Technical Report Documentation Page

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Sandstorm Investigation in Coachella Valley Between Garnet and Thousand Palms on Road VIII-RIV-26-D Station 720+- to Station 810+-

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6. PERFORMING ORGANIZATION

7. AUTHOR(S)

D.R. Whetsel

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Materials and Research Department

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16. ABSTRACT

The expressway between Garnet and Thousand Palms on Road VIII-Riv-26-D,E Fig. 1, has been a source of numerous complaints about sandstorm damage to motor vehicles. The highway is located in an arid region with sandy soil and sparse vegetation. The area is at times subject of winds which transport sand of such grain size and at sufficient velocity to erode paint and damage windshields on vehicles which use this section of highway. This section of highway was reconstructed in 1957 along an alignment adopted while E.Q. Sullivan was District Engineer. Mr. Sullivan has stated that the problem of damage to vehicles by blowing sand was recognized and that the alignment through this area was arranged to be exactly parallel to the direction of prevailing winds. It was Mr. Sullivan's belief that if the winds should blow directly down directly down the line of the pavement no sand would be picked up or carried. Whether or not this premise is sound is debatable, but in any event the prevailing winds do not parallel the highway alignment but cross at a flat angle.

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STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

SANDSTORM INVESTIGATION in COACHELLA VALLEY between GARNET AND THOUSAND PALMS

63-03

August 2, 1963

State of California
Department of Public Works
Division of Highways
Materials and Research Department

August 2, 1963

VIII-Riv-26-D

Mr. J. P. Murphy
Deputy State Highway Engineer
Division of Highways
Sacramento, California

Dear Sir:

Submitted for your consideration is:

REPORT

of

SANDSTORM INVESTIGATION

in

COACHELLA VALLEY

between

GARNET AND THOUSAND PALMS

on

ROAD VIII-RIV-26-D

STATION 720± TO STATION 810±

Study made by .... Materials & Research Dept.
Dist. VIII Materials Dept.
Under general direction of .... T. W. Smith
Work supervised by .... D. O. Tueller
L. S. Hannibal
P. C. Morris
Report prepared by .... D. R. Whetsel

Very truly yours,

F. N. Hveem
Materials and Research Engineer

Attach.
cc: LR Gillis
CV Kane
PC Morris
EL Tinney
WL Warren
JF Jorgensen
JA Legarra

The expressway between Garnet and Thousand Palms on Road VIII-Riv-26-D,E, Fig. No. 1, has been a source of numerous complaints about sandstorm damage to motor vehicles. The highway is located in an arid region with sandy soil and sparse vegetation. The area is at times subject to winds which transport sand of such grain size and at sufficient velocity to erode paint and damage windshields on vehicles which use this section of highway. This section of highway was reconstructed in 1957 along an alignment adopted while E. Q. Sullivan was District Engineer. Mr. Sullivan has stated that the problem of damage to vehicles by blowing sand was recognized and that the alignment through this area was arranged to be exactly parallel to the direction of prevailing winds. It was Mr. Sullivan's belief that if the winds should blow directly down the line of the pavement no sand would be picked up or carried. Whether or not this premise is sound is debatable, but in any event the prevailing winds do not parallel the highway alignment but cross at a flat angle.

A comprehensive investigation was started in the summer of 1957 by the Materials and Research Department in cooperation with the District. The purpose of the investigation was to obtain data on the wind and sand movement which is causing damage to motor vehicles on this road, and to determine methods for alleviating such damage. In the initial investigation, we proposed a series of painted columns or stand pipes along the road to determine both the direction of the blowing sand and the height of damage to a painted metal surface. The district constructed these columns of used paint buckets which proved to be very satisfactory and gave clear indication that the winds usually were approaching the highway between Station 600+00 and Station 850+00 at an angle ranging from five to ten degrees. Fluorescent sand grains were also scattered in areas outside the right of way and these "tracer sand grains" were found as far as 4000 feet down the highway from the point of origin.

Various means of controlling blowing sand have been tried at various times and places by other agencies. These include fences, dikes, surface treatment of the desert floor, and various types of vegetation. This report covers that portion of the investigation in which the objective was to determine the degree of benefit from a high berm or dike in reducing the abrasion damage to cars. The construction of an experimental dike was initiated by Headquarters. Work was started by the District in the latter part of 1961 and was completed in January of 1962. The dike, constructed upwind and parallel to the traveled way, was approximately one-half mile in length and 15 feet in height.

The first method of testing the effectiveness of the dike was conducted by the District Materials Department and involved placing flat painted metal panels for a comparison study of damage by blowing sand. The results of this study indicated that a more detailed evaluation system should be provided. This department suggested that the series of cylindrical columns constructed of paint buckets again be placed at intervals on both sides of the traveled way in the test area. The purpose here was to compare the damage from blowing sand in the section adjacent to the dike to that existing beyond the influence of the barrier. The cylindrical shape also provided a means of evaluating the effect of wind direction.

Details of the experimental dike and location of the test panels and columns are shown in plan on Fig. No. 2. Reference to correspondence and reports which cover these test installations in more detail are given in the addendum.

Tests made with the painted panels and painted cylindrical bucket columns during the period of more severe blowing sand in the spring and early summer of 1962 indicated that the dike provided some protection for painted surfaces that were stationary. The protection was in a somewhat limited area down wind from the dike with more protection provided on the left side of the roadway, close to the dike, than on the right or far side. It was not evident whether the same amount of protection would be afforded a vehicle moving against the wind.

In order to evaluate the effectiveness of the dike in relation to moving vehicles the Materials and Research Department proposed a device that would rotate a narrow vane agains the wind in such a way as to register damage to paint on the moving vane. The district proposed the mounting of some type of test panel on a vehicle which could be driven through the test area when a sand storm developed.

Design and construction of the rotary sandstorm device was carried out by personnel of the Materials and Research Department. The rotary devices developed consisted essentially of four main parts: (1) a vertical, dust free, bearing shaft, (2) a wind blade cage which propelled the device at speeds depending upon the velocity of the wind, (3) a mounting for the painted metal test vanes or impact arms, and (4) a concrete base which would support the device and house test instruments. Photographs of a rotary sandstorm measuring device are shown in Fig. No. 3 and 4.

The impact arms were mounted on the lower portion of the devices as shown in Fig. 4. These arms could be removed for observation and measurement of the abrasive damage after periods of severe blowing sand. The impact arms were painted with six layers of contrasting colored automobile paint.

Instrumentation of the rotary sandstorm devices consisted of placing revolution counters on three of the devices and a recording tachometer on a fourth. An eight-day clock advanced the chart paper for the recording tachometer. This chart gave readings in revolutions per minute on thirty second intervals. A revolution counter was also included as an integral part of the recording tachometer.

Installation of four rotary sandstorm devices was completed on February 8, 1963. One of the units was installed west of the dike, upwind, where there is no protection, two were installed in the shelter of the dike where presumably maximum protection should be provided, and the fourth was installed downwind or east of the dike where the degree of protection was questionable. Details of location of these devices are shown in plan on Fig. No. 2. The recording tachometer was placed on Device No. 1. The revolution counters were placed on Device Nos. 2, 3, and 4.

After installation of the rotary devices, the District supplied personnel to maintain the equipment, record test data and make observations of storm conditions or other pertinent data. All records were to be forwarded to the Materials and Research Department for study. Data which was received from the District consisted of the damaged impact arms, the recording tachometer charts, weekly reports on the operation of the rotary devices, including revolution counter readings, and records of the periods when storm warning signs were displayed on the highway. The authorization and supplemental allotment for continuance of this investigation are given in a letter from Mr. C. G. Beer to Mr. C. V. Kane, dated March 18, 1963.

The period of operation and observation of the rotary sandstorm devices was from February 26, 1963, to May 14, 1963. During this time several storms of damaging intensity occurred. A chronological record of the storms, as indicated by the recording tachometer on Device No. 1, is shown on Fig. No. 5. The intensity of the storms are shown in terms of revolutions per minute of Device No. 1. The periods when the storm warning sign was posted on the highway are also shown on Fig. No. 5.

During the test period, the impact arms were replaced approximately once a week or whenever damage was sufficient to warrant replacement. The arms were replaced at the same time on each of the four rotary devices except as noted below. The exposure periods are shown in the following table.

Exposure of Impact Arms

Exposure Period	Date (1963)			Remarks
1	2-26	to	3-5	Device #3 not operating because of a cocked bearing.
2	3-5		3-11	See remark above. Revolutions of Device #2 not recorded because of broken belt.
3	3-11		3-19	Device #3 not operating because of a cocked bearing. Restored to operation on 3-20-63.
4	3-19		4-16	No damage to impact arms as of 3-26-63. Arms were replaced on Device #1 on 4-3-63.
5	4-16		4-23	
6	4-23		5-7	No damage to impact arms as of 4-30-63.
7	5-7		5-14	

The damage sustained by the impact arms is shown on the record photographs, Fig. No. 6 through Fig. No. 13. The exposure periods indicated on the photographs correspond to the periods given in the above table. The scale shown on the photographs represents distance in feet and tenths of feet from the axis of rotation of the devices.

In order to compare the damage to the impact arms of the four devices it was necessary to know how the rotational efficiency of these devices compared. During inspection visits to the test site District personnel took readings of wind velocity and rotational speed of the devices. These readings were taken with an anemometer and calibrating tachometer, respectively. The values obtained are plotted on Fig. No. 14 to give a graph of the efficiences of the rotary sandstorm devices. From this chart Device Nos. 2, 3, and 4 appear to have operated at very nearly the same efficiency. Device No. 1 was slightly less efficient. This means that Device No. 1 rotated more slowly in a given velocity of wind than the other three devices. The resulting damage to the rotating impact arms of Device No. 1 would be slightly less than if it had operated at the same speed as the remaining devices.

Another observation of the comparable rotational efficiency of the four units may be seen in the plots of cumulative revolutions on Fig. No. 15. The fact that the curves are relatively parallel over the test period, i.e., the rate of increase in revolutions is very comparable, indicates that the devices rotated with very nearly the same degree of freedom. The slight divergence of the curve for Device No. 1 from the curves of the other three points out, once again, the slight inefficiency of Device No. 1 in comparison to Device Nos. 2, 3, and 4. It should be observed, as noted on the figure, that revolutions were not accumulated by Devices No. 1 and 3 during certain periods. An adjustment for the unrecorded revolutions would obviously give a closer grouping of the curves.

