,200 B.C. the lettering was too weak on very dark brown leather. By infrared photographs the texts were revealed with most satisfactory legibility.

In 1933 F.W. Martin obtained an infrared photograph of a bloodstain on dark blue cloth.

In 1935 C.A. Mitchell found that bloodstain on a red cloth is transparent to infrared unless the iron of the haemoglobin is converted into prussian blue.

In 1936 N.F. Beardsley could revealed the badly discolored papiri.

In the same time J.Eggert found the behavior of various Kind of blood in the near infrared. Later, O.Merkelbach confirmed these

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1 - Clark,Wl, Infrared Photography, pp. 209 - 213.

results they found that oxyhaemoglobin is relatively transparent in the near infrared, but reduced haemoglobin is opaque in this region and increased in transparency with increasing wavelength.

Eggert could detect the carbon monoxide poisoning. A drop of poisoned blood was spreading on a glass slide next to a drop of healthy blood. A poisoned will appear transparent while healthy blood will appear dark.

In 1937 M.Plotnikow placed a closed envelope in contact with infrared plate and exposing it to infrared radiation,. He obtained a shadowgraph similar to an X - ray photograph.

H.C. Staehle successed in deciphering documents charred by fire. The infrared photograph reveals three fingerprints which were not visible on the charred paper.

Another application is the infrared photography of criminals at work in the dark. The following photographs are some application in documentary and criminology.

See page 73.

No.C_1 is an ordinary photograph of censored passage.

No.C_2 is an infrared photograph of the same passage. The censored passage is revealed sharply.

No.C_3 is an infrared photograph of a sealed envelope. The message inside can be revealed without destroying the envelope.

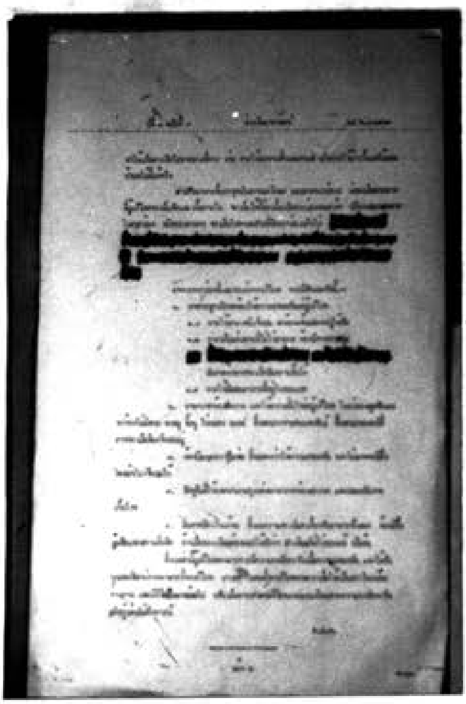
See page 74.

No.C_4 is an ordinary photograph of a blue cloth with bloodstains which is invisible.

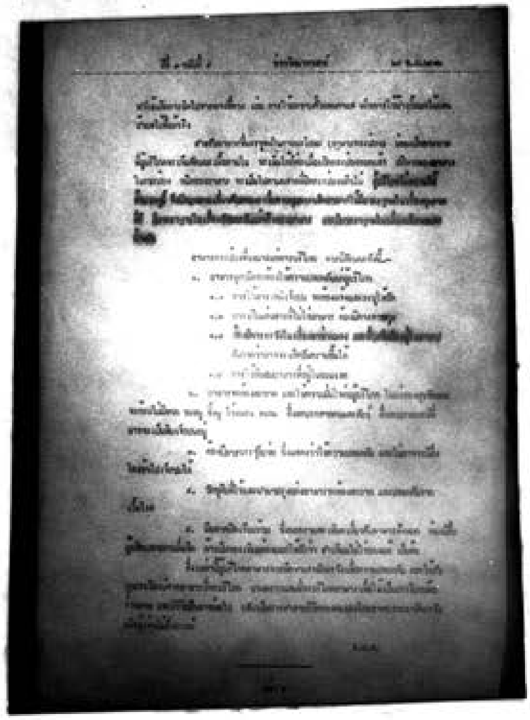
No.C_5 is an infrared photograph where bloodstains are visible

No.c_6 is an ordinary photograph of a red cloth with bloodstains which is invisible. When this cloth is stained with prassian blue and then take an infrared photograph (No.C_7) bloodstains are visible.

No.C_8 is an infrared photograph of a charred document shows an original writing.



