PROGRESS REPORT ON OPERATION DIOGENES

February 15, 1952

February 13, 1952

MEMORANDUM

TO: [redacted]

FROM: [redacted]

cc: [redacted]

STAT

SUBJ: Status Report on Design of Filtered Lamp - 3rd Model

First tests of the third model of filtered lamp were run on the night of 12 February 1952 in the field and the next morning in the laboratory. The model was satisfactory as a powerful source of a near infrared beam (see field test report) but was not satisfactory in the respects listed below. Most significant was the failure of the lamp to burn in the laboratory without damage to the filter assembly. Also important is the mechanical weakness of the assembly which might allow the cylindrical lens and filter assembly to be jarred seriously out of center with respect to the mantle if the lamp were allowed to tip over on a flat surface. Corrections seem to be possible on both of these and the other difficulties listed below but on these two points small changes are likely to produce a "borderline" solution.

PRESENT DIFFICULTIES

I Overheating of Butyrate Filter Assembly - The top of butyrate cylinder is damaged where it attaches to bakelite ring.

Correction probable by using pyrex chimney 7 1/2 inches long in place of present chimney approximately 5 1/4 inches long.

II Mechanical rigidity of the light proofing assembly relative to the tank is not adequate. It feels flimsy and would be damaged by rough handling.

Corrections:

1. Addition of three clamping screws through blocks attached to bottom of base light trap and bearing against the formed base plate of the standard burner assembly.
2. Modification of a hole size in one of the bottom light baffle plates to allow positive seating of the standard support ring on the top of the gas tank.
3. Modification of the flint lighter mounting to keep this part clear of the base light trap when seated in the standard formed base plate of the burner assembly.

III Light proofing failed

1. Illumination of the bottom of the top cover probably from the Fresnel lens.
2. Leaks through the filter assembly top and bottom and at the lap joint.
3. Pinhole leaks in the standard formed base of the burner assembly.

Corrections:
1. Black top edge of Fresnel lens.
2. Mask the filter assembly between the sheets of butyrate instead of outside the butyrate sheet assembly.
3. More blackened Saureisen cement applied at pinhole leaks.

IV Mechanical support for Fresnel lens and pyrex chimney when lamp is inverted is missing in present model.

Correction should be easy. Design will depend upon the possible extension of the pyrex chimney.

V Carrying handle should be added.

STAT

DEP:dmc

OPERATION DIOGENES

by

[redacted] STAT

Period Covering
February 4, 1952
to
February 13, 1952

My responsibility in this work was the testing of the various components of the lamp. The kinds of tests which were performed are:

1. A test of the four possible infrared filters.
2. A decay test on the various lamps using a photocell which had the same photosensitivity as the photocell and the sniperscope.
3. A test of completely circular Fresnel lenses.
4. A test of the vertical distribution of the light from a Coleman lamp with a Fresnel lens and with an ordinary Pyrex chimney.
5. Two field tests (to be reported on [redacted] STAT who did the viewing). [redacted] STAT

The results on these tests are as follows:

TEST #1.

THE FOUR INFRARED FILTERS - The filters used were the following:

1. A XRX55 filter.
2. A XRX30 filter.
3. A Gillander $\frac{1}{2}$-18W glass cylinder.
4. A 1F-25 Gillander cylinder.

The four filters were compared with the S1 photosurface and with two lamps and one standard lamp. The intensity of light going through them all, on the average of six determinations, was #55 - 1, #30 - 0.38, #18W - 0.75, and #25 - 0.26. No correction for background illumination was made and it is possible that the #25 was actually worse. This data is relatively compatible with the field estimates. The trouble with the 18W lamp is that it leaks through a lot more visible light than does the #55 filter.

A recapitulation of the field tests results might be in order here. The 18W filter was considered as good as the #55. The #30 was considered a factor of two down, and the #25 a factor of four or five down. Some of this discrepancy may be due to the impossibility of making good visual estimates and some may be due to the nonlinearity of the fluorescent screen that is used.

Our conclusions from these measurements were that the #55XRX filter should be used, if possible, but that if a lot more light leak was permissible the low #18W might be quite valuable.

TEST #2.
THE DECAY OF THE LAMPS UNDER VARIOUS CONDITIONS - The four included graphs give the results of the rate of decay of light. These show, in general, a factor of two loss in light after about four or five hours and a factor of four or five loss after seven or eight hours. Presumably, pumping up the lamps after five hours would increase the brightness. Another possibility is that at least 10% of the gasoline is not used because the fuel pump does not reach the bottom, and for the last 75 cc. or so only gasoline vapor gets up into the lamp. Incidentally, lamp design shows that it would not be a good idea to have CO_2 above the mixture because to start the lamp a mixture of the high pressure gas and the liquid is used. Then when the valve is turned completely, the flow of air is shut off.

TEST #3.
THE CIRCULAR LENSES - All the completely round 360° Fresnel lenses broke when put near the lamps, even without a filter in the outside. The two 180° field of view Fresnel lenses did not break when put in that position and so future work was done with two 180° Fresnel lenses tied together.

In both field tests in the cold night, these lenses cracked but stayed in position so that there was no appreciable diminution in brightness.

TEST #4.
DISTRIBUTION OF VERTICAL ILLUMINATION FROM A FRESNEL LENS
Measurement seemed to show that we gain a factor of two at 15° and without any appreciable loss in energy at zero and 30°; therefore, it would seem that a Fresnel lens has a distinct advantage.

Rate of Decay and Fuel Test Febuary 5, 1952

o - Coleman Lamp #1 (500 c.c of gas)

x - Coleman Lamp #2 (250 c.c of gas)

Lamp #1 had 70 cc of fuel left after test

Lamp #2 had 40 c.c of fuel left after test

Current from Si surface Photocube (μa)

1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1

1

Rate of Decay and Fuel Test February 6, 1952

●-Standard Lamp
△-Coleman Lamp A (75 c.c. of gas.)
X-Coleman Lamp B (" " " ")
○-Coleman Lamp C (" " " ")

Current from Si surface Phototube (ud)

1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1

High Tank Pressure Decay Test - Febuary 12, 1952

● Standard Lamp
△ Coleman Lamp A-(60D c.c. of gas) - 130 pump strokes
× Coleman Lamp B-(750 c.c. of gas) - 90 pump strokes

Current from S_1 surface Phototube (μa)

1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1

1

February 15, 1952

MEMORANDUM

TO: Project #5077

FROM: [redacted] STAT

SUBJ: Diogenes and [redacted] Test Dog - Date February 12, 1952 STAT

The weather for this fourth ground-to-ground test was excellent (except for the comfort of the participants). The night was clear and cold, the temperature being about 18° F., wind velocity variable about 30 miles per hour, northwest to north northwest. The time of the test was 8:30 p.m. EST with location of Diogenes [redacted] STAT
[redacted] as in the previous tests. STAT STAT

Visibility was excellent.