The similar efficiencies of the rotary sandstorm devices indicates that damage to the impact arms may be directly compared. Fig. No. 16 shows a comparison of the damage for each of the exposure periods given in the table above. The damage evaluation used in this chart is based on the amount of paint abrasion at a distance measured in feet from the axis of rotation. Heavy damage means the complete or nearly complete removal of all six paint layers. Moderate damage means removal or chipping of two or more paint layers while slight damage means the removal or chipping of at least one paint layer. In general, Device No. 1, west and upwind of the experimental dike, received the most severe damage. Device Nos. 2 and 3, in the area sheltered by the dike, received the least damage in terms of moderate and heavy abrasion. Device No. 4, being east and downwind of the dike, received slightly more damage than Device Nos. 2 and 3 but less damage than Device No. 1. However in terms of slight damage Device Nos. 2, 3 and 4 show nearly as much damage as Device No. 1.

A comparison of the revolutions of the rotary sandstorm devices during the seven exposure periods is shown on Fig. No. 17. Device Nos. 2, 3 and 4 recorded more revolutions than Device No. 1 during all exposure periods. Device No. 2, although presumably in the most protected area, recorded the highest number of revolutions. The greatest damage was sustained by Device No. 1 having the least number of revolutions while the greatest number of revolutions and the least damage was sustained by Device No. 2 protected by the dike. These facts indicate that the dike was effective in reducing the amount of sand abrasion to the devices on the edge of the roadway.

Although the above data indicate that the dike offers some protection from abrasive damage to painted surfaces the degree of protection is the important consideration. The amount of moderate and heavy damage is reduced downwind from the dike. However, in the heavier storms slight damage still occurs within the dike protection area and is sufficient to be intolerable for the painted surface of passing vehicles.

Further verification of the results shown by the rotary sandstorm devices was obtained from test runs made with vehicle mounted test panels. The equipment used for these tests was constructed by the District. This equipment consisted of a special frame mounted on the front of a pick-up truck as pictured on Fig. No. 18. A series of painted metal panels were hinged to this frame in such a way that the panels could be exposed to the blowing sand for controlled intervals as the vehicle traveled along the roadway. Details of the panel mountings and the exposure control levers are shown on Fig. No. 19. The control rods, also shown in these figures, were operated from the cab of the vehicle.

A heavy storm was in progress when District personnel arrived at the test area on April 9, 1963. Two test runs were made with the vehicle mounted panels during this storm. In each test run, three panels were exposed in sequence for equal intervals of 2200 feet. The vehicle was driven into the storm along the northbound or westbound lanes from a point easterly of the dike, to a point westerly of the dike. The limits of the test runs and the exposure intervals are shown in plan on Fig. No. 2.

In test run No. 1, Panel 1-1 was exposed easterly or downwind of the dike, Panel 1-2 was exposed through the area where the dike presumably affords the maximum protection, and Panel 1-3 was exposed westerly or upwind of the dike. The vehicle was driven at a speed of 50 mph for this test run. The damage to the three panels was insufficient after one pass to properly evaluate the damage. Two additional passes were made with the same three panels, exposing them in the same sequence as above and at the same speed. A photograph of the panels from test run No. 1 is shown on Fig. No. 20.

Test Run No. 2, exposing Panels 2-1, 2-2, and 2-3, was made in the identical manner of test run No. 1 except that the vehicle was driven at a speed of 55 mph. A photograph of the panels from test run No. 2 is shown on Fig. No. 21. It should be noted that the distance that each panel was exposed is only about one-sixth the distance that a vehicle would be exposed in the sandstorm area. Hence in a comparable sandstorm a vehicle would be much more severely damaged than the panels were.

The damage to the vehicle mounted panels was greatest for those panels (1-3 and 2-3) exposed westerly and upwind of the dike. The least damage occurred to those panels (1-2 and 2-2) exposed in the protection area of the dike. These results are consistent with the data from the rotary sandstorm devices.

In summary the results of the test runs with the vehicle-mounted panels and the data from the rotary sandstorm devices both indicate a degree of protection is afforded by the earth fill dike. However, damage amounting to the destruction of at least one paint layer can still occur in the area "protected" by the dike. Indications are that damage to vehicles will occur when wind speeds are in excess of 20 to 25 miles per hour. In our opinion this amount of damage is too great or the protection furnished by the dike is insufficent to justify the expense of dike construction across the entire area subject to blowing sand.

Based on the data obtained in this investigation, and after thorough study of all known methods of preventing sand from moving acorss an area, it is believed that the treatment described below is most likely to be effective. A plan, Fig. No. 22 and typical section, Fig. No. 23, are attached. Under this scheme ultimate protection would be provided primarily by tree planting consisting of three rows of tamarisk planted in a 50-ft. wide strip just outside the present right-of-way line, and a ground cover of giant reed grass or other appropriate vegetation in the area between the tamarisk wind break and the roadway. However, the tamarisk would not be effective as a windbreak for a few years after planting, and the plantings could not be expected to survive unless protected from sand erosion until established. Therefore, a snow-type wire and slat fence is proposed at a distance of 400 ft. from centerline; this fence will provide temporary protection for the new plantings and should help to alleviate vehicle damage until the vegetation becomes established. The sand will be deposited on the lee side of the snow fence, but in a short distance beyond a fence the wind can again pick up a new sand-load. To prevent this, the entire area between the snow fence and the roadway would be given a temporary surface treatment of asphaltic material.

The "snow fence" must be located a sufficient distance outside the tamarisk wind-break to protect the plants and provide a storage area for the sand drifts which will be deposited on the lee side of the fence. This installation will require the acquisition of additional right of way or easement (a strip 250 ft. wide) on the side of the road to be treated. The snow fence would be located fifty feet inside the new right of way line, thus providing a fifty-foot wide strip on the windward side of the fence for sand drifts, which should prevent drifts from encroaching on adjacent private property.

Such a planting program will necessitate developing a substantial water supply and installation of necessary pipe lines and sprinklers. Operating costs for irrigation of the plantings will include pumping costs and upkeep of the pumps, pipe lines and sprinklers.

If the treatment is applied on those portions of the project where sand blast damage has been most severe it will be necessary to treat the following areas in the manner described above, on the right between Station 416+00 and Sta. 650+00, and on the left between Sta. 600+00 and Sta. 856+00. This means approximately 9.3 miles of roadside treatment, but due to the overlap represents protection along approximately 8 miles of highway. It is estimated that the annual operating and maintenance cost will be near $100,000 per year, of which the major expenditure will be for water. There is little reason to believe that tamarisk trees or any other type will ever become self-sustaining in this area; at least the reported depth of some 500 ft. to the water table makes such a possibility seem very unlikely. The estimated cost of the treatment within these limits would be between $1,000,000 and $1,500,000 including watering of the plants for one season. This estimate of cost is based on information contained in Mr. C. V. Kane's letter to Mr. G. T. McCoy, attention Mr. F. N. Hveem, dated August 1, 1958. No treatment is considered necessary on the lee side of the highway, nor on certain portions of the project where the sand blast damage is much less severe, namely Station 186+00 to Sta. 416+00, and Sta. 856+00 to Station (E)16+00, the end of the project.

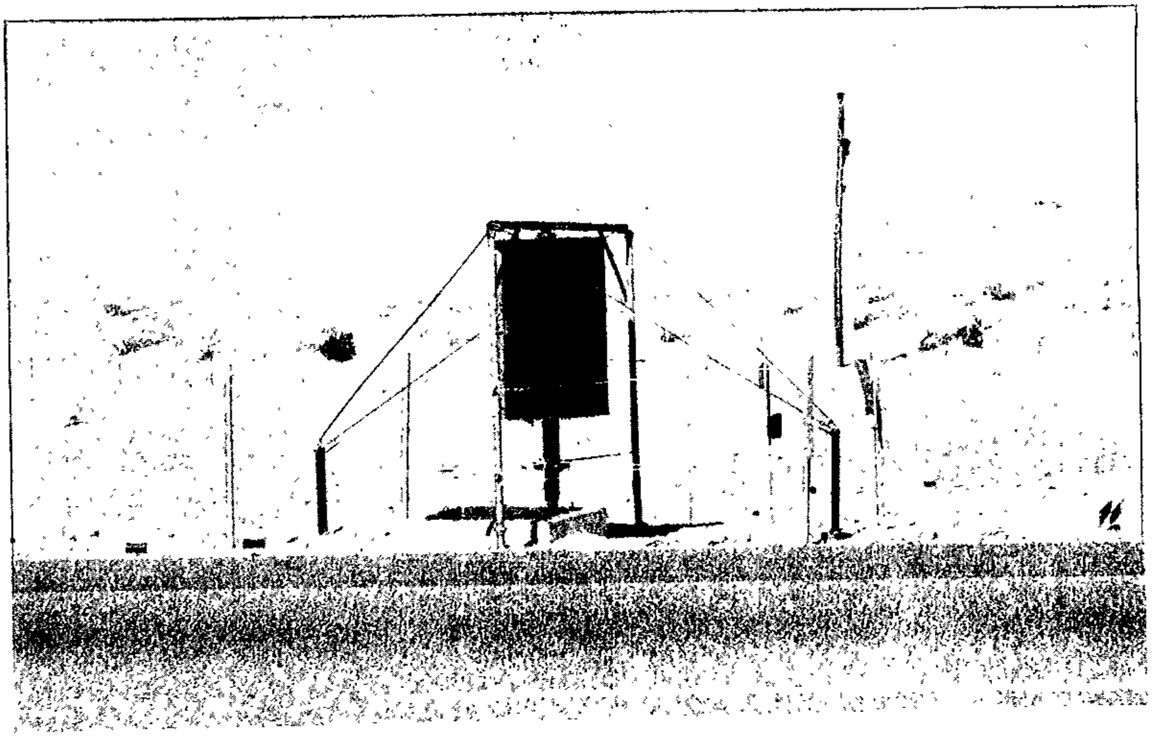


Fig. 3. Rotary Sandstorm Device Installed at the Test Site.