C1

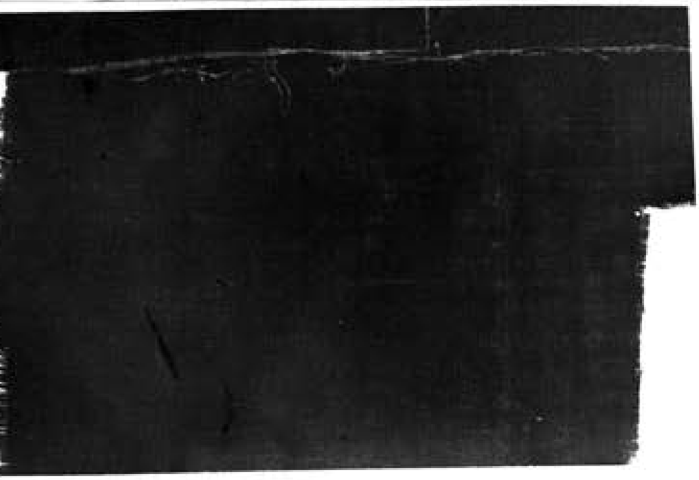


C - 2

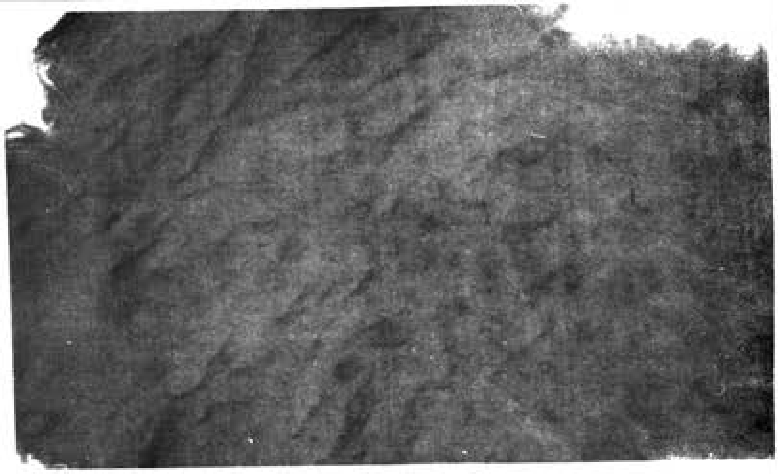
(See page 72)