[redacted] participated in the test [redacted] end STAT
and observed the tests through the two sniperscopes set up there.

Since the moon was just past full, it was considerably east of zenith and did not contribute directly to either background illumination or the accomodation of the observers' eyes. As all traces of snow had disappeared, the landscape was reasonably black except for such light-colored objects as could be seen in the reflected moonlight. The color of the sky on the horizon was somewhat lighter than the color of the horizon itself. At the conclusion of the test another photograph was taken of the field-of-view, using a 5 1/4 inch focal length lens at f/4.5 and Eastman XX Pan film. The negative shows a clearly distinguishable skyline and a considerable detail on the ground in the near foreground. An enlargement from this negative is attached. The two white lights on the house reported in the previous test were on at the beginning of this test also but were soon turned off and did not cause any troublesome background illumination. Prior to the turning off of these lights, an XRX-60 filter was tried over the sniperscope to see if this would cut down the background illumination. It was found that general illumination was cut down by a slight degree but no spectacular difference was noted.

The test was begun at Diogenes and by setting up a straight Coleman lantern so that [redacted] could get oriented. This lantern was clearly seen. Also STAT
clearly seen was a flashlight which [redacted] flashed in our direction. STAT
This was probably the brightest light seen from Diogenes by the naked eye. The flashlight was not observed in the sniperscope.

The "final model" lamp was steamed up and was clearly visible in the sniperscope. The filter of this lantern was then taken off since this was the only piece of XRX filter that they had and it was needed for the next test.

55

Filters of four types were put successively over a Coleman lantern fitted with Fresnel lens, and the reduction in brightness in the sniperscope was estimated relative to the lamp alone. The following estimates were made by [redacted] STAT

1. XRX-55, less than a factor of 2 reduction in brightness.
2. XRX-30, factor of 2 reduction.
3. Gillinder-18, less than a factor of 2 (same as 55).
4. Gillinder-25, factor of 5 reduction.

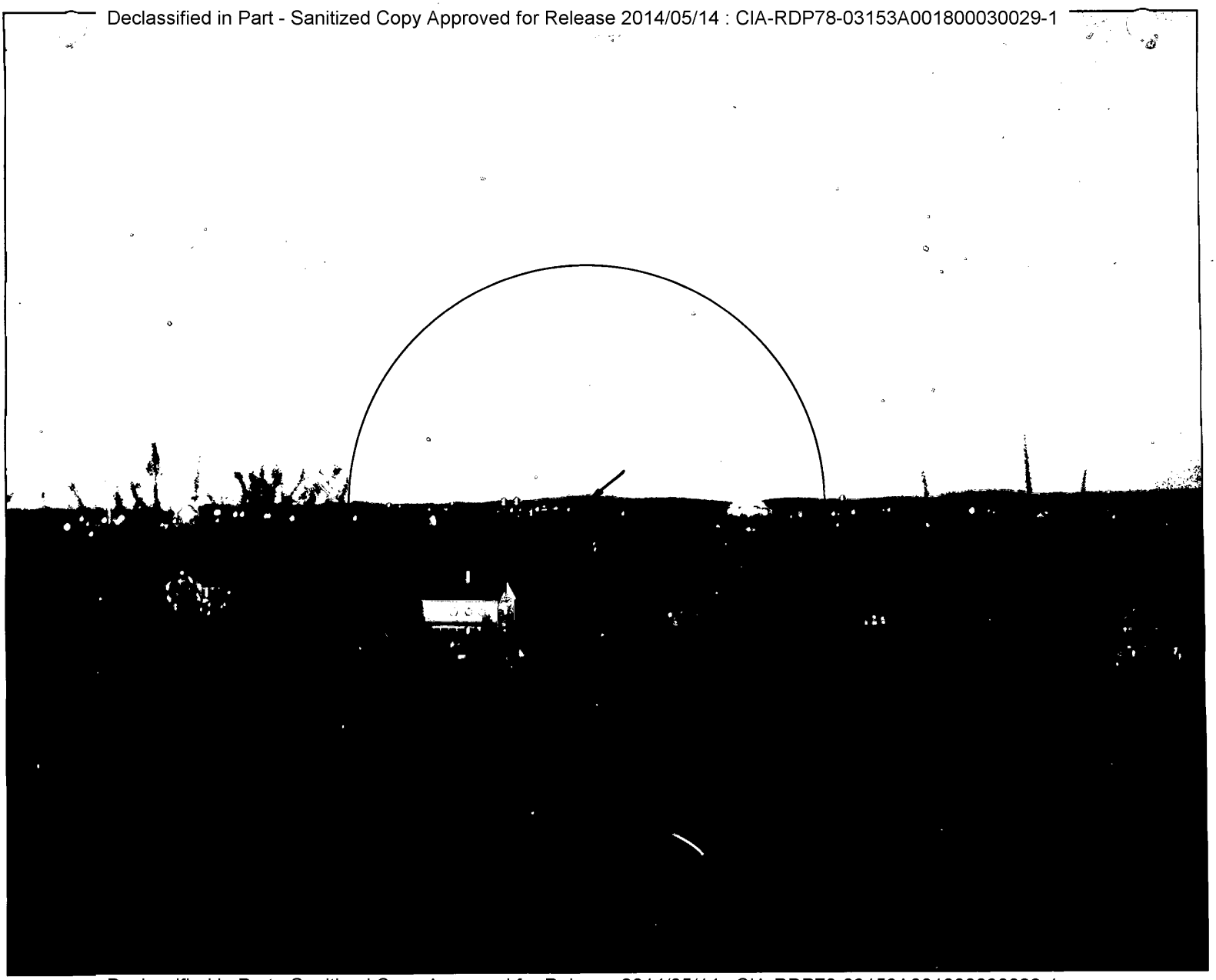
The distance away that the lamp could still be seen using the Gillinder-18 was not determined during this test since the lantern was not sufficiently light-tight. Also, no 100-octane gas had been obtained at that time, and the lamps were not run on 100-octane. Since the test, and before this memorandum was written, 100-octane had been obtained and a lamp was successfully operated on it. Diogenes also reported no trouble with the lamps due to wind or temperature. It should be noted, however, that due to their location on the hill, they were not exposed to the full force of the wind.