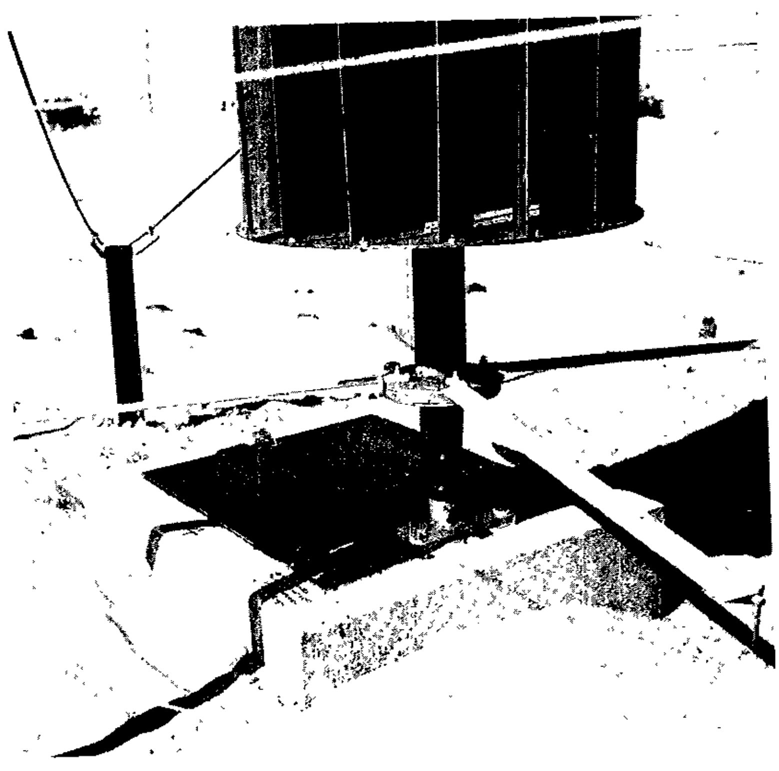
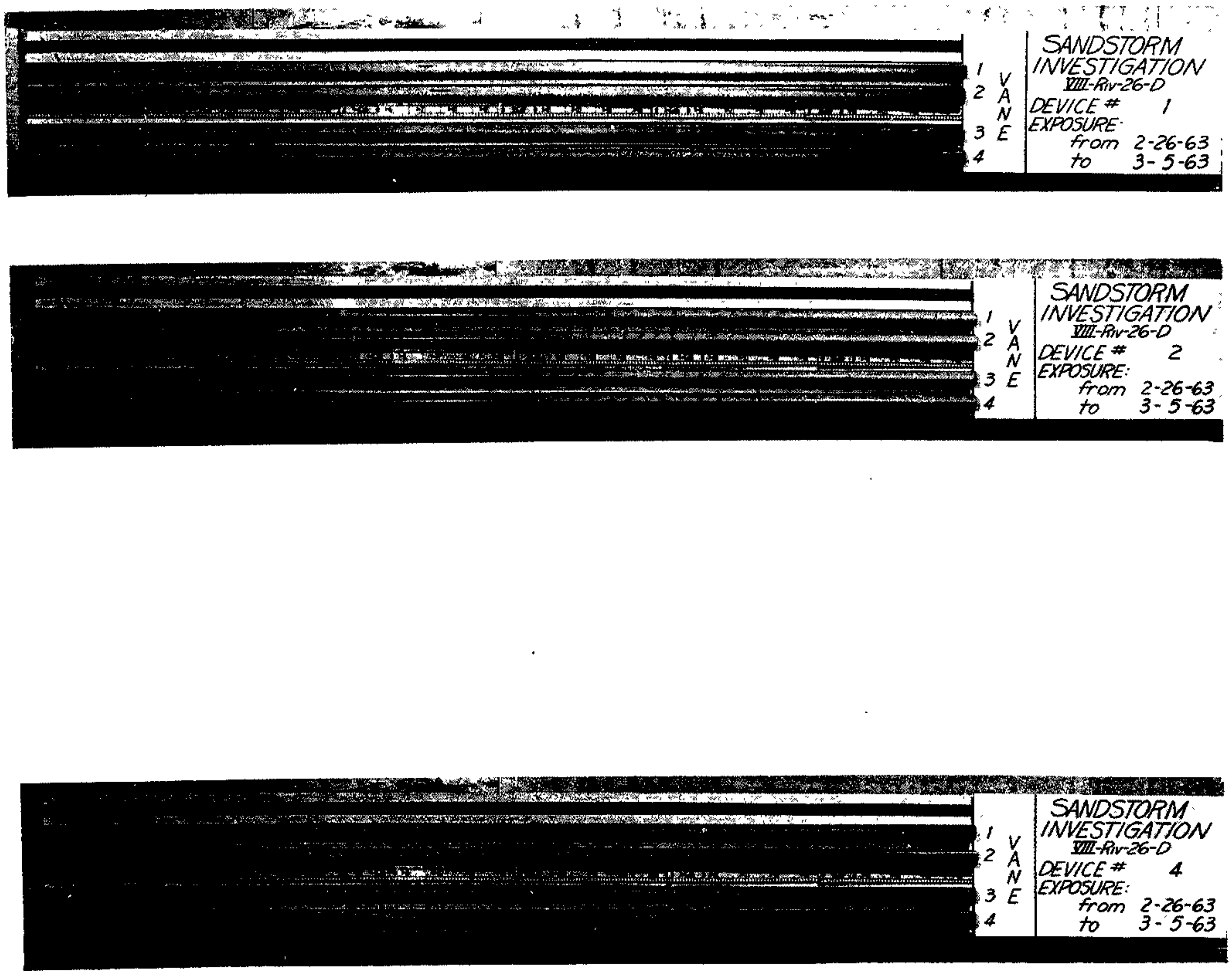
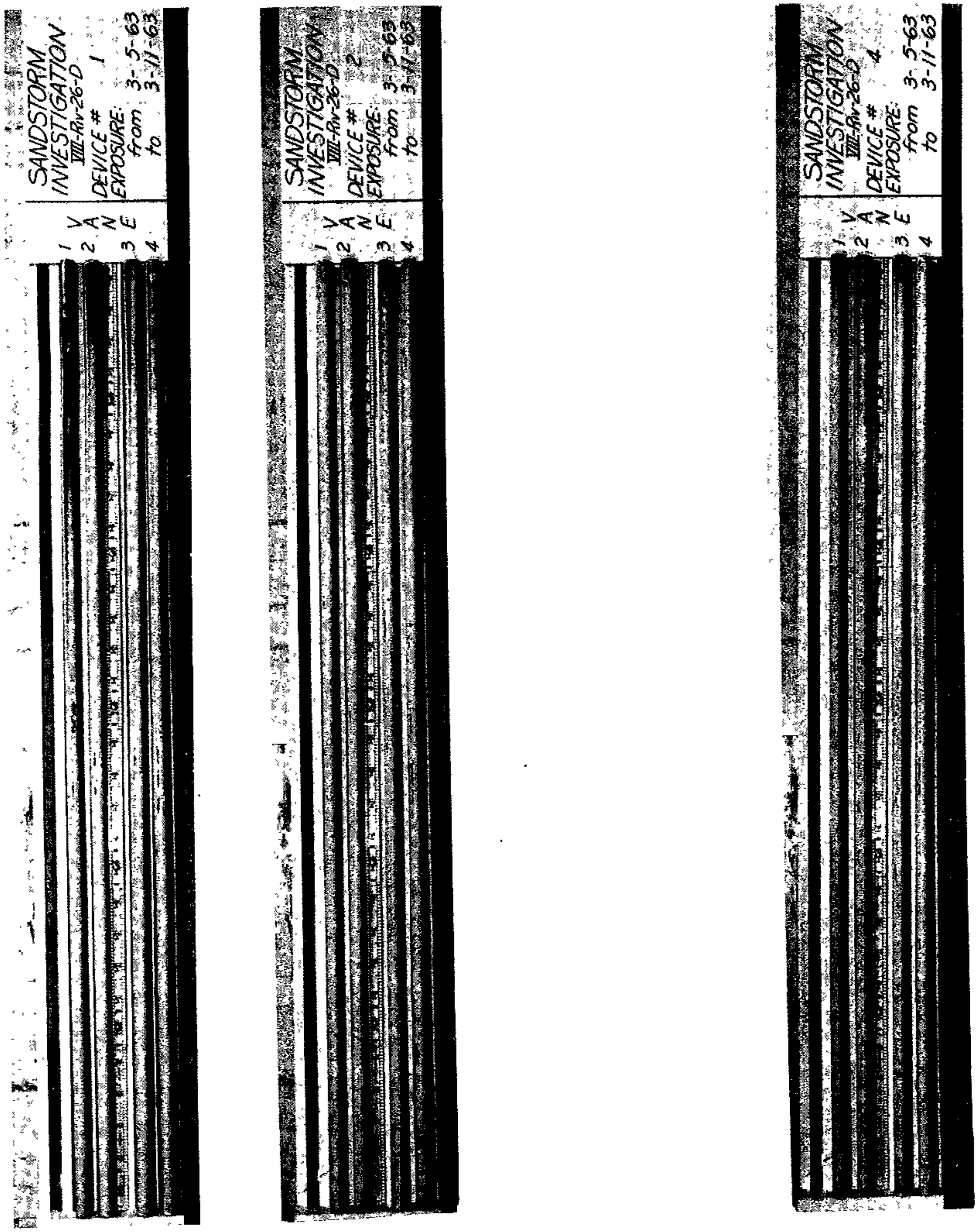