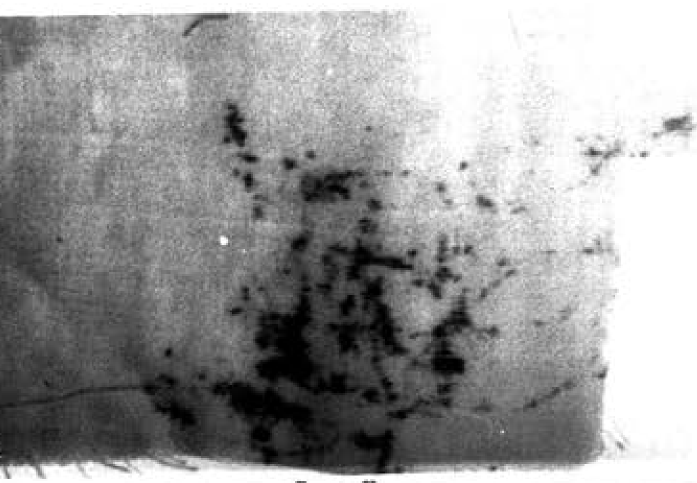
C - 3

C - 4

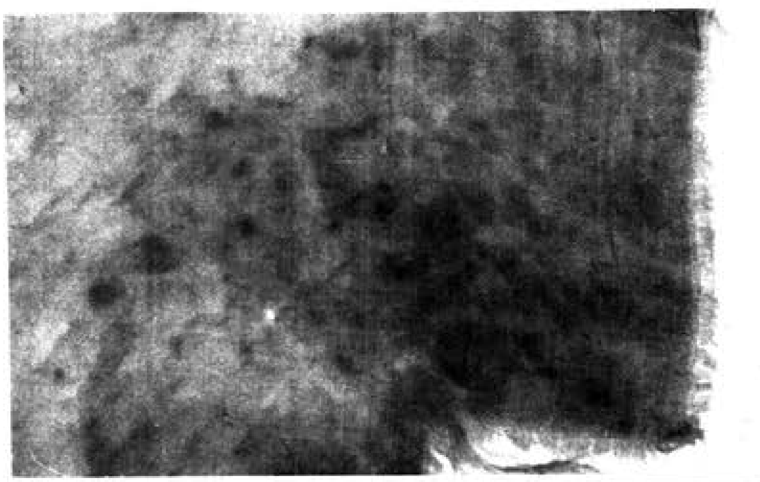


C - 6



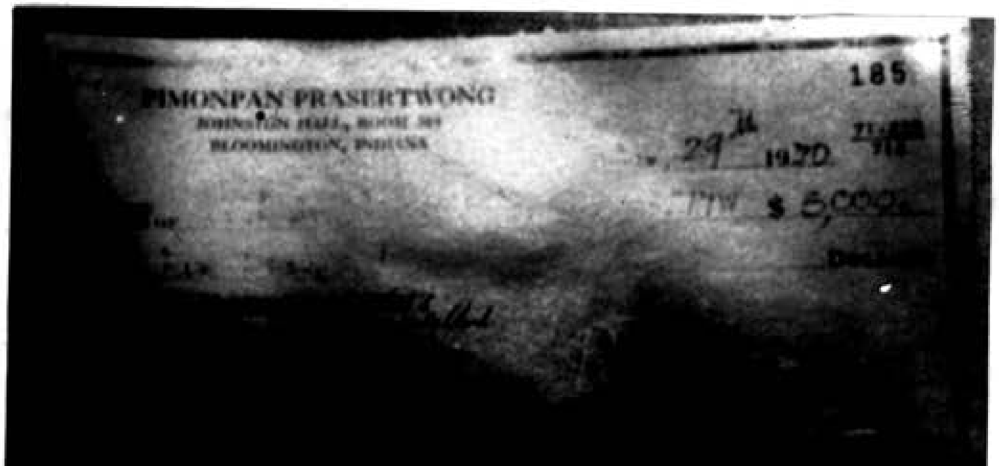


C - 5



C - 7

(See page 72)



C-8

4.2 Infrared Photography in Medical Diagnosis.[1]

4.2.1 Introduction.

1933 Haxthausen described how he was able to show the subcutaneous venous system in infrared photographs which were made primariry for the study of skin diseases. He reproduced a series of illustrations, which compared ordinary photographs with those made by infrared. He stated that whereas in ordinary photographs and by direct observation it is possible to see only the very superficial small veins and the very large subcutaneous stem, in the infrared photographs there is a clear delineation of all the small subcutaneous veins which form an anastomosis with the bigger stems. He quite clearly stated that veins which cannot be seen by direct observation of the skin appear in infrared photographs.

1934 Barker and Julin reported that the infrared photographs of the cutaneous veins can show the obstruction of the blood flow.

In the same time Payne showed that by using infrared plates it is possible to get photographic demonstrations of superficial veins which are not recognizable clinically or by means of ordinary plates.

Massopust was one of the first to make an extensive systematic study of medical infrared photography. A number of interesting photographs of the upper and lower extremetics of the male and female were shown up quite clearly. He studied the changing pattern of the superficial veins in a case of human pregnancy, there is a marked difference in the appearance of infrared photographs of primipara and multipara.

Jones concluded that infrared photography offers a better means of demonstrating the collateral venous circulation in the abdominal wall than is afforded by any clinical method. He considered the infrared technigue an excellent means of recording abnormal degrees of superficial venous distension.

1

- Clark,W., op.cit pp. 218 - 252.
- Kodak's, Medical Infrared Photography, pp. 1 - 84.

Interesting infrared photographs have been made by the University Hospitals, Cleveland,Ohio, showing marked dilation of the superficial veins of the breast assodiated, in one case, with a tumor and another with chronic cardiac compression.

Hardy and Muschenheim concluded that photography of the human body by infrared could yield detail not obtainable by ordinary photography, at least for structures within a few millimeters under the surface, although the detail might not be very sharp owing to scattering.

Jeager showed photographs of varices by visible and infrared and commented that the infrared plate showed all the veins lying under the skin to a degree which had never been suspected.

Braga of the Cancer Institute in Lisbon used infrared photography to show the superficial venous network in cancer tumors.

Infrared photography is employed at the present time as a routine method in many hospitals, since it is a means of diagnosis and record which cannot be ignored. Distinct changes from the normal pattern have been recorded in connection with several diseases. Axillary thrombois, cirrhosis, and some tumor show a marked disturbance of the adjacent venous circulation.

3.2.2 Lighting for photography of the Superficial venous system.

The greatest single factor for success in infrared photography is flat lighting. The lighting must be consistent.

(1) Direct lighting.

(2) Indirect lighting.

3.2.2.1 Direct lighting.

It is vital to avoid (as much as possible) surface shadows from contrasty lighting, edge shadows and reflections from improper setting of the light sources. There are two requirements in the illumination employed.

(1) Eveness

(2) The correct lighting angles

3.2.2.2 Indirect lighting or diffuse lighting.

Since direct lighting photographs have some shadow areas including the hot spot areas which obseure the detail of the photographs, even when the complete direct lighting is employed.

To get rid of these disadvantages, indirect lighting is chosen. This is because the diffuse light has no shadow areas and the subject does not suffer from the hot spots.