ADDENDUM

The attached photographs show the field-of-view on the second and fourth tests. Both exposures were made using the same film, aperture, and time. The approximate field-of-view of the sniperscope is indicated by the black circle. Since the photographs were taken after the conclusion of the test, there were no lights visible at the test site [redacted] which is STAT indicated by the point of the arrow. Undesired lights and stars occasioned by dirt on the negative have been marked out with ink.

[redacted] STAT

DEW:dmc



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February 12, 1952

MEMORANDUM

TO: J.O. 5077

FROM: [redacted] STAT

SUBJ: Diogenes [redacted] - Test Charlie Date: February 8, 1952 STAT

This third ground-to-ground test was set up as previously with Diogenes on [redacted] STAT
The time of beginning the test was 8:00 p.m. EST.

Weather conditions as reported by [redacted] prior to the beginning of STAT
the test were: visibility, 15 miles. After the conclusion of the test, [redacted] was checked again and was giving visibility at 10 miles as STAT
reported by the Air Force. At this time they reported that a light snow had begun to fall. My own observations [redacted] were that the visibility STAT
was no better than on the second test when the Air Force had been reporting 7 miles visibility. There were definite evidences of haze and some of the fainter lights in the field-of-view were difficult to see. The airline distance [redacted] is 5 1/2 statute miles. STAT

The ambient light conditions were particularly bad for this test. The age of the moon was 13 days, which put it a little west of zenith at the time of the tests. Owing to the presence of a recent light fall of snow, the immediate surrounding terrain was fairly bright. The moon itself was too far out of the field-of-view to be of any practical consequence and there were no bright clouds on the western horizon. The principal contribution to high background in the sniperscope was caused by two white lights on the outside of a house less than 1 mile from the observation site. These lights were approximately 1 degree of arc from the direction of Diogenes (as judged by a gloved thumb held at arm's length) (reason for gloved thumb; it was cold). There was no practical way of preventing light from these lights entering the sniperscope except the erection of some large object at a distance from the sniperscope. This was not tried.

As a consequence of the high background illumination of the sniperscope and the poor accomodation of my eyes due to moonlight and other lights, I would judge that the conditions of test were between lousy and terrible.

To complicate matters, the sniperscope which was supplied for this test was a different one than had been used for the first two tests. Although no definite indications of this performance could be obtained, the suspicion always exists that it did not have as great sensitivity as the other scope. In future tests, both sniperscopes will be used and it may be desirable to determine differences in sensitivity between a larger batch of scopes.

Some Polaroid filters (I believe XRX 55 and XRX 60) were available for use over the sniperscope. Since the target lamps were not easily distinguishable, I did not use these filters. It has been suggested that the filters might have been used to cut down the background in the sniperscope, and I believe that this would have helped. We will try it on the next test.

Visibility of the white light sources was fair to good throughout the test. The white light source in use was the Coleman lantern with cylindrical Fresnel chimney. This source could also be seen well with the naked eye and through the binoculars. Tests which were run to determine the optimum angle of view led to no conclusions since my eye is too poor a photometer and an adequate and comfortable support for the binoculars was not available.

The unfiltered Coleman mentioned above had been in operation for about 4 hours continuously without pumping. This lamp could also be seen [redacted] in the sniperscope when a sheet of filter was placed over it. The filtered Coleman with light baffles etc. which had been prepared as a model for this test was also visible in the sniperscope. In both cases, however, the filtered lamps were poorly visible, a circumstance influenced heavily by:

a. Accomodation of eye
b. Background in sniperscope
c. Weather conditions.

I regard it as encouraging that the filtered lamps could be seen at all.

It should be noted here that the filtered Coleman had been supplied with a filter laminated between two sheets of plastic. It was found after the lamp was taken apart after the test that the inner sheet of plastic had buckled, warped, bubbled, and discolored in large areas, particularly near the top. This would have resulted in a decrease in light intensity at some time during the test. Whereas seeing conditions did not permit good comparisons to be made, it was my impression that the 4 hour Coleman with a filter over it was somewhat brighter than the filtered Coleman which suffered the damage mentioned above.

In conclusion, appreciation should be given to the Motorola Company for their loan of 2 Handy-Talkies which made radio communication an absolute pleasure, and incidentally allowed communication during the operation of the sniperscope, a situation not possible with the other radios. In addition to this, the Motorola Handy-Talkies have been tested in the metal fuselage Cessna 140 and found to work well at a range of 7 miles, ground-to-air, with altitude 3,500.

STAT

DEW:dmc

M E M O R A N D U M

TO: [redacted] STAT

DATE: FEBRUARY 5, 1952

FROM: [redacted]

SUBJ: AVAILABILITY OF INFRARED FILTERS

According to [redacted] there are two sources of infrared filters. STAT

1. Gillender Brothers
   Port Jervis, New York

2. Polaroid.

Corning Glass apparently does not make filters which are satisfactory. Gillender Brothers makes infrared transmitting glass in ton lots. From this they cast plate or blow cylinders. They can probably make other shapes. Mr. Fletcher Gillender, with whom I talked, says that the glass does not have as steep a cut-off as Polaroid filters. The total infrared transmission runs from 12 to 18%. The visual transmission runs from 4.2×10^{-10} to 2.5×10^{-7}. This is for a glass thickness of .18". They will supply cylinders of any of these glasses - 4" O.D. and 5" long for $10 apiece. In lots of 25 the delivery would be perhaps 2 or 3 weeks. A lot of 250 might take 4 or 5 weeks. Polaroid will supply 6" x 18" XRX-30 sheet in two weeks delivery at $4 apiece for a batch of 25. The XRX-50 material will have to be hand cast. About 25 sheets can be made in a week. In a batch of 25 the price will be $45 a sheet. In a batch of 250 the price will be $32.50 apiece. The delivery of 25 will be six weeks - of 250, four months. If some pressure were put on Polaroid, these delivery dates could be halved.

BHB:ad

February 4, 1952

MEMORANDUM

TO: [redacted] STAT

FROM: [redacted]

SUBJ: Operation on February 1, 1952

Tests were set up in the same location as on the previous night for the purpose of completing that part of the experiment which resulted in failure due to lamp troubles. That is, the test using a Coleman lantern with infrared filter.

Warm air had moved into the area during the previous 24 hours which resulted in reduced visibility. A check made with [redacted] at the completion of STAT the tests revealed that the Air Force was reporting 7 miles visibility. [redacted] STAT has no check point farther than 6 miles away and, if they had been obliged to estimate visibility without Air Force information, they would have estimated 6 miles plus. The distance [redacted] is STAT 5 1/2 miles [redacted] STAT

Time has been devoted to improving the operation of the radios which, I should like to state for the record, are very poorly constructed devices. On this night it was possible to get in excellent radio communication which fact improved the conduct of the test immeasurably.