Fig. 4. Details of Impact Arm Mounting

Fig. 6

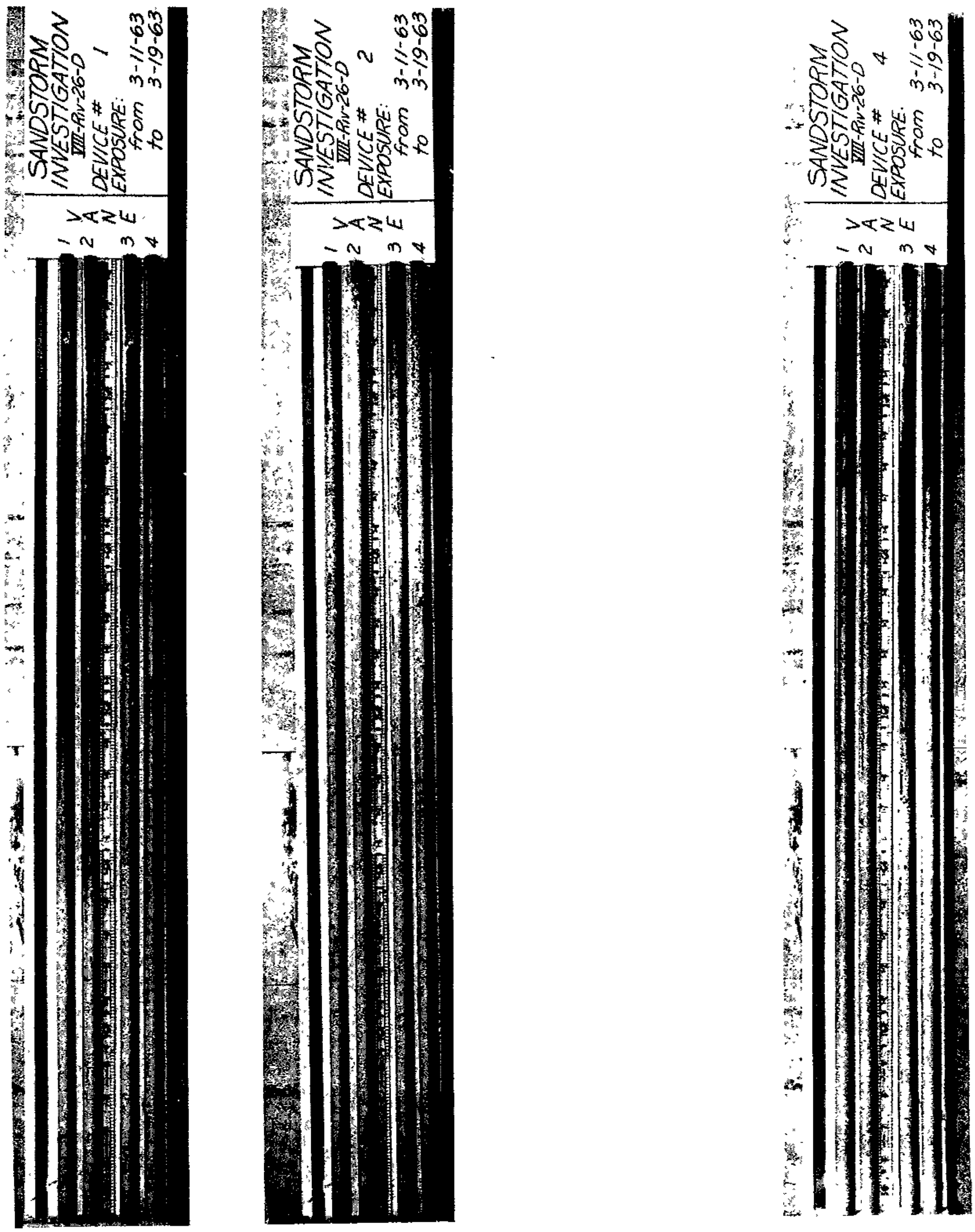


Exposure Period 1



Exposure Period 2

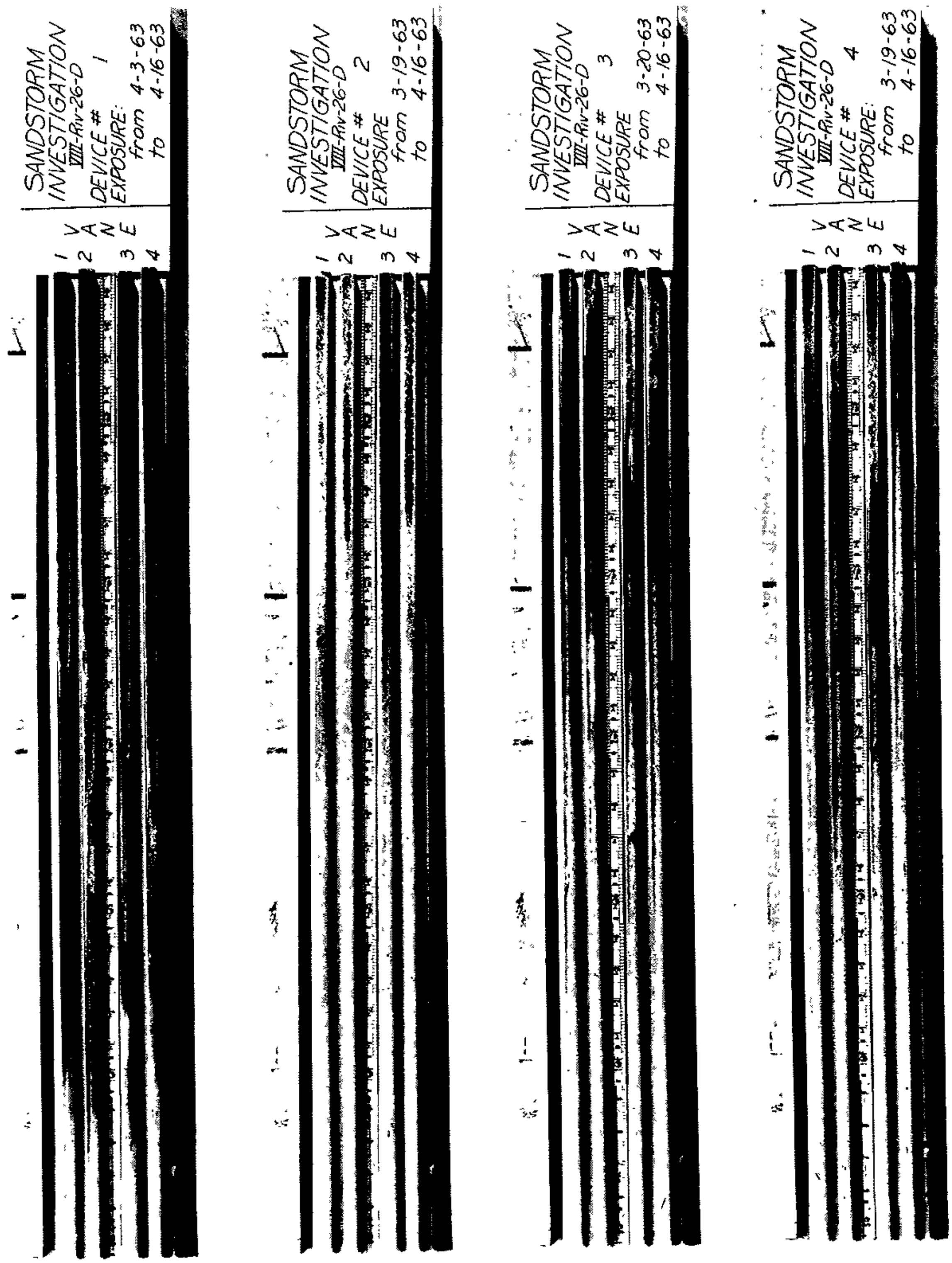
Fig. 8



Exposure Period 3

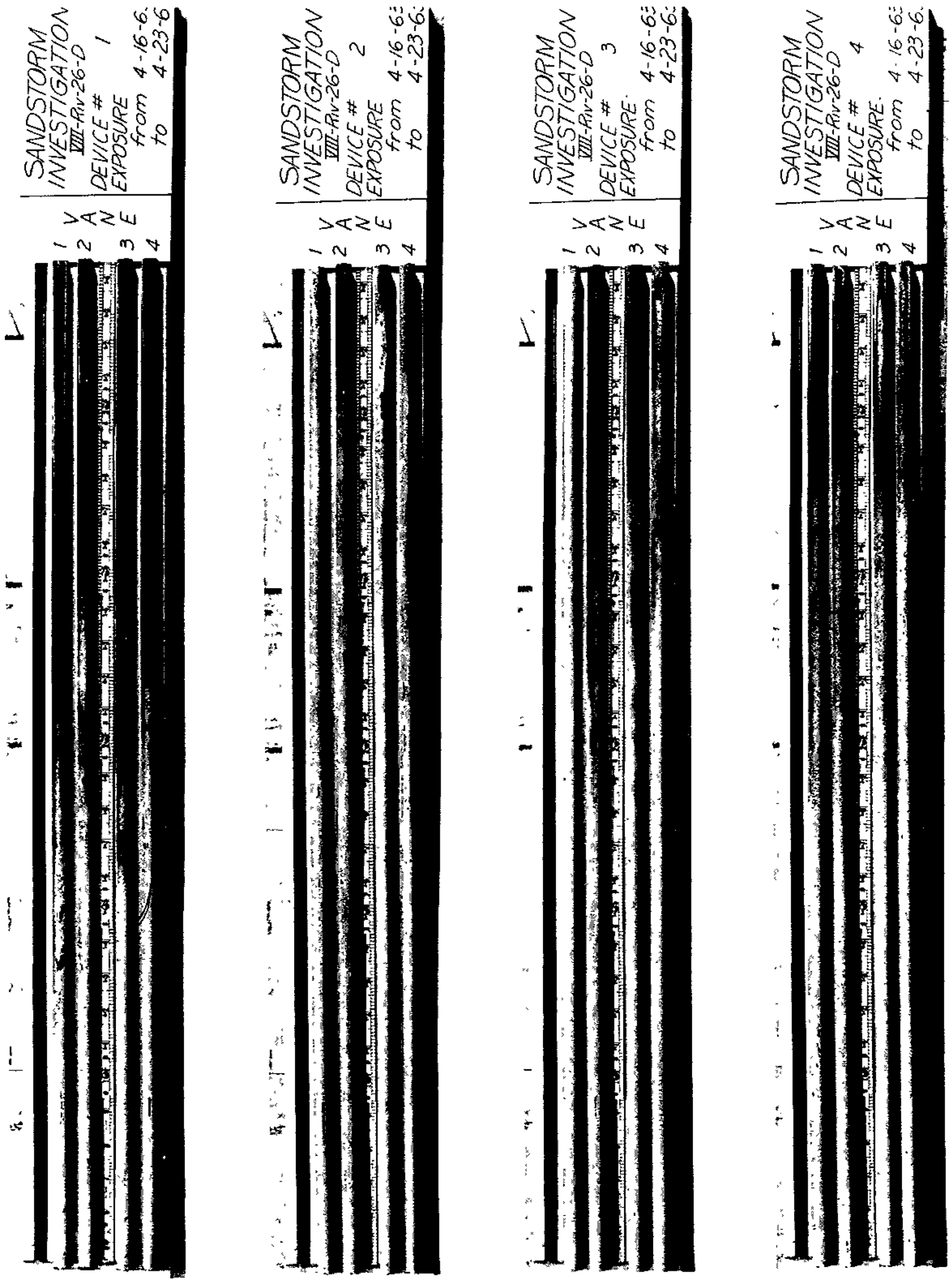
Fig. 9

Exposure Period 4



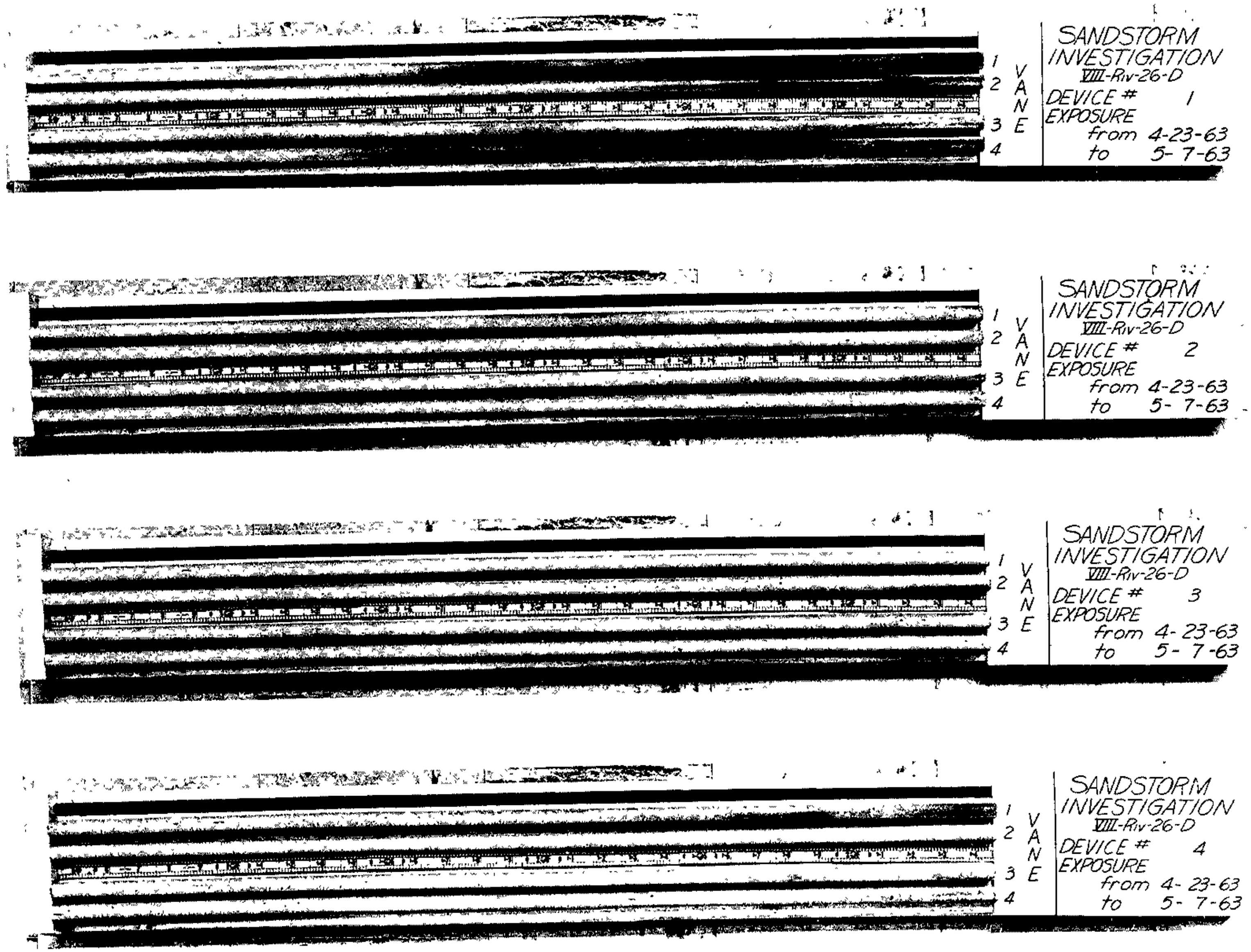
Exposure Period 4A

Fig. 11