There are several methods of lighting for medical infrared photography. The writer should like to exclude the details of lighting. The following photographs are the results of medical infrared photography:-

No.1
Setup I , Filter No.88A
f/16, 1/2 sec.

No.2
Setup I , Filter No.88A
f/16 , 1/4 sec.

No.3
Setup I
87C , f/5.6
1/2 sec.

No.4
Same as No.3

No.5

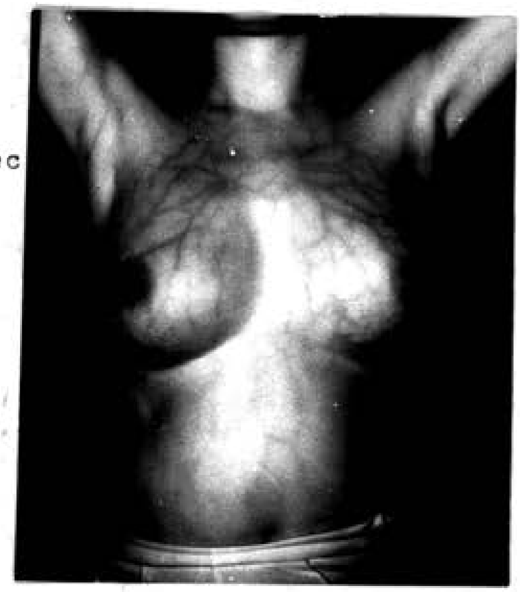
Setup 11

non - pregnant woman f/6.3.1/2sec

No. 6

Gibson's lighting 88 A.f/11 1/4 sec

pregnancy at 8 months.



No.7

88 A,f/16 1/2 sec

No.8 Some as No. 7

No.9Setup III
f/16,1/4sec.

No.10 Same as No.9

No.11 Same as No.9

NO.12 Same as No.9

4.3 Infrared photography by Flash light.

4.3.1 Introduction.

Infrared flash has been used for a variety of special purposes, including press photography in the blackout and in situations where a bright flash would be disturbing; candid photography; photography in darkness; detection of criminals in the dark; cinema audience-reaction studies; unobtrusive instrument recording in aircraft; dark adaptation and other studies of the eye; photography of industrial operations in the dark (e.g., sensitized material manufacture and processing) and photography of any ceremonies.

4.3.2 Equipment and material

Infrared flash photographs can be taken with ordinary cameras and flash attachment. The special requirements being a filter infront of the flash bulb (e.g. Kodak flash bulb No.5R,22R) is used together with a film sensitive to infrared rays, either Kodak IR-135 or HIR-421. In some cases it may be necessary to make a slight adjustment of the focus in the form of a slight forward shift as though the subject were somewhat nearer than its actual distance. The focusing correction have already been discussed.

The infrared light emitted from the flash (ordinary or electronic flash). is a dim reddish glow at the instant of ignition. Therefore the subject would see nothing, except anyone looking directly at the flash. The infrared flash bulbs are coated with a lacquer which acts as an infrared filter. The amateur can make infrared flash bulbs easily by dipping a clear flash bulb in the following solutions:-

<u>Solution A</u>

200 cc. warm water + 10 cc. glycerine + 4 gm. methyl-violet.

Solution B

200 cc. warm water + 10 cc. glycerine + 4 gm. tartrazin.

4.3.3 Technique

Since the subject should be unaware of being photographed though it is practically impossible , so that the attention of the subject must always be drawn away from the light source, or the light source must be hidden.

The actual exposure depends on the nature and shape of the reflector and it is not possible to give a precise data. With the infra-red materials and flash bulbs available through the normal sources of supply there is no difficulty in achieving a flash factor of 50 or even 100 for an exposure time of 1/50 second. The flash factor is the product of the f-number and the lamp-to-subject distance in feet.

The following photographs are the results of Infrared flash photography:-

No.I was taken in a dark room at a distance 15 feet. The exposure was f/16,1/25 sec.,setting X-synchronization. Flash bulbs No.5R with bowl shaped reflectors were used.

No.2 is the same as No.1 but at a distance 20 feet and the exposure was f/11. 1/25. sec.

No.3 is the same as No.1 but at a distance 15 feet and the exposure was f/16;1/25 sec.

No.4 is the same as No.1 but at a distance 30 feet and the exposure was f/8;1/30 sec. The negative was under exposed. The correct exposure should be f/5.6;1/30 sec.

No.5 A clear flash bulb was used in conjunction with a filter No.87C over the lens and the exposure set at f/5.6;1/30 sec. This is better than No.4 but the negative was under exposed since a filter factor 87C was too high. It should be No.87 or 88A.