A plain Coleman lantern without reflectors was placed on the hill to establish the location of the test point [redacted] STAT This lantern was readily visible with the naked eye and the sniperscope. The principal test, however, involved the use of a filtered Coleman lantern with a plain reflector array. This combination could not, of course, be seen by visual means but was plainly visible in the sniperscope, although apparently at much reduced brightness than the unfiltered Coleman. The reduction in brightness resulting from the application of the filter is difficult to judge by eye at these low light levels. I would say that the difference was at least a factor of two, but might well have been much more. The filtered Coleman showed some variation in brightness which, however, may have been due to variation of visibility which occurred during the tests. At one point a request was made for a check on the burning condition of the lamp, and after this was made the brightness seemed to have been improved. Visibility of the lamp also appeared to be better when it was steady and not flashing. The very short flash with a fairly long wait in between flashes which is obtained through the use of the phonograph turntable was particularly hard to distinguish, possibly due to the time constant of the Phosphor in the sniperscope. Longer flashes of the order of 2 seconds on and 1 second off would probably be better. The preference for no flashing during the tests may have been because the test site was easily located by reference to other lights in the field-of-view. This, of course, would not be true under actual operating conditions.

When a 30% screen was placed over the filtered lamp, the visibility was marginal if, indeed, it could be said that the lamp could be seen at all.

The filtered Coleman was tipped downward 30° as a test of its vertical angle, whereupon it became invisible.

As a test on the resolving power of the sniperscope, two lanterns without filters were used and it was discovered that at a separation of 30 feet could be readily resolved at a distance of 5 1/2 miles in the sniperscope. It was my impression that I could also resolve the two lanterns with the naked eye, although this was rather marginal.

With regard to the visibility again, I took more precautions to have my eyes adapted for the dark by keeping as many of the car lights off as possible and having a red shield over the dash light. In addition to this, a tubular extension was put on the sniperscope to prevent the airport beacon from shining into the lens. This baffle was not entirely successful, as it was not a dead black, but doubtless helped some. There was, however, one light that could not be avoided, this being the moon which was fairly low in the sky and reasonably bright.

Note should be made that the lights that were mentioned in the previous report as being marginally visible with the 6 x 30 binoculars and readily visible with the sniperscope were hard to distinguish with the sniperscope in this test due to the amount of haze. They were so near on the edge that changes in visibility could readily be estimated by how easy it was to see them and sometimes they were easily visible and other times they could not be seen at all. For this reason, the pattern light seen in the field-of-view appeared to be different than on the previous night. An effort will be made to discover the distance that these lights are from the Parker School and also the nature of the lights.

Two photographs were taken of the area using f/4.5 with Super XX Pan exposures of 1 minute and 5 minutes. In the event that these turn out, they may be of some assistance in a report.

STAT

DEW:dmc

Extended test of operation

TRY MODIFICATION OF DOUBLE BURNER LAMP

Coming glass filter? OPERATION DIOGENES

Making present lens shorter 1/8 to 1/4 inch

no flash

100 octane fuel ?

Red glass Thermal lens to distribute heat load

Discussion of Design Problem

On 28 January 1952 it had been decided to concentrate on the possible use of the Coleman Model -- gasoline mantle lantern as the light source. It was to be modified or used with suitable auxillary equipment to make it flash once in one to three seconds, in a verticle directional pattern from horizontal to 30° from horizontal for eight hours and be so shielded and filtered to be practically invisible at night. The design was to be guided by considerations of minimum weight and bulk, safe design for reliability, and the data acquired in field tests.

Three general questions of design were met.

1. The shielding and filtering could be added to the lamp as an auxiliary enclosure or the lamp itself could be modified. The first would mean fewer changes on the lamp but would require a completely colapsable enclosure to satisfy the aim of compact portability.

cut flash tubes in bottom half

2. The flashing action could be realized from a beacon or an interrupted light source.

3. The flashing mechanical motion whether beacon or interrupted light source requires a motor. The source of power for this motor could be the heat of combustion in the mantle or it could come from a separate power supply; i.e., mechanical spring or electric battery.

Light Proofing

The first design question was initially attacked by laying out a triangular pyramid folding enclosure intended to shield and support the lamp. This was considered not suitably portable. Further, designs and models have attempted to get adequate light proofing from baffles added to the standard lamp structure. One model nears completion. The problem is made difficult by the need for cooling air circulation between the pyrex chimney and the

infrared filter. The filter may be operated at only 200°F. Dead air between the filter and the glass may exceed this temperature. To keep the assembly reasonably compact and to allow easy access to the lamp controls, the baffling has been added inside the original assembly wherever possible. The condition of burning of the lamp should be checked on a number of units in various ambient temperatures since the draft through the chimney and over the vaporizer is certainly affected.

Type of Flash

Until after the first successful field test of this lamp at full range of 5½ miles on 31 January 1952, attention had been concentrated on the beacon type of flash found more economical of power for recognition by the naked eye. Single curved surface parabolic reflectors were modeled which could be attached to the lamp and rotated and which would provide the 30° vertical angle required. For flash rates in the order of one in every two seconds the bright

interval for these parabolic reflectors was found to be too short for best recognition. The field tests showed that a flash sequence of equal light and dark intervals or longer light than than dark intervals were easier to find in the field of the sniperscope. With a desirable long light interval the intensification of the beam possible with a reflector is slight. A model with plane reflecting surfaces has been tested which provided too short an interval of high intensity. A model also using plane reflecting surfaces has been made to provide a wider beam angle. This model should be field tested. Recognition of the filtered lamp without reflectors has been reliable at 5½ miles in two field tests.

The Coleman lamp has been flashed successfully in the laboratory by controlling the fuel supply at the pinhole where the gasoline vapor enters the air stream. A model has been built to turn the cleaning pin crank of the lamp with an electric motor to further test the operation of the lamp when flashed in this manner.

This method applies particularly well to a flash the light interval of which is long compared to the dark interval. This type of cycle upsets the internal heating of the lamp parts very little. It should be pointed out that whereas substantial intensification of the beam by reflecting or lens suffaces is impossible by this method, that fuel is saved and the burning time of a given weight of lamp increased.

The Flash Motor

Only one type of motor has been modeled. A turbine was placed in the air stream of the chimney. It rotated a reflector supported on a single jewel bearing. For reliable operation the chimney needed several inches extension. The jewel bearing is necessarily fragile enough to require special protection during normal handling.

