DEVELOPMENT OF A RETRACTABLE SLOPE-LINE APPROACH-LIGHT UNIT

By

Marcus S Gilbert and H J Cory Pearson

Airport Division

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U S DEPARTMENT OF COMMERCE

Charles Sawyer, Secretary

CIVIL AERONAUTICS ADMINISTRATION

C F Horne, Administrator

D M Stuart, Director, Technical Development and Evaluation Center

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SUMMARY

This report discusses the development of a slope-line approach-light unit which, when not in use, will retract into a position on the ground, in order to reduce the possible hazard to aircraft taking off over the approach-light system Two designs were completed, one for a hinged type and the other for a type that withdraws axially into a metal housing sunk into the ground The hinged type was selected for fabrication and test as it offered a partial answer to the problem at a minimum cost of installation and minimum of maintenance and operating difficulties The experimental model has operated satisfactorily in various kinds of weather during the period of 18 months in which it has been in use

INTRODUCTION

In considering any approach-light system, attention must be given to the introduction of obstructions into the approach zone Technical Standard Order N-18, which covers both civil and military requirements, has defined an instrument approach surface (for civil requirements) as an inclined plane beginning at threshold elevation, 200 feet out from the threshold and rising into the approach zone at a slope of 1 in 50 The minimum width of the approach surface is 1,000 feet at the inner or runway end Any object rising above this plane is defined as an obstruction

For regular Department of Defense air bases the approach surface begins at 1,000 feet instead of 200 feet outward from the end of the runway The Air Force representatives on the Air Force-Navy-Civil Aeronautics Subcommittee reported that the Air Force requires the overrun area 1,000 feet wide, symmetrical about the runway axis and extending 1,000 feet into the approach, to be free of all obstructions which might interfere with taxiing It was indicated, however, that the Air Force will tolerate approach-light structures within this area if they do not encroach on the area included between the extensions of the runway edges

Any approach-light system so far devised will involve the use of structures which may be classified as obstructions under the previous definitions From a practical standpoint the magnitude of an obstruction varies with its mass and rigidity, its location and its height above the approach surface

The standard slope-line approach-light unit weighs approximately 300 pounds and is sufficiently rigid to cause serious structural damage to aircraft upon impact In this respect it differs from the usual elevated runway light fixture which can be struck by aircraft without the likelihood of major damage On the other hand, it is not as massive as the heavy supporting structures required for many installations of other types of approach lights

From the standpoint of obstruction location the slope-line system offers some advantages, as the light units are not mounted directly on the extended runway center line The width of the corridor between the rows of light units will vary with individual installations due to differences in terrain, glide angle and touchdown point The minimum corridor width for an average installation is approximately 90 feet This can be increased somewhat by setting the light units at an angle of 30° to the horizontal instead of the standard angle of 45° This has been discussed in a previous report[1]

On level ground a standard slope-line unit extends ten feet above the surface of the runway end which it serves Half-length units at reduced longitudinal spacing may be used in order to reduce the obstruction height While in use during landing operations the height of the structures cannot be reduced further without a corresponding decrease in guidance For take-offs in the opposite direction and for landings in either direction when the approach lights are not in use, the obstructions can be either reduced or eliminated entirely by using either partially or wholly retractable units

Two such types of unit have been designed The first, a simple hinged type which retracts to a height of 24 inches, is described and evaluated in this report The second type, which can be completely withdrawn into an underground housing, offers a more nearly perfect solution to the problem A preliminary study indicates, however, that it will be much more expensive than the first type and may present serious construction and maintenance difficulties

[1] Roy E Warren and H J Cory Pearson, "30-Degree Modified Slope-Line Approach-Light Systems," CAA Technical Development Report No 137, February 1951