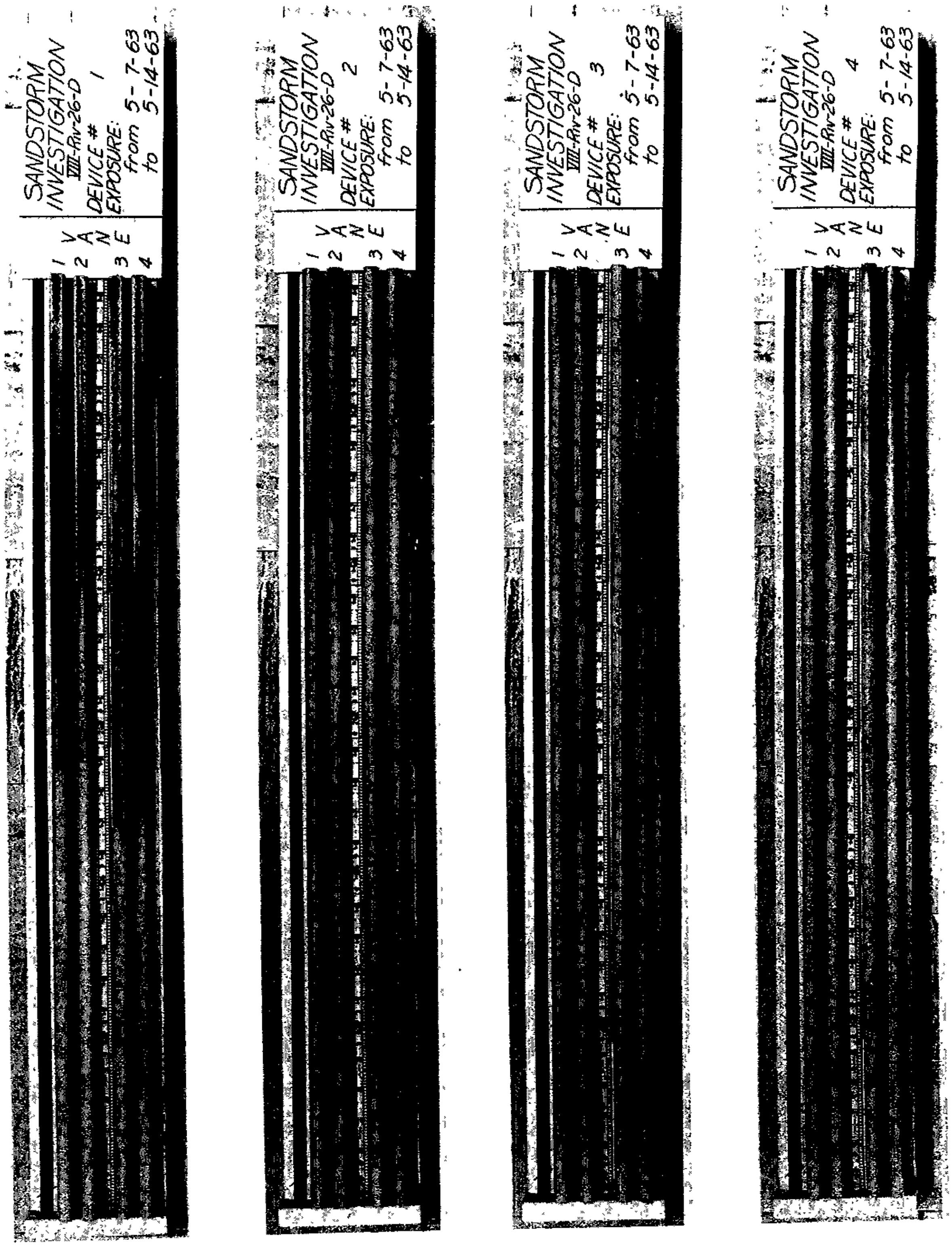
Exposure Period 5

Fig. 12



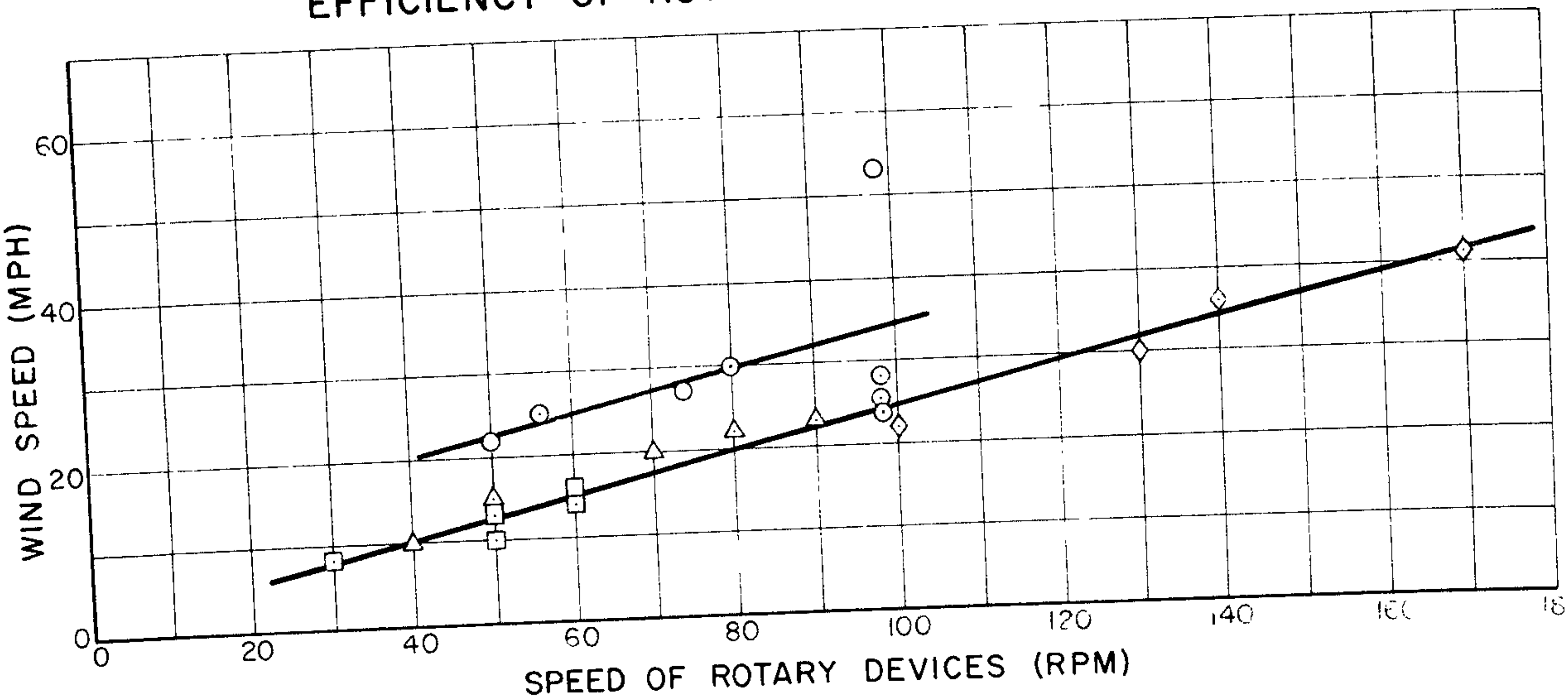
Exposure Period 6

Fig. 13

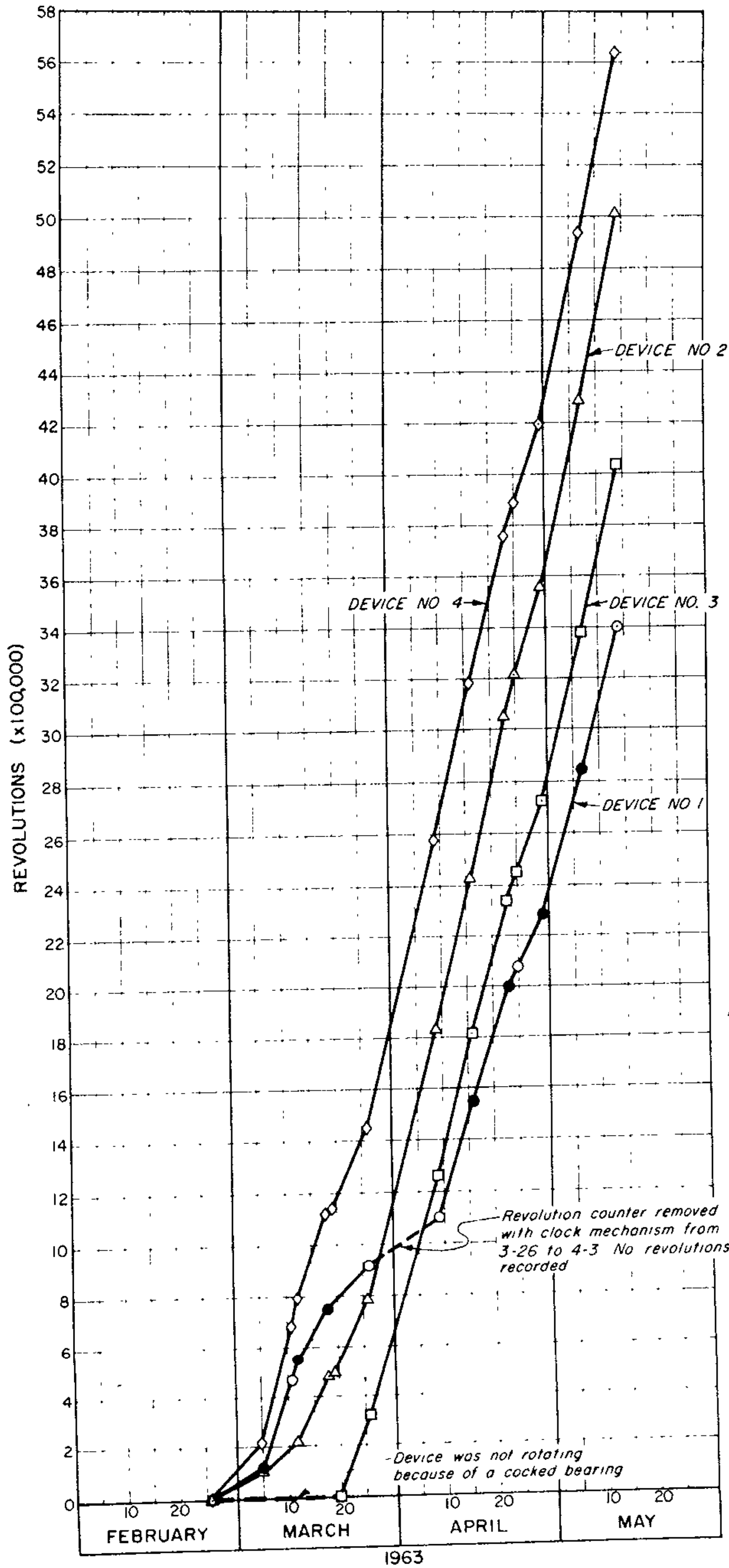


Exposure Period 7

EFFICIENCY OF ROTARY SANDSTORM DEVICES



Legend	Device	Date	Remarks by District Personnel
⊙	1	3-11-63	Wind blowing 25 mph.
△	2	3-12-63	Steady wind 20± mph blowing sand
⊡	4	3-12-63	Steady wind–no blowing sand
◇	3	4-9-63	Heavy dust and sand blowing – gusts 40 mph stinging sand 4.5' above ground.



NOTE.

Revolution counters on Devices 2,3 & 4 accumulated totals from installation to removal of the devices. The revolution counter on Device I was reset to zero on dates indicated by (●).