Some data has been gathered on possible spring or electric motors. It appears, however, that the swinging of a

beacpn mirror with a self-contained power supply of light weight is more difficult to solve than a system of fuel control. It is suggested that the most promising type of design is a heat or spring motor driven needle valve operating to control the gasoline vapor supply to the air mixing pipe.

February 4, 1952

MEMORANDUM

TO: [redacted] STAT

FROM: [redacted]

SUBJ: Operation of January 31, 1952

On the night of the above date the operation was set up between [redacted] STAT as follows: The sources were taken [redacted] STAT where they were set up and operated by [redacted] STAT The sniperscope was set up in [redacted] STAT in the parking area behind the [redacted] by myself. The airline distance between these two points as calculated from the topographical survey map is 5 1/2 miles. Operations formally began at 9:50 p.m., the night being clear and cold, wind calm, and temperatures probably in the low twenties.

Provisions for communication had been made in the form of "little phone" radios, and in addition an agreed upon signal of light had been arranged for my use in signaling the hill using the car headlights for this purpose. No signaling provisions by light beam were provided in the other direction since it was not feasible to take the car to the location where the sources were to be set up. In the event that all communications failed (which they essentially did) a schedule was set up which was followed. The following is my copy of the schedule with my notes made at the time concerning the visibility of the sources either with a 6 x 30 binocular or the sniperscope, ~~suitably amplified to clarify the~~

9:50 p.m. - Test #1 - Glass [redacted] Fresnel lens and no filter. Manually blinked with about 3 second on, 3 second off period. Visual perception of this source was good, both with the naked eye and with the binoculars. The source could also be seen clearly in the sniperscope but could not be seen with a 30% screen over the sniperscope. In this connection, it should be mentioned that the use of the screen for cutting down intensity at the sniperscope was not successful since the screen used produced a diffusion of all images and thus did not act as a purely "neutral" filter.

10:00 p.m. - Test #2 - Plain Coleman lantern, no reflector. Visual perception with binoculars satisfactory. I was not aware that this source was better than that in Test #1, and it may have been a little poorer. View in the sniperscope was very clear and the visibility appeared to be marginal when using the 30% screen.

10:05 p.m. - Test #3 - Coleman lantern with reflector and filter. Visual perception was practically nil. The occasional impression that some light could be seen in the area may or may not have been the source since it was later discovered that there was a very faint light just below the test area which had not previously been discovered. The same comments apply to visibility through the sniperscope.

10:10 p.m. - Test #4 - Same as Test #3 but no filter. Visual perception O.K. Sniperscope perception O.K. but not as good as Test #1. The light flashed at about 1 second intervals indicating that it was on the turntable.

10:15 p.m. - Test #5 - Same as Test #1 but with 30% screen. No perception either visually or with sniperscope.

10:20 p.m. - Test #6 - Same condition as Test #2 but with 30% screen. Visual perception O.K. Sniperscope perception O.K., but could not be seen with the 30% screen.

[redacted] report that they located the lights of my car and could have read the signals from them had they had time available to keep watch. They did not see a roman candle which I used to signal for location purposes, probably because they were busy doing something else. The radio failed completely so far as my end was concerned, and I continued to try it sporadically through the test. [redacted] report that they did hear me call them at one time, but communication was not established. STAT STAT

Attention is called to the discrepancy between the appearance of the field-of-view through the binoculars and through the sniperscope. Of particular interest are two faint red lights which could only be seen through the binoculars at the conclusion of the test when I took the time to allow my eyes to become properly dark adapted. These red lights, however, showed up very prominently in the sniperscope. A white light in the same group showed up very faintly in the sniperscope but showed up quite brightly through the binoculars. The test light and the light just below it which has been mentioned as being a possible source of confusion in Test #3 apparently had the same threshold for the binoculars and sniperscope.

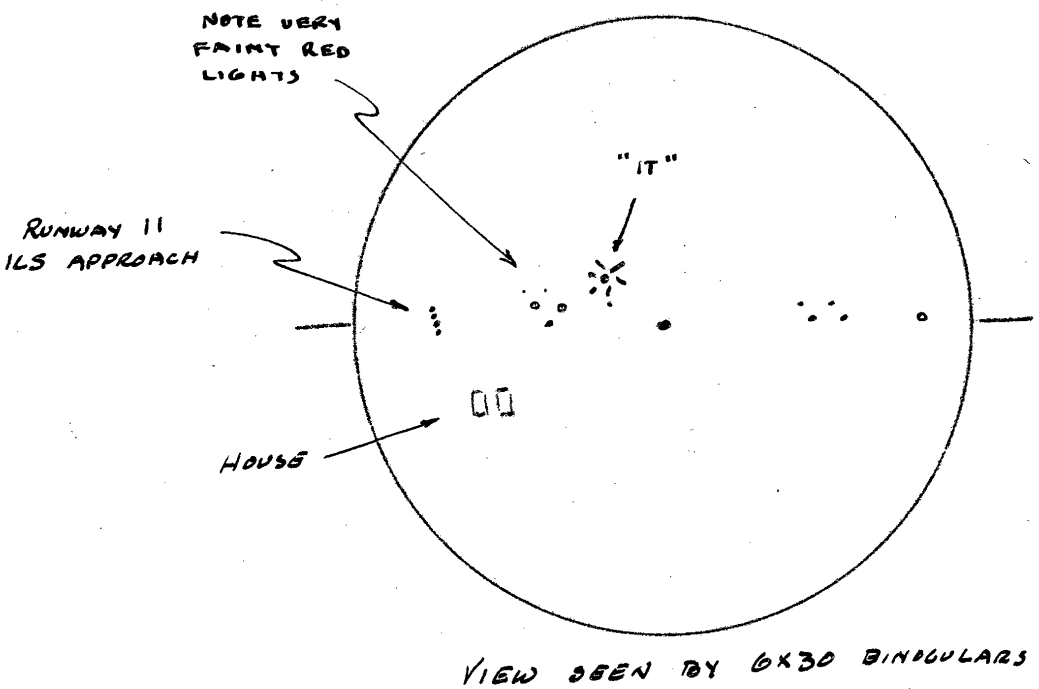
Recommendations and Conclusions:

1. It is recommended that one of the essential features of such a test is satisfactory communication between the test points.
2. Owing to the necessity of reading my watch, reading my notes, and making notes using the lights of the color and intensity that happened to be provided by the [redacted] my eyes did not become properly dark-adapted. The use of properly prepared light with a red filter and eliminating the necessity of using car headlights for signaling purposes would doubtless allow better visual acuity both for sniperscope use and binocular use. STAT
3. The field-of-view surrounding the test site is not particularly brilliant, although there are quite a number of lights easily visible. The principal bright light is the occasional flash from the airport beacon which is the principal offender in producing background illumination in the sniperscope. Although this light could not be seen in the field-of-view, it splashed into the lens where the persistence of the Phosphor held up the background illumination for several seconds. This effect could be eliminated by a mailing tube or other baffle in the front end of the sniperscope.