No.6 is a panchromatic photographs using electronic flash and the exposure set at f/5.6;1/50 sec.

No.7
The cinema audinece-reaction study, taken by HIR-421 with flach bulb No.5R, without filter, the exposure setting was f/5.6, 1/25 sec. at a distant 30 feet. The near-by subjects were over exposed and the angle was not correct.

No.8
The same as No.7 but setting at f/5.6, 1/15 sec.

The correct exposure should be f/8, 1/25 or f/16, 1/25 sec. at a distant 10-20 feet.

4.4 Infrared Photomicrography.

In 1837 Reade made the first permanent photomicrographs. Since then, by skillful understanding of the use of the microscope, and knowledge of the properties of photographic plates and films, photomicrographers are able to obtain results showing fine details with the utmost clarity. By using light filters, the contrasts of differently colored parts of their subjects can be control to any desire extent.

In 1912 Kohler was the first, who attempts at photomicrography with long - wavelength radiation, at that time infrared plated were not available commercially. His plates was sensitive in the region 6,400 A. - 7,100 A. which is deep red light region.

In 1926 C.E.K. Mees had studied the dyes commonly used for staining biological preparations for microscopic investigation. He suggested the use of the invisible ultraviolet and infrared in photomicrography.

In 1926 - 29 Calzavara, Bertrand and his college clearly the conditions necessary for obtaining good contrast and detail of infrared photomicrography and its technique.

In order to obtain satisfactory rendering of contrast in infrared to which the film responds. If satisfactory rendering of detail is to be obtained, the subject must be transparent to the infrared.

For black and white infrared photomicrography more care is needed because the general microscope optics are not corrected for infrared radiation. In general, apochromatic objectives will yield a sharper image than achromatic ones.

4.4.1. Method of Focusing.

Method I. the Kodak Wratten Filter No. 29 (F, red) is placed in the light path and a careful visual focusing is made through this filter. The filter is then replaced by Kodak Wratten Filter No. 87 (infrared) and the trial exposures is taken to determine the correct exposure time.

Method II A Kodak Wratten Filter No. 61 (N,green) is placed in the light path and a visual focusing is made Note the fine adjustment reading and the procedures are repeated with the filter No. 29. The fine adjustment reading is again noted. The additional shift of fine adjustment from the red focus to achieve infrared focus, is then the difference between the green and red settings multiplied by two for apochromats and by 1.4 for achromats. After the correction have been found, a filter(green or red) should be selected to be employed during the focusing of a given specimen. (the choice will depend on which one furnishes the visual focus more readily). Thus, the infrared extension can be made from either the green or red index.

An Example of infrared correction.

Index setting	Green	Red	Red - Green	Infrared
	8	13	5	13 + 5x 2 = 23 for apochromats
				13 + 5x 1.4 = 20 for achromats

Then remove the focusing filter and replace by the in frared filter, e.g. No. 87. Determine the best exposure by making a few trials exposures around the infrared index so found.

These photographs were taken through Zeiss Opton microscope with Zeiss K16 ocular and 16 watts tungsten projection lamp.

No. P_1 Rhizopus sporangium taken with panchromatic film (X-135) without filter for 1/30 second exposure.

No. P_2 The same as No.P_1 taken with Infrared film (HIR-421) with filter No.29F for 1/2 second exposure.

No. P_3 Striated muscle taken with X-135 film without filter for 1/30 second exposure.

No. P_4 The same as No.P_3 taken with HIR-421 film with filter No.70 for 1/2 second exposure.

No. P_5 Potato tuber taken with X-135 film without filter for 1/30 second exposure.

No. P_6 The same as No.P_5 taken with HIR 421 film, with filter No.88A for 1 second exposure.

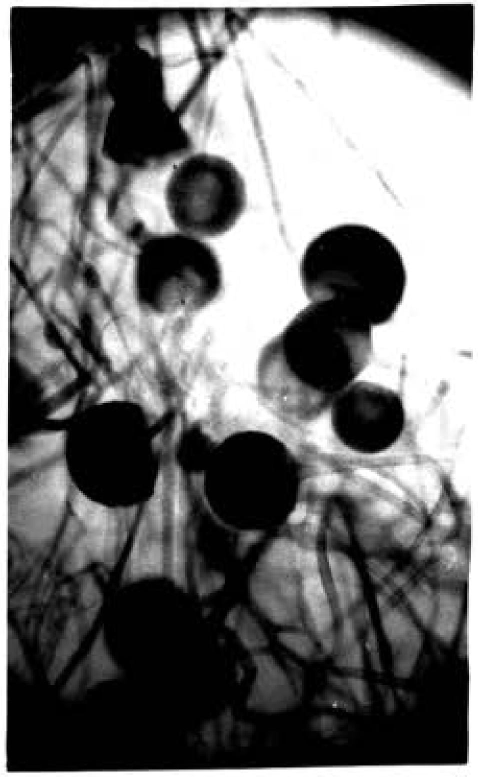
No. P_7 Corn Kernel starch taken with X-135 film without filter for 1/30 second exposure.