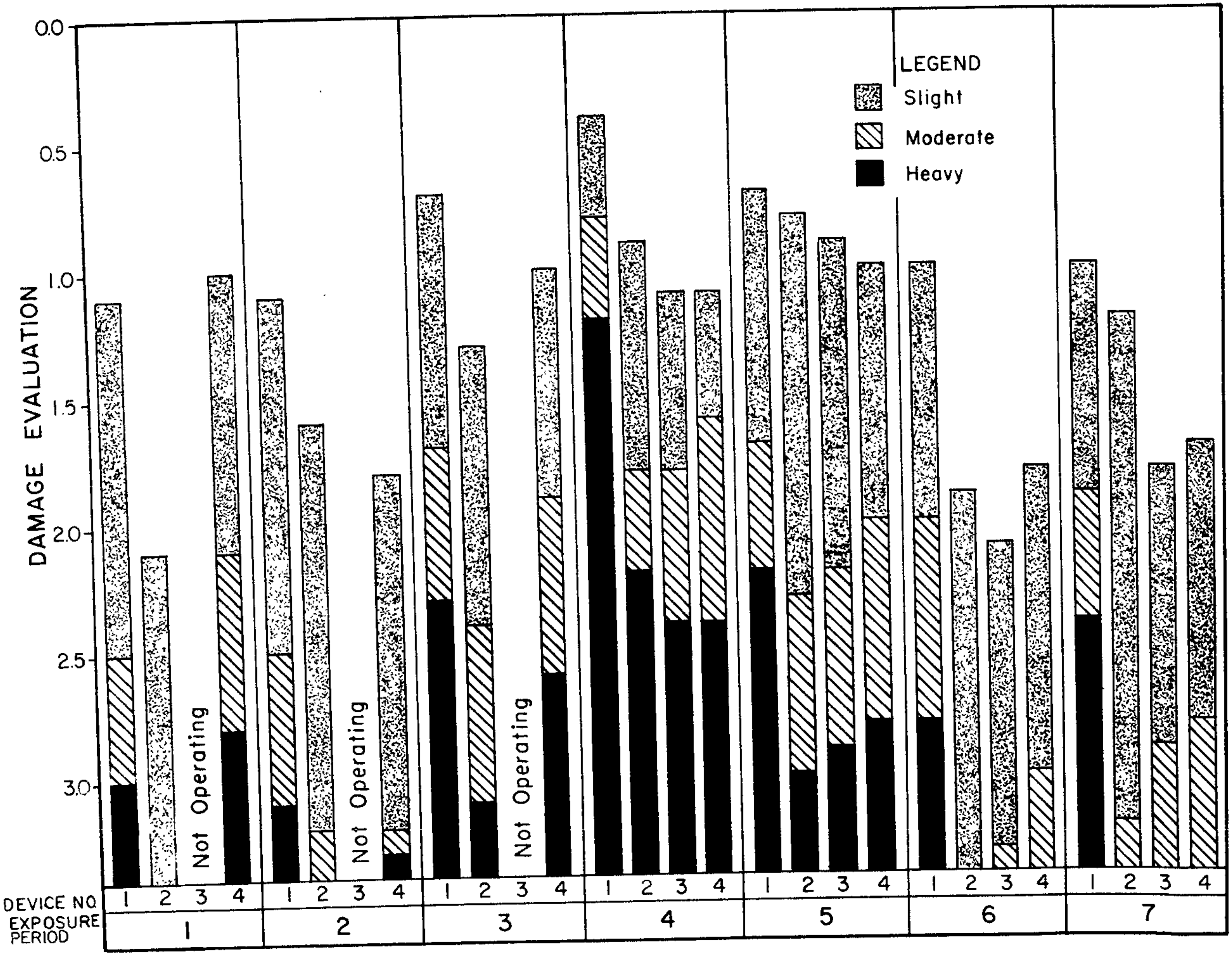
SANDSTORM INVESTIGATION

Road VIII–Riv–26–D

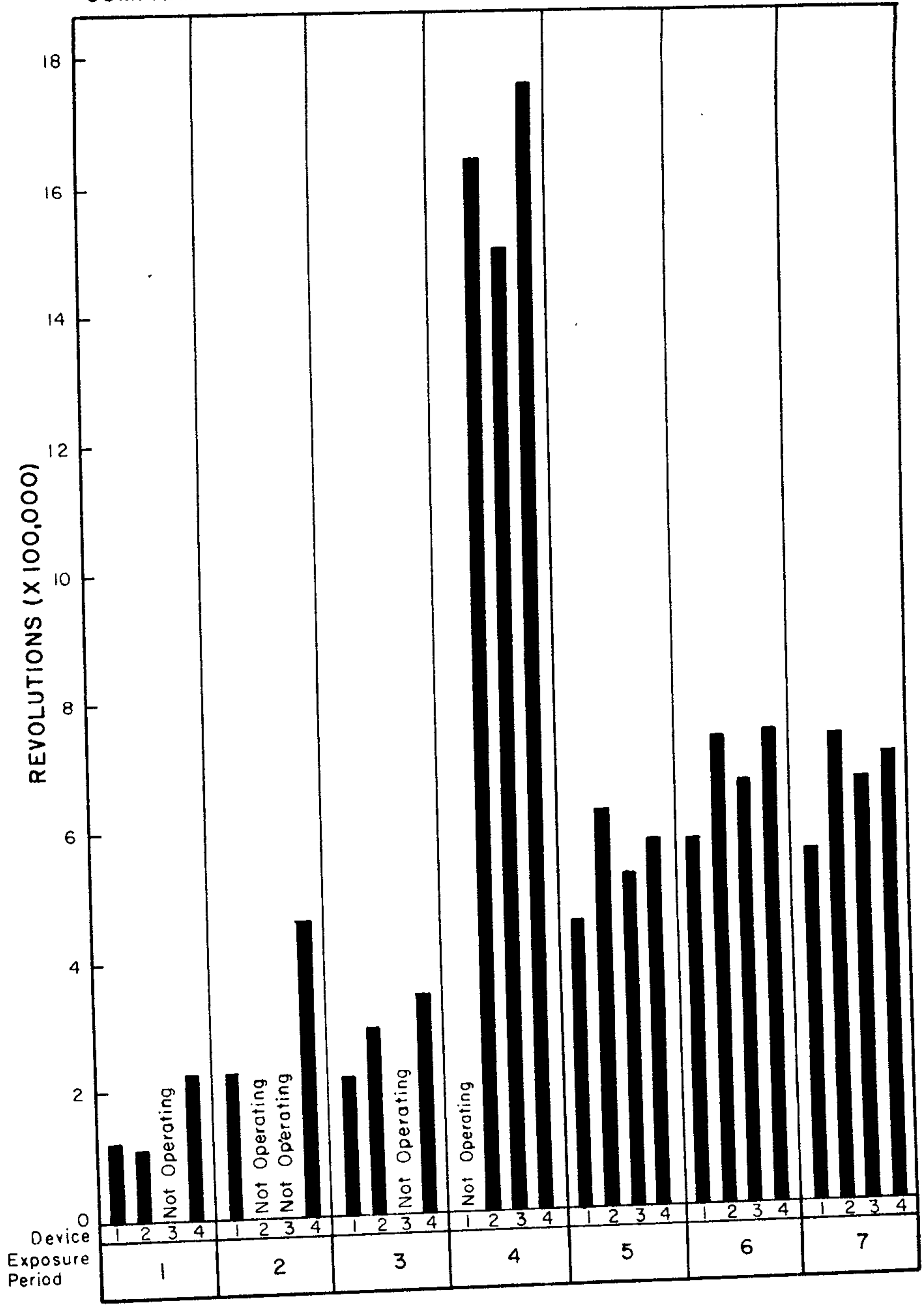
Coachella Valley

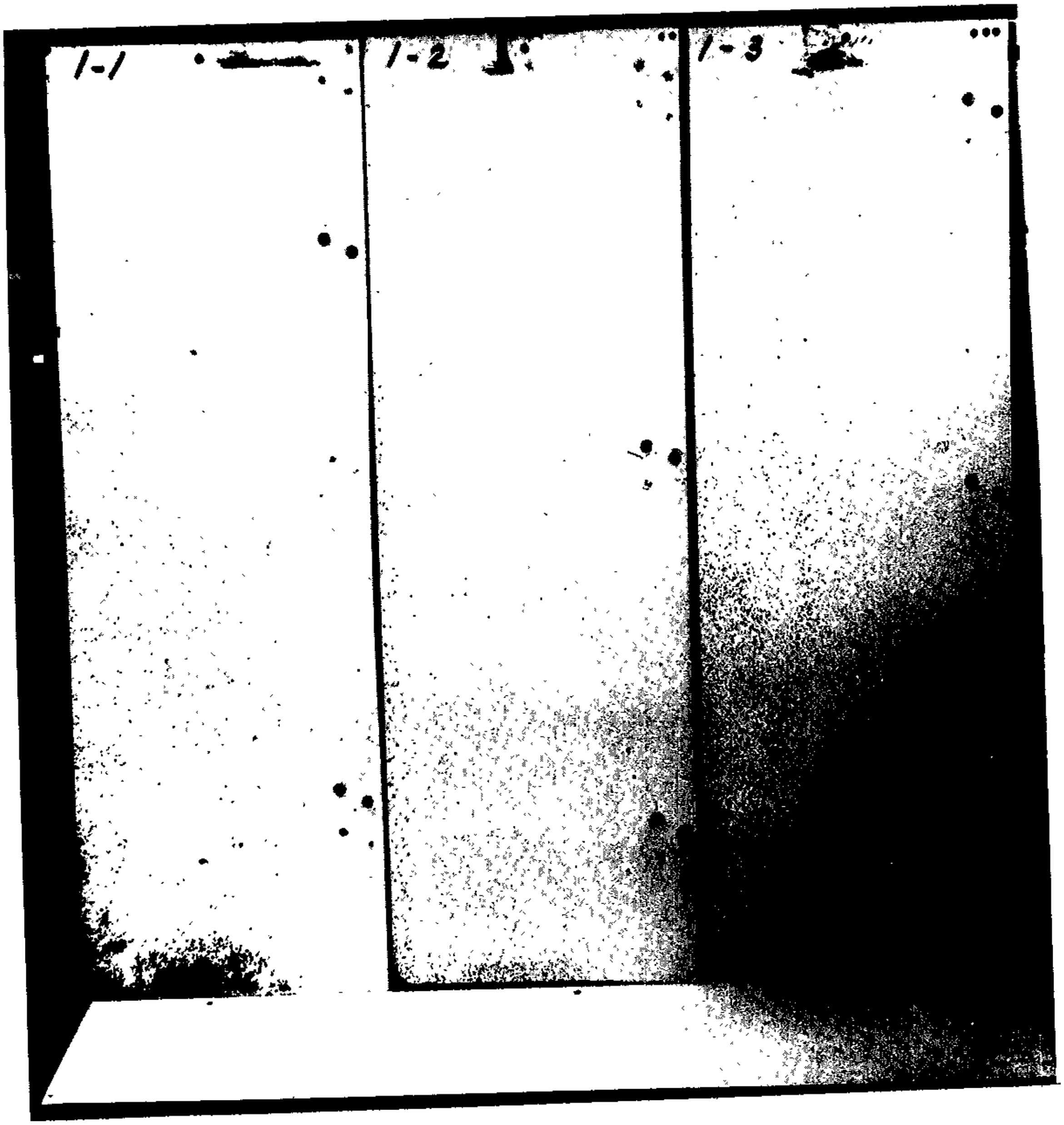
Cumulative Revolutions of the Rotary Sandstorm Devices