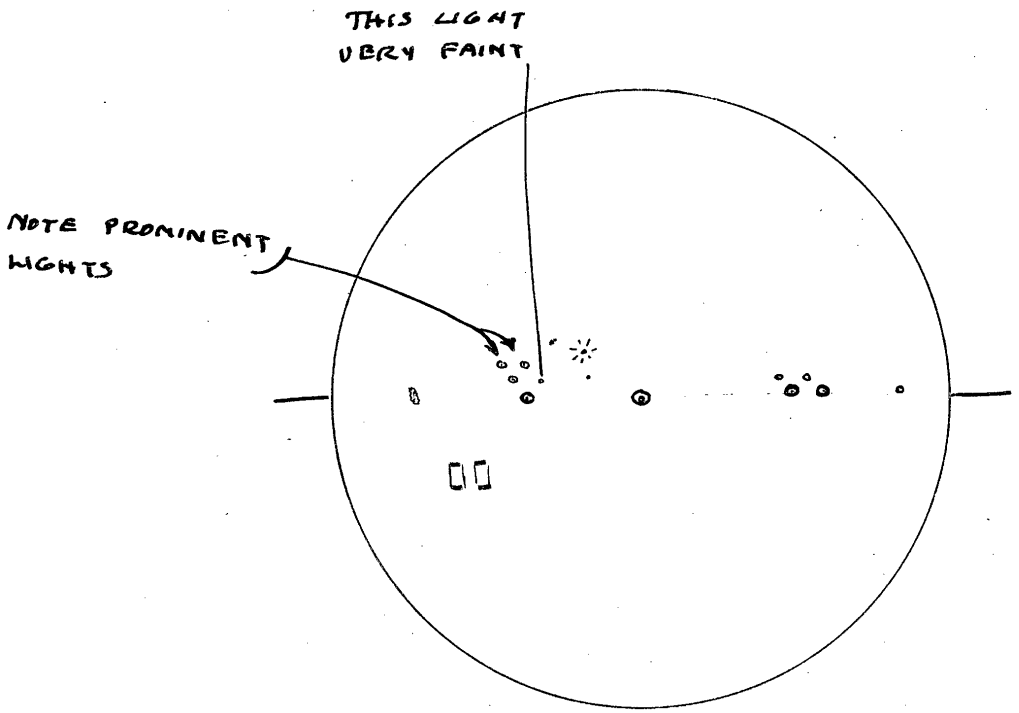
4. This test was successful since it established visibility of the lamps over a considerable distance and proved the feasibility of making tests in this way. It is unfortunate that the filtered light did not operate properly and this part of the test will have to be repeated. It is also recommended that the two red lights which appeared so well in the sniperscope and so faintly through the binoculars be investigated for whatever might be learned by this means.

STAT

DEW:dmc



VIEW SEEN BY 6X30 BINOCULARS



VIEW SEEN THRU SNIPERSCOPE

SIZE OF CIRCLE PROPORTIONAL TO MAGNITUDE

January 30, 1952

OPERATION DIOGENES - SECOND PROGRESS REPORT - COVERING THE PERIOD JANUARY 22 TO JANUARY 28, 1952 -- [redacted] STAT

On Wednesday, January 28, the walkie-talkies arrived. Accordingly, on Wednesday evening tests were made on the [redacted] STAT and [redacted] branch lines. The distance was about a mile and we will STAT get it exactly. For this test we used the following sources:

1. The flashing 21 candle power lamp.
2. The Coleman gasolene lantern.
3. The Aladdin kerosene mantle lamp.
4. A prepo blow torch with a Wellsbach mantle on top of it.

These sources were all visible from about a mile with two 30% screens in front of the telescope and with the XRX-30 filter. The walkie-talkies worked only sporadically, in fact only for identification and ~~xxxx~~ flashlight signals had to be used to do most of the work. The movement to a four mile distance was not as satisfactory since there were yards lights from the General ~~XXXXXXX~~ Motors Company and a street light up aways. However, it was possible to see the light although when the XRX filter was put in the light was quite dim. One thing that should be noted here is that ~~xxx~~ although the light is approximately as bright with and without this ~~xxxxxxxxxx~~ sniperscope, there is a background to the sniperscope and a definite threshhold

above which the light should go. This makes a quantitative comparison of light output relatively meaningless unless the light is a bright one. It looked as though a mantle light source would have sufficient brightness for the work and work was done during Thursday and Friday on shielding the kerosene mantle lamp. Various kinds of shielding were attempted. One or more baffles placed around the air intake together with long stovepipe tubes moving up or baffles up at the top. However, the air supply is so critical that the electric fan operating nearby was able to cause a smoky flame to come off in that lamp and to ruin the brightness of the lamp itself. Therefore, at this point, the Aladdin kerosene wick mantle lamp was abandoned. It seemed obvious that the shielding required, although perhaps not too heavy, would be extremely pokey and would require a number of traps. Although the lamp itself gives out very bright light in the laboratory, its use for field work of this type seems to be precluded. At this point we were left with three possible sources.

1. A Coleman lamp operating on gasolene vapor.
2. A mantle lamp operating from a Bunsen burner or a similar burner.
3. A carbide lamp.