No. P_8 The same as No.P_7 taken with HIR-421 film, with filter No.88A for 1/4 second exposure.

No. P_9 Leaf clear taken with X-135 film without filter for 1/15 second exposure.

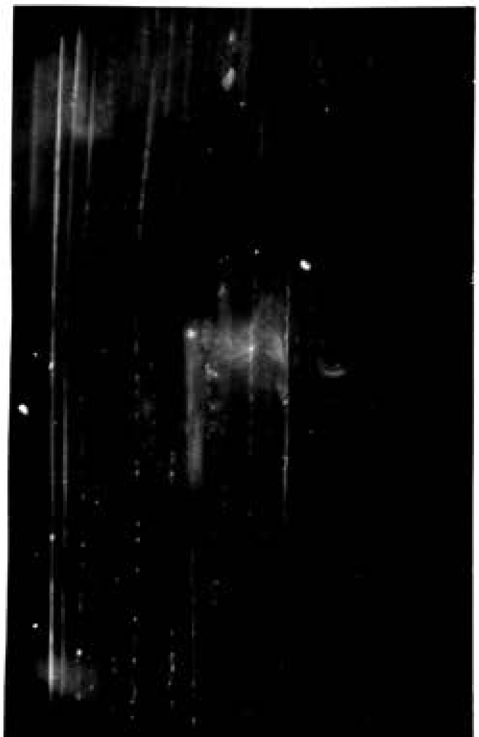
No. P_{10} The same as No.P_9 taken with HIR-421 film, with filter No.88A for 1/8 second exposure.

P$_2$



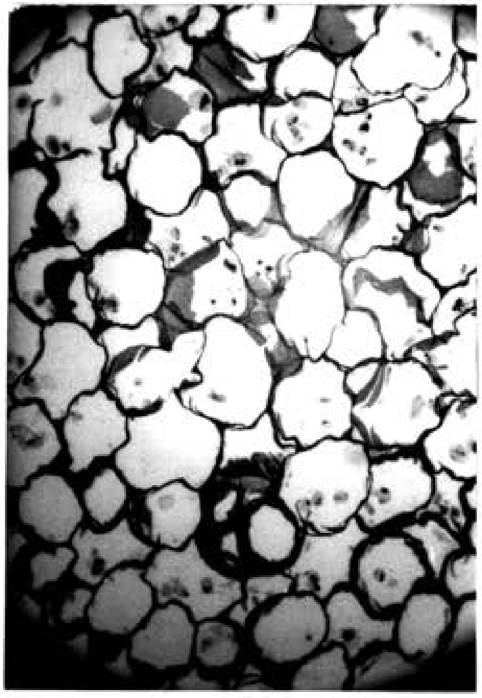
P$_1$

P$_4$

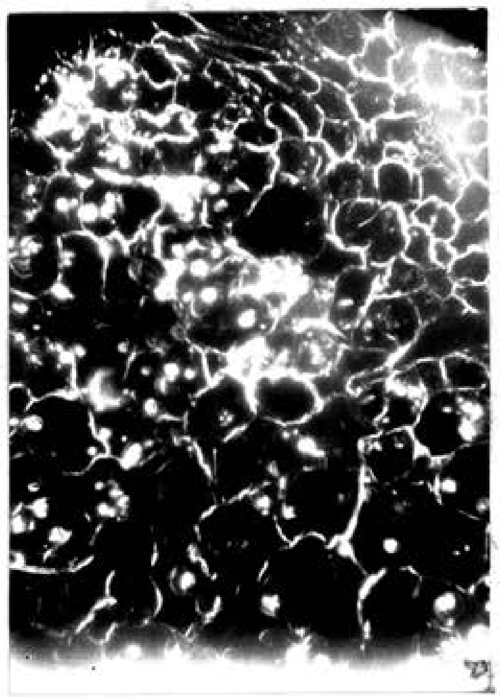


P$_3$

(See page 87)