COMPARATIVE IMPACT ARM DAMAGE OF ROTARY SANDSTORM DEVICES



COMPARATIVE REVOLUTIONS OF ROTARY SANDSTORM DEVICES





Vehicle Mounted Panels   Test Run 1

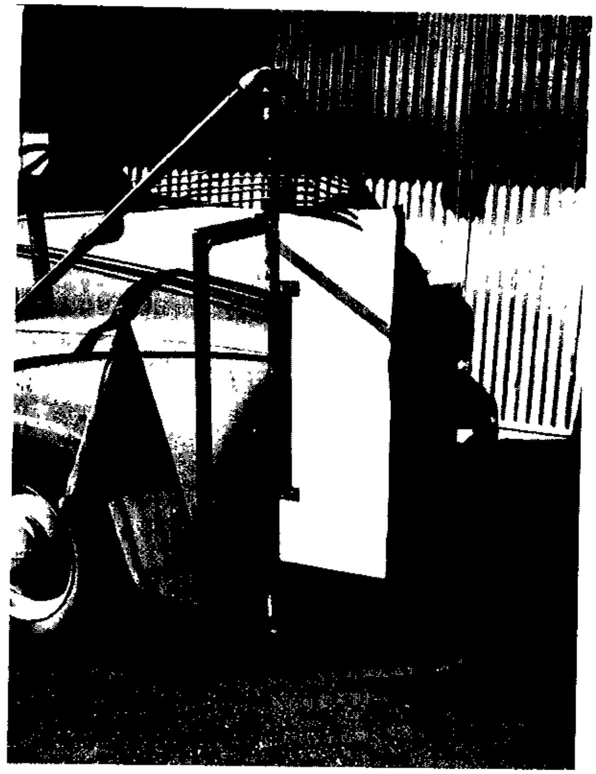


Fig. 18. Vehicle Mounting of Painted Test Panels

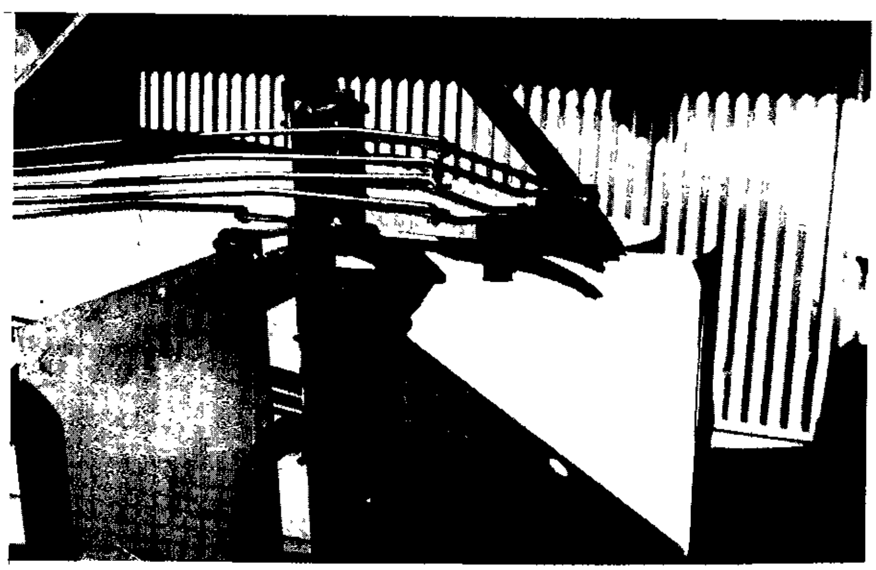
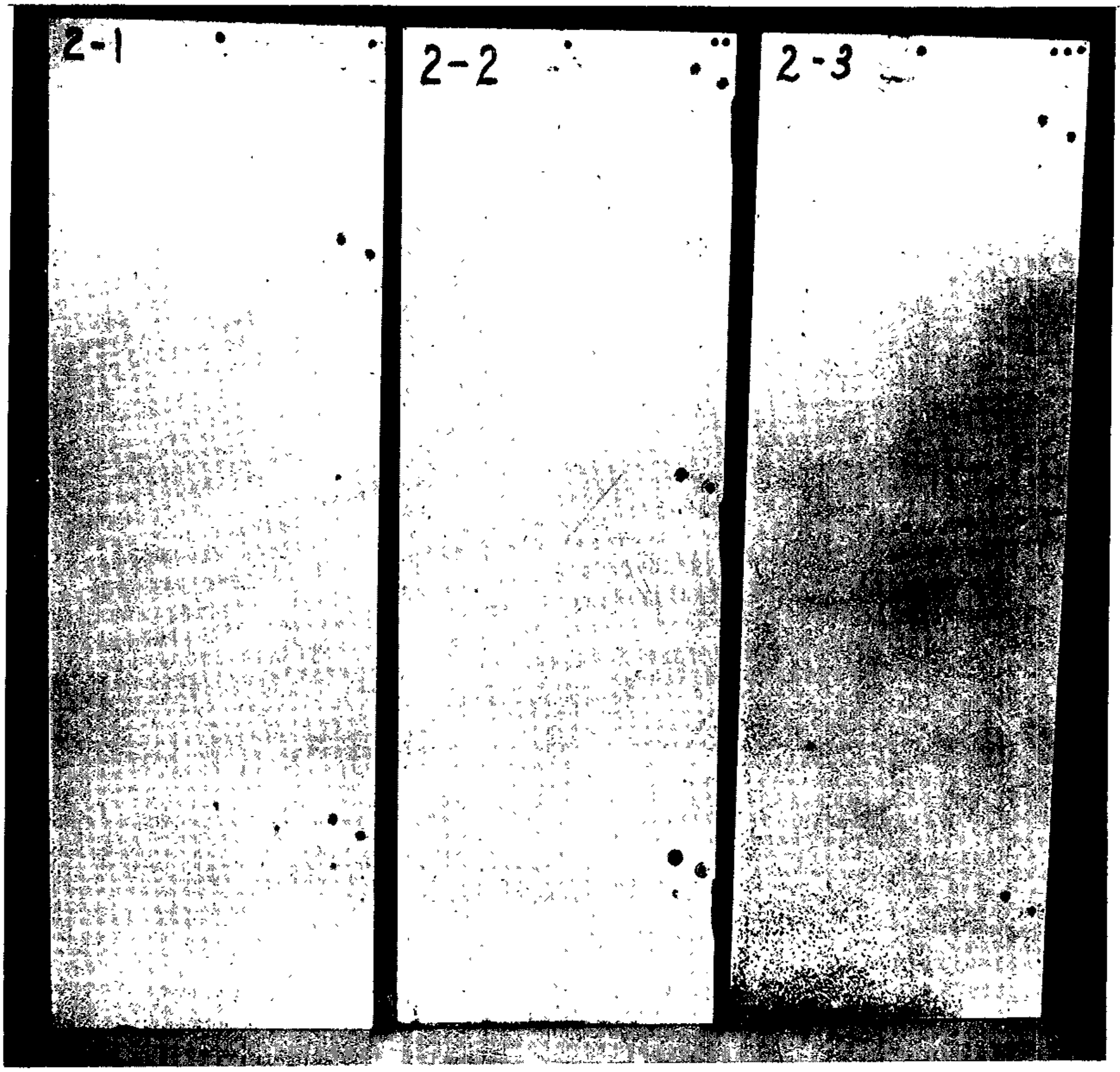
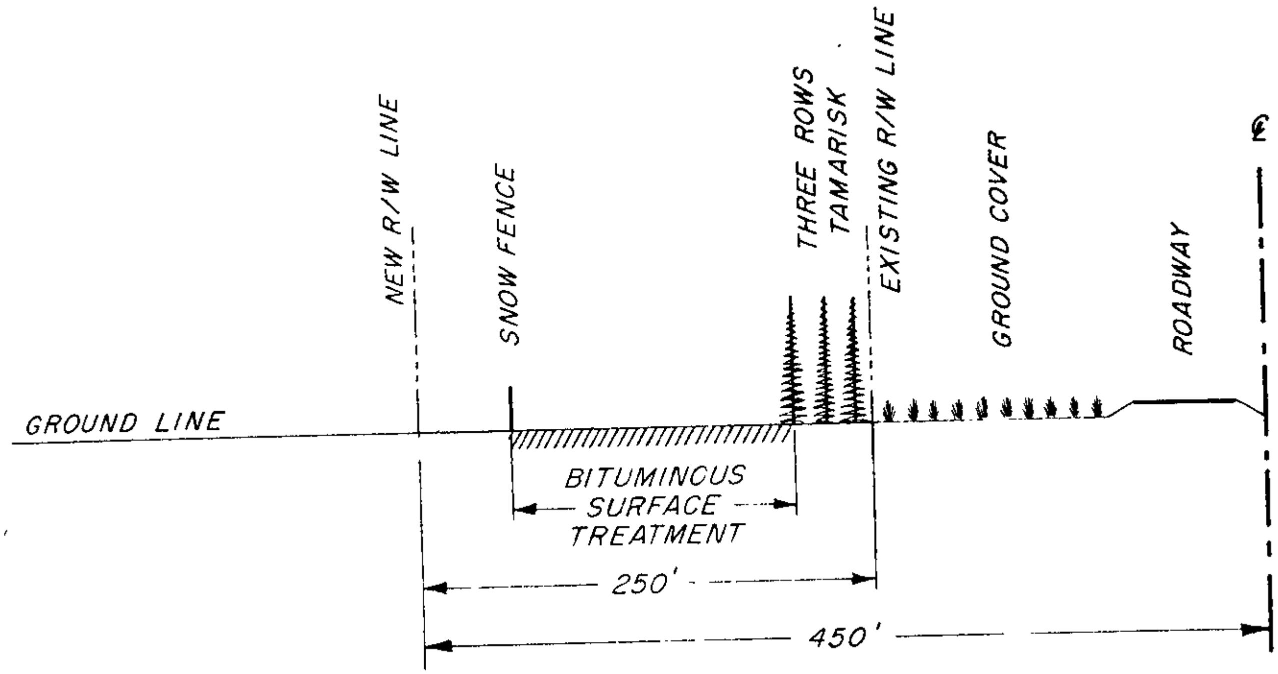


Fig. 19. Detail of Test Panel Mechanism



Vehicle Mounted Panels   Test Run 2



TYPICAL SECTION

Proposed Sand Control Treatment VIII - Riv.-26 - D

CHRONOLOGICAL STATEMENT OF CORRESPONDENCE
ON
SANDSTORM INVESTIGATION

(February 1962 to May 1963)

February 21, 1962	Letter Morris to Kane First interim report on control of blowing sand by the experimental dike installation.
February 23, 1962	Letter Kane to Womack Comments on first interim report, see above.
April 3, 1962	Letter Morris to Kane Second interim report on control of blowing sand by the experimental dike installation.
April 13, 1962	Letter Kane to Womack Comments on second interim report, see above.
May 1, 1962	Letter Murphy to Kane Recommendation for installation of painted bucket columms for more detailed evaluation. of experimental dike.
May 10, 1962	Letter Kane to Womack Report on Wrought Washer Co. fence installation.
May 23, 1962	Letter Kane to Womack Report on storm damage to painted panel installation.
May 31, 1962	Letter Kane to Murphy Report on installation of painted bucket columns (May 17-May 22)
June 11, 1962	Letter Kane to Womack Report on storm damage to bucket column installations.
June 22, 1962	Same as above
July 16, 1962	" " "
August 22, 1962	" " "
August 23, 1962	Letter Hveem to Gillis Evaluation of bucket column installations and dike protection area.
August 29, 1962	Memo Smith to Hveem Report on meeting in Mr. Murphy's office. Discussion of developing rotary sandstorm devices and vehicle mounted test panels.

September 20, 1962	Letter Kane to Womack Report on storm damage to bucket column installation.
September 24, 1962	Letter Womack to Steel (BPR) Transmittal of design details for experimental dike and discussion of status of sandstorm investigation.
October 26, 1962	Letter Kane to Womack Report on storm damage to bucket column installations.
October 31, 1962	Letter Kane to Womack Evaluation of Wrought Iron Washer Co. fence installation.
December 17, 1962	Letter Kane to Sprank Reply to citizens suggestions for alleviating blowing sand problem.
February 1, 1963	Letter Hveem to Gillis Request for special investigation allotment in lieu of continued financing of the sandstorm investigation on a laboratory account.
February 8, 1963	Teletype Kane to Womack Request for news release covering recent installations at site of sandstorm investigation.
February 13, 1963	Letter Hveem to Kane Discussion of meeting on Aug. 27, 1962 in Mr. Murphy's office concerning status of sandstorm investigation. Report on construction and installation of rotating devices to measure damage to moving objects in storm conditions.
February 13, 1963	Letter Hveem to Murphy Draft of press release proposed in connection with sandstorm investigation.
February 13, 1963	Letter Hveem to Kane Reference to installation of rotary sandstorm devices and request for district personnel to inspect devices and record data.
March 13, 1963	Memo Eagan to Hannibal Report of field observations and condition of equipment during field trip to site of sandstorm investigation.

March 13, 1963	Letter Hveem to Kane Instructions for repair of rotary sandstorm device.
March 15, 1963	Letter Murphy to Borges Reply to Wrought Washer Mfg. Co. concerning developments in sandstorm investigation that pertain to experimental fence installations.
March 18, 1963	Letter Beer to Kane Authorization of supplemental allotment for sandstorm investigation and designation of the Materials and Research Department as the department which will prepare the final report.
April 5, 1963	Letter Kane to Womack Reports on operation of rotary sandstorm devices.
April 25, 1963	Letter Womack to Hauk Reply to query concerning use of snow fence to control sand drifts.
May 6, 1963	Letter Kane to Womack Reports on operation of rotary sandstorm devices and test runs with vehicle mounted painted panels. Request for removal of rotary sandstorm devices.
May 8, 1963	Letter Kane to Womack Report on operation of rotary sandstorm devices.
May 15, 1963	Letter Kane to Womack Final report on operation of rotary sandstorm devices and notification that dismantling of devices began on May 14, 1963.