A fourth possibility would be a magnesium ribbon flare. The prepo blow torch is a very convenient butane operated blow torch would is relatively

insensitive to air currents around it. Unfortunately, the can of prepo lasts for about one hour and a half and another kind of source would have to be used. The can of five or six times the volume would probably be too excessive in weight. There are no conveniently available gasolene self operating blow torches but a like alcohol blow torch was available. It gave a very good flame but lasted only one half hour on 60 cc of alcohol. The problem of designing a self operating blow torch where the alcohol vapor is supplied by the heat from the blow torch is such that an increase of a factor of 20 to 1200 cc of alcohol would require some development, but might very well be possible. Further work on a Bunsen burner mantle was suspended when it was found that the Coleman gasolene mantle could be pumped up so that it could run for nine hours continuously without appreciable diminuation in brightness. It was decided that in the time available the Coleman lamp would be the easiest thing to work with since it is already relatively wind proof and fire proof. On Sunday night, [redacted] and I went out again to the [redacted] tracks - this time with only the carbide lamp and the Coleman lamp as sources. Instead of the XRX-30 filter, a 2" square of XRX-60 and 55 filters were available and the 60 was used in front of the telescope instead of in front of the lamp. Both the Coleman light and the carbide lamp were visible but the carbide lamp had a large reflector behind it. A magnesium flare was rather dim from this one mile distance but it was still visible. All these sources were viewed with screens on

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both ends so that they should be equivalent to a 3.6 mile distance. When I went to the place five miles away, the yard lights were so placed that it was difficult to see exactly which was John's light. I thought that I mistook it but was able to see when a light went off and called in the radio that I presumed that the light was turned off. This happened at the exact moment that John had turned out the light so it looks like the Coleman lamp is easily visible for a five mile distance. The walkie-talkies were still not working well.

OPERATION DIOGENES

Summary Report
by

[redacted] STAT

This report covers the work accomplished in the past week and a half and shows what we have done.

The problem is the following. We wish to build a lamps which will radiate only in the near infrared so that they can be viewed with a sniperscope. These lamps are to be used as airplane beacons and their properties should be as follows:

The first lamp should be visible for five miles when the background is black; should be light, portable, carry its own power, simple to operate and assemble. The second type of lamp should be perhaps brighter and give a flashing signal to an observer five miles away.

The first problem is to find the visible brightness of a source which is necessary to give the required brightness on the screen. Calculations show that one lumen of filtered 2870 radiation should yield one lumen of light on the fluorescent screen. Therefore, if we have any lamp whose candle power is such that it can be seen with the naked eye at five miles, it should be possible to use this lamp with a filter in front of it and the sniperscope and thus observe it. This presumes that the background radiation level of the sniperscope is as low as the radiation from the outside.

Tousey seems to show[1] that we should be able to see a nine candle power lamp at five miles. The safety factors which was put in the calculations is about a factor of three. If we use a cylindrical lens in front of the source to restrict its angular size by a factor of five, we might gain this factor of five in brightness and this would reduce the brightness required. A lot of lamps have been obtained as well as some sniperscopes and they are being assembled as follows.

The first source used was an 21 CP automobile headlight bulb operating on a flasher. This bulb was in a container around which was a cylindrical lens and in front of the lens an XRX filter (Polaroid) was placed. This battery was operated off two large six-volt Burgess dry cell batteries but could also be operated off a storage battery. In series with the lamp was an electric flasher of the type used on automobiles which is put in series with the lamp and draws about 8/10 of an ampere when the light is not in operation.

As a general rule we should not plan to use a battery-operated headlight for this purpose. There is at present available exactly this kind of equipment which has ~~the following disadvantage.~~ is much too heavy for the power obtained from it. A storage battery is not an efficient way to carry power. However, this flashing light is a very good standafd by which we can make

1. Tousey, J. Opt. Soc. Am. (1946).

measurements on these lamps. These are the lamps which are now under consideration. The first type of lamp is a mantle lamp. It would use a Welsbach type mantle and could perhaps run on butane, gasoline, acetylene, or kerosene. We have obtained a gasoline lantern which has to be pumped up, a kerosene mantle lamp manufactured by the Aladdin Company, a butane blowtorch which goes under the tradename of Preppo, and all these have been put in working order. The simplest and most reliable one of these sources is the Aladdin kerosene mantle lamp which works on a wick. The Coleman lantern must be pumped up to give a bright source and it will not stay bright for more than a couple of hours at a time. The butane burner seems to work fine, also, but there is a problem here of life.

need for a reducing valve?

In addition we have considered the use of acetylene lamps either as an acetylene lamp itself or as a carbide lamp which will deliver the acetylene. We have obtained a 4000 candle power floodlight for use in construction projects which uses about one cubic foot per hour of acetylene from a Presto-light tank. We also have obtained a small carbide lamp manufactured by the Just-Right Company which also should be tested.

Sniperscopes have been obtained by [redacted] STAT from Washington. The first night-time experiments were made Friday night, January 18. For these experiments the following sources were available.

A flashing 21 candle power headlight with and without a filter.

A Coleman gasoline mantle lamp

An acetylene floodlight.

This is what happened that evening. [redacted] and I were separated by about 9/10 of a mile on the road running into [redacted] The only means we had of signaling to each other was by flashlight, using a prearranged code. The experimental conditions were not ideal since there was some background, particularly to him since he could not see my flashes, and an automobile coming down the road made accurate observation impossible. It was possible to view all the sources which were then available even when the infrared filter was put in front of the telescope. In addition, it WAS possible to view the sources when a screen transmitting 30 percent of the incident radiation was placed in front of the telescope. Further experiments carried on later showed that it was possible to see both the Coleman lamp and the tungsten lamp when a 30 percent transmitting screen was placed in front of both the lamp and the telescope, and the filter was also in place in front of the telescope. These results were encouraging but obviously further field tests must be tried and the conditions should be better. For example, if we are to go to longer distances we must find a straight path of ~~four miles or~~ three or four miles. Then,

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we should have walkie-talkie radios since visible flashlight signaling becomes more hazardous and more time-consuming. Thirdly, more sources should be available for test. Fourthly, we should be as little disturbed as possible, anyway.

It was with this in mind that we went down to the [redacted] STAT [redacted] to see ~~what could be accomplished insofar as we could~~ whether we could obtain use of any straight regions of track which went for long distances. Telephone calls made it obvious that personal appeals were necessary and so we went in to see the District Engineer on Monday, January 21. While the District Engineer, [redacted] STAT, did not speak to us personally, we spoke to his assistant who went in to speak to him and [redacted] STAT passed the buck down to the General Manager's office. Accordingly, the assistant, who obviously was unhappy about even doing this but didn't have the guts to say no, brought us down to the General Manager's office. The General Manager's secretary also didn't want to take the responsibility for making a decision one way or the other and said there probably wasn't that much track anywhere, which the District Engineer's assistant agreed fervently. So he said he would take us back and show us the track layout and we would see what was available. ~~On going~~ Back to the District Engineer's office we saw that there was no track between [redacted] but when the assistant went STAT

out one of the draftsmen who was not in on this said that from [redacted] branch there was a very long tangent and sure enough there is a four-mile stretch from [redacted] STAT STAT to four miles from [redacted] (really!!!) on [redacted] branch line. STAT When the District Engineer's assistant came back he was most unhappy that we had found this but was still polite and said, "Oh. You don't want to use a branch line, anyway". But, since we had to go back to the General Manager's office, we did so and when his secretary asked I said that there seemed to be an ideal place and could we please speak to the General Manager. The General Manager, Mr. [redacted] STAT [redacted] was very cordial. I used all my titles, pulled all the secrecy STAT stops out, told him about how it would help the Armed Services, waved the American flag in front of his face a few times, and got his permission to do this. John and I signed general releases and we have the whole-hearted cooperation, at least on the upper echelon, of the [redacted]. I think it would STAT be nice if you were to write a letter to [redacted], General Manager, STAT thanking him for his cooperation.