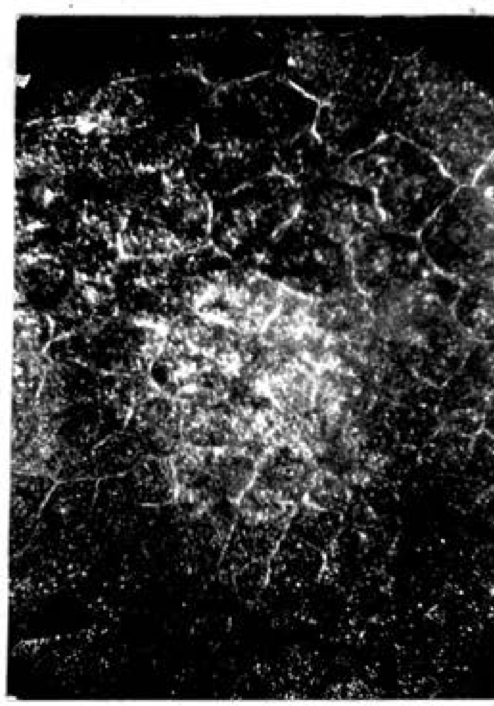


P-5



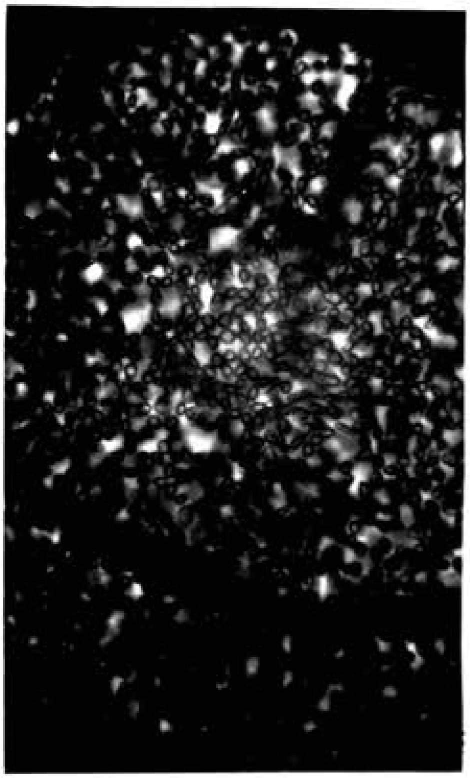
P-6

P-7

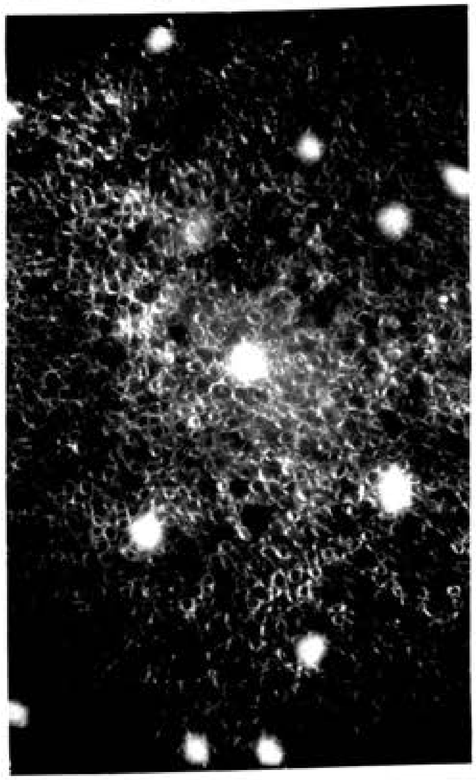


P-8

(See page 87)



P_9



P_{10}

(See page 87)

4.5 Infrared photography as compared to Ultraviolet Photography.

Infrared photography extends the vision of the camera beyond the limits of the human eye. It penetrates haze and renders the sky, green foliage and fabrics distrinctly. Investigation of questioned, altered and fade documents;etc.

Ultraviolet photography uses the same equipments as ordinary photography except pecial lamps are required and certain filters are needed. Special films and processing are not required. All films respond to ultraviolet without being specially sensitized which differs from infrared where special materials are required.

There are two distinctly different methods in using ultraviolet radiation for taking photographs. The first is the "reflected-ultraviolet method." It is strictly analogous to ordinary photographic methods, however, the source of ultraviolet radiation or the camera lens is covered with a filter (eg.Kodak Wratten Filter No. 18) which transmits only the invisible ultraviolet. The second method is the "fluorescent light method." This depends on the fluorescence of certain objects which, when subjected to invisible ultraviolet in darken room, will give off visible radiation. The color of this light depends upon the nature of the material. When this method is used, it is necessary to place a filter (No. 2 A or 2B) over the camera lens to absorb the reflected ultraviolet.

The following photographs are reflected ultraviolet photographs comparison to infrared or ordinary photographs.

No. U_1 an infrared photograph.

No. U_2 a reflected ultraviolet photograph taken in total darkness.