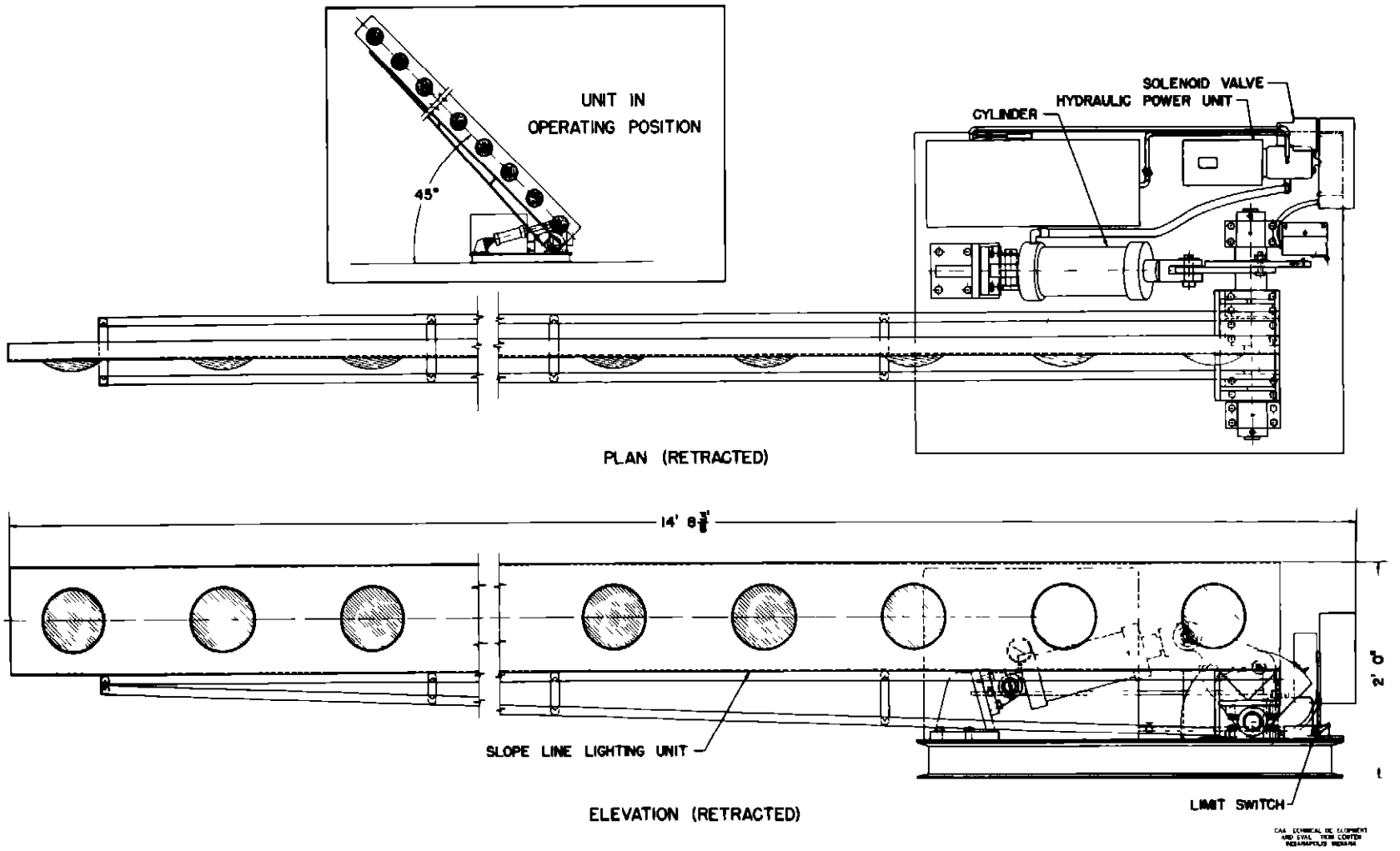

Fig 1 Slope-Line Approach-Light Retractable Unit

THE HINGED-TYPE RETRACTABLE UNIT

In March 1949, Emarco Corp , of Dayton, Ohio, was given a contract to develop a unit based on the following functional specifications drawn up by the Technical Development and Evaluation Center

"Mounting shall be positive in action, rising, upon application of an electric impulse, from a prone position to an upright position forming a maximum angle of 45° to the ground, this position to be variable to lesser angles as determined by installation conditions This mounting shall return to a prone position upon breaking of the electrical circuit All movements shall be positive and not subject to restriction by formation of ice or other normal outdoor weather conditions The maximum over-all height, including slope-line light housing, shall be not more than 24 inches The entire structure shall be rigid and substantial "

The unit, as furnished by the contractor, consists of an arm on which the lamp holders are mounted This arm is pivoted on a base It is operated through an angle of 45° by a Logan Model 6036-A motor-driven hydraulic-power unit, which can deliver a thrust of the order of 4,500 pounds See Fig 1

The power unit is operated by a separate 120-volt circuit The circuit feeding the approach system lamps is regulated to provide varying voltages for intensity control and, therefore, is not suitable as a power source for mechanical equipment The circuits are so arranged, that when the lights are turned on, the 120-volt circuit also is energized, and the power unit raises the arm to the 45° angle position against a stop

A limit switch operates to close a solenoid valve to hold the pressure on the power unit and to stop the motor when the unit is in operating position If the arm starts to drop from the operating position while the lights are on, the limit switch allows the motor to operate to restore it When the lights are turned off, the circuit is de-energized, and the solenoid valve opens to relieve the hydraulic pressure and let the arm drop back by gravity

This unit operated satisfactorily for approximately 18 months without any maintenance At the end of that time it was necessary to add a small amount of hydraulic fluid Observations were made during cold weather to determine the effect of low temperature and icing Results are shown in Table I Figs 2, 3 and 4 illustrate icing