We also purchased a carbide lamp after looking all over town and some more mantles and chimneys for the kerosene lamp that was available. The kerosene lamp ran for eight hours yesterday without adjustment of wick. The only thing wrong with it is that the chimney is overly long and perhaps fragile. We would do well

to design something better. Perhaps this length of chimney is necessary. We are running life tests on the carbide lamp and it seems to give a good light although no where near as steady as the kerosene mantle lamp.

The weather at present does not ~~look~~ bode well for field tests and the walkie-talkies will be coming in tomorrow. The first night available with good weather John and I will go out to Framingham with the walkie-talkies and the equipment and continue the tests.

Incidentally, the kerosene lamp holds about 900 ccs and when full should run a little longer than twelve hours in my estimation.

STAT

January 22, 1952

kvs

The next thing that should be mentioned is the way to get these things flashing. Since we have eliminated from consideration any electric means of getting our power, we are left with a mechanical switch of one kind or another. It seems fairly obvious that the flow of fuel cannot be easily interupted and still get yourself a good flasher, so this means that there must be some means of shuttering the beam in one way or another. The beam should still be able to radiate in 2 π radians, however, and so we restrict ourselves to something that must rotate cylindrically. This can be a shutter with holes cut in it or a set of lenses. If we have a shutter with holes cut in it then all we do is change the intensity of the light without increasing in brightness. This shutter might run from convection currents coming out of the kerosene lamp. These are pretty strong. The other possibility is to have a series of lenses going around the cylinder and these lenses rotate. This possibility means that the plastic lenses, perhaps even fresnel plastic lenses, will be necessary since the weight that has to be rotated becomes pretty large. In addition, complications will occur, it seems to me, if these things are to run in all kinds of weather.

Another suggestion was to get a one rpm clock motor which runs on one and a half volt dry cell and use this to do the turning. This kind of positive feed will be very helpful. The additional

weight should not be very much. The only question is whether the power involved is enough to be meaningful.

Filters

We have been thinking about XRX filters to do this job but there is no real reason why such an efficient filter is necessary. The filter that we have has pretty poor transmission where we want it and we might like to get something a good deal better even though the visible cut-off might not be so great.

Experiments done today show that the Aladdin mantle lamp is rather sensitive to an electric fan, which is not surprising, but perhaps shielding on this device can be more effective. The carbide lamp also runs pretty steadily without appreciable change in brightness. Further work shows that almost the whole length of the chimney is necessary for good operation of the Aladdin lamp.

DZR/kvs

1/22/52

Memorandum to [redacted] STAT

To DEP

This is a summary of the work I have done over the past day and a half.

I. Calculation of efficiency of image tubes

The only information easily at hand is that in the NDRC book on these Devices. They define "conversion" as the ratio of thenumber of lumens emitted by the fluorescent screen to thenumber of lumens falling on the cathode. Since the light falling on thecathode contains infra red as well as visible light this conversion factor can be greater than one. The conversion factor is measured with a lamp of color temperature 2870 K.

The conversion factors for the 1P25 low voltage tube runs about 0.64. Measured value run from 0.25 to 1.5 lumens per lumen. For theMA-4 tube theuseful conversion factor is said to be 5 to 8 times that of the 1P25.

It should be noted that this conversion factor is for an unfiltered light source. The photocathode response is cut to a factor 1/3, if a Wratten filter is put in front of the2870 K source. We can say then as a reasonable approximation to the Truth

1 lumen filtered 2870 radiation yields 1 lumen of light from the fluorescent screen.

SAFETY FACTOR ½ 2

Therefore if we know the distance at which we can see a tungsten lamp, this will be the same distance at which we will see a filtered tungsten lamp of this color temperature.

II Distance at which we can see an uncollimated lamp.

Knoll, Tousey and Hulbert show in theJOSA 1946 that an illumination of 10^{-9} foot candles can be seen in starlight and 10^{-8} at moonlight levels. Thes measurements were made with a steady source and not with a flashing source as is contemplated here.

SAFETY FACTOR 1.5

We will say we would like a source which will give an illumination of 10^{-8} footcandles at 30,000 feet.

III. Candlepower of lamp necessary

The candlepoer of a lamp is obtained by taking the illumination and multiplying it by the square of the distance.

$$I = Er^2$$

$$I \text{ is } 10^{-8} \times 9 \times 10^{8} = 9 \text{ candle}$$

Use of cylindrical lens

Since the light is to be restricted to a horizontal plane we can gain a factor on thebare lamp by putting a cylindrical lens in front of it. We should gain a factor of 5 or ten by this move. If

we are conservative and say we gain by a factor 4.5 we need a lamp of intrinsic candle power in all directions:

I of 2 candles

SAFETY FACTOR 2

Power required to run a two candle power lamp for 12 hours.

A lamp giving of 2 candles per stearadian gives off about 25 lumens. A good value for most lamps is 10-15 lumens per watt. A lamp of 2.5 watts should give enough light for thepurpose. To run this for 12 hours we would need a 30 watt hour battery. From a six volt battery this would mean 5 ampere hours. The small willard batteries are said to give 20 ampere hours. They would be sufficient.

1.5

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Relative Efficiencly of Gas heating and a Tungsten source.

It should be possible to heat a refractory oxide to about 1500 c and use the heat from thegas to rotate a shutter in front of the source. A cylindrical lens is possible here.

Since the source is cooler than the tungsten lamp, and in addition has an emmissivity of about 0.5 in the region in question we have a loss of a great deal of the e ficiency of the system. We lose at least a factor of 5 from the black body curve and we also lose a factor of 2 from the emissivity. The source will then have to have about 10 times the area of the tungsten source. We need therefore a hot ceramic which will radiate 25 watts. If we assume that we can keep the ceramic at this temperature with 1% efficiency then we need 2500 watts from the flame or 30KW-hr of power for 12 hours of operation. This would require about 2.5 Kg of kerosene since kerosene gives 13 kw-hr/kg