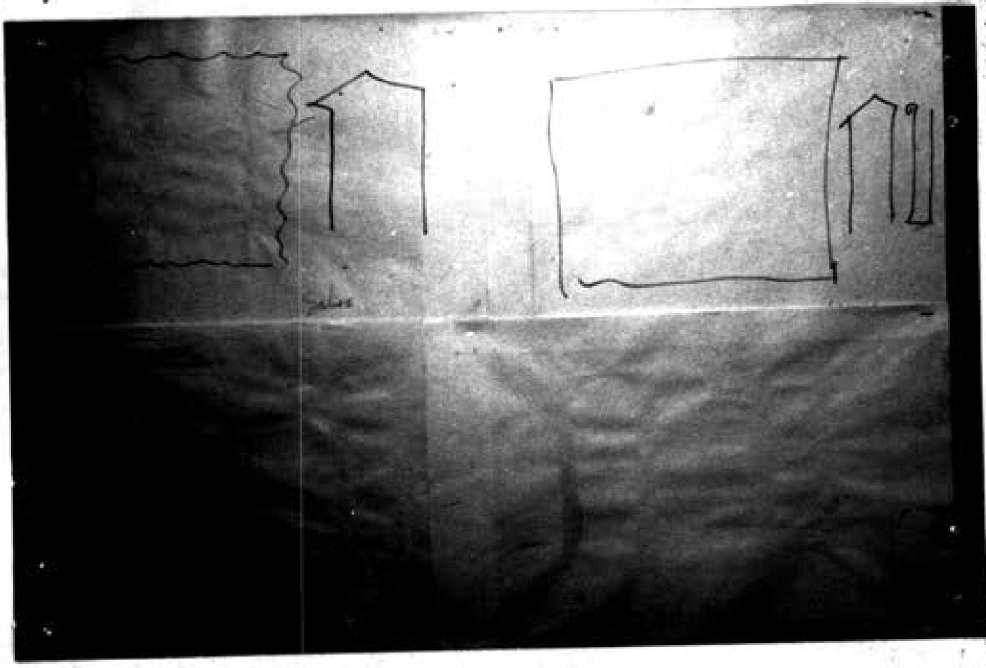
No. U_3 an infrared photograph of a secret writing paper.

No. U_4 is an ultraviolet photograph of the same object. A secret writing is visible.

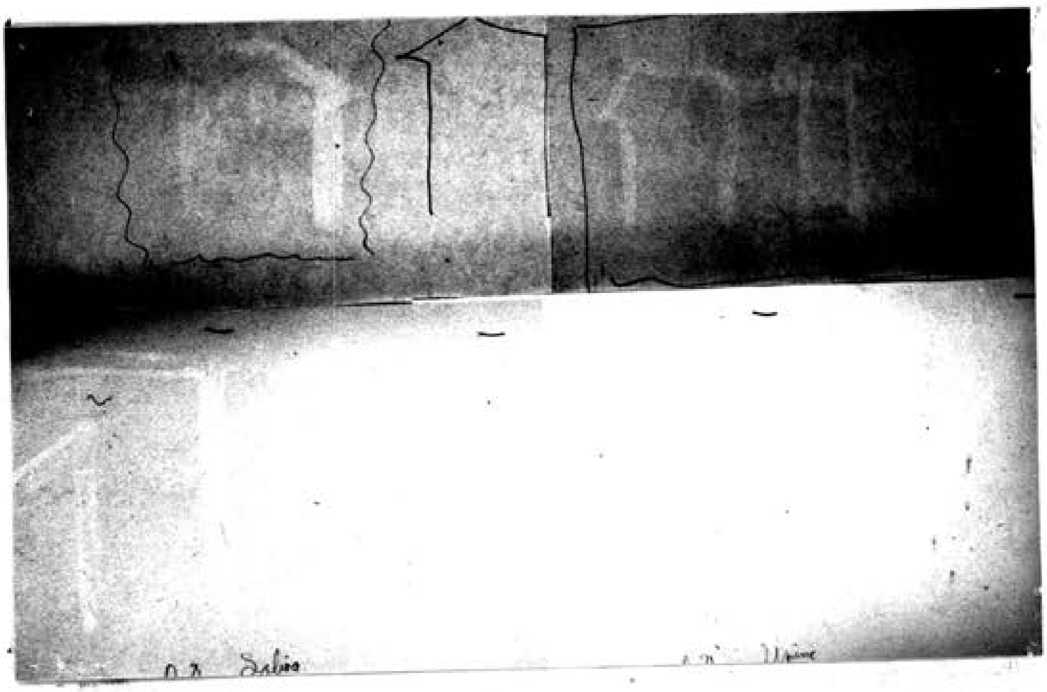
U - 1

U - 2

(See page 91)



U - 3



U - 4

(See page 91)