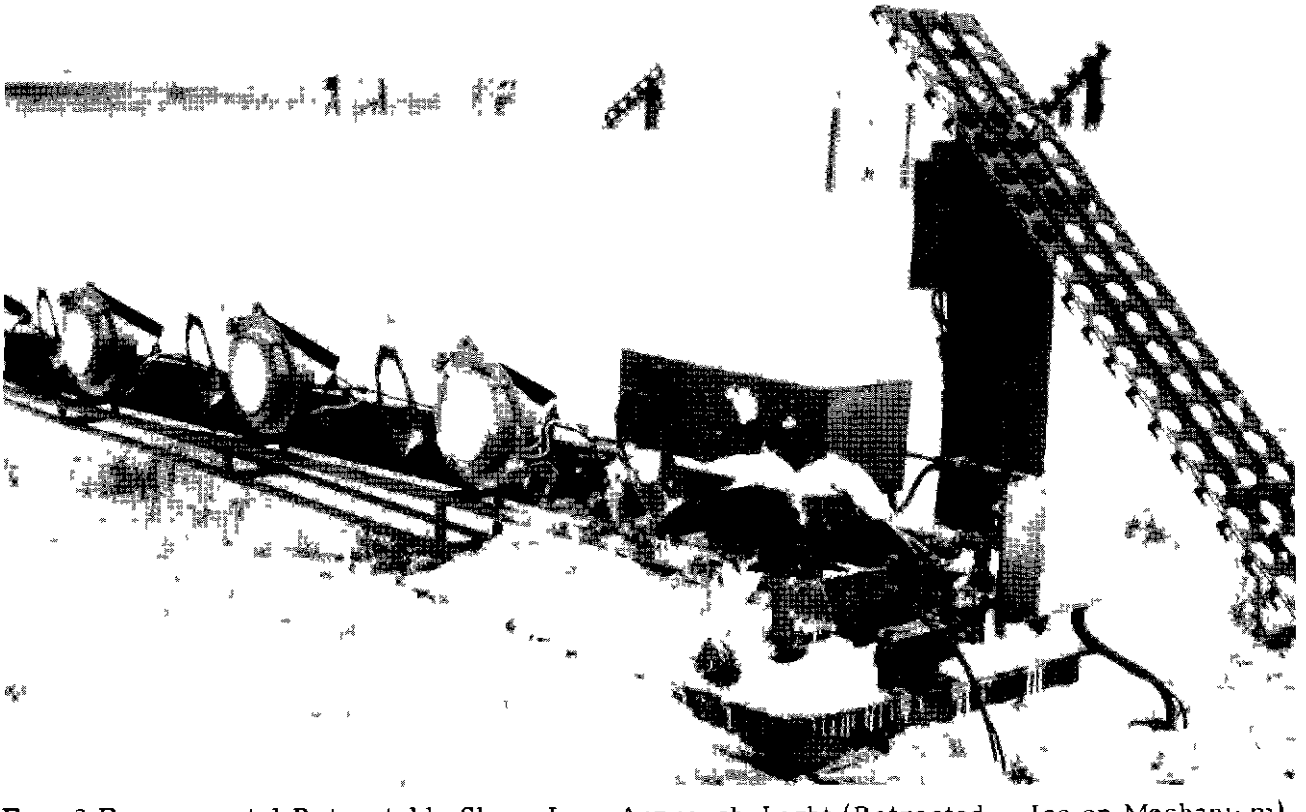

Fig 2 Experimental Retractable Slope-Line Approach-Light (Retracted — Ice on Mechanism)

TABLE I

Time-Temperature Readings
On Operation of Type I Retractable Slope-Line Unit

Hour and Date		Air Temp °F	Time to Rise Min	Time to Fall Min	Description of Existing Weather Conditions — Also Remarks
11 05 a m	11/26/49	38	0 34	0 68	Cloudy but dry
11 10 a m	11/28/49	44	0 34	0 50	Cloudy but dry
11 10 a m	11/29/49	54	0 34	0 36	Clear
9 15 a m	12/ 1/49	36	0 34	0 75	Cloudy but dry
10 40 a m.	12/ 5/49	38	0 35	0 62	Clear
10 40 a m	12/ 7/49	38	0.33	0 60	Clear
9 40 a m	12/ 8/49	27	0 34	0 87	Cloudy and snowing lightly
9 00 a m	12/ 9/49	25	0 34	1 25	Cloudy
10 20 a m	12/ 9/49	25	0 26	1 25	Unit iced slightly by pouring water on it Ice was soft
11 02 a m	12/14/49	24	0 33	1 00	Clear and dry
11 15 a m	12/16/49	32	0 32	0 90	Clear
9 00 a m	1/ 5/50	20	0 45	1 25	Ice on base held unit down for approximately 0 1 minute Water added to unit failed to freeze satisfactorily
9 00 a m	1/ 6/50	32	0 38	0 56	Ice on base — heavy, but soft, slight delay in operation
11 30 a m	1/10/50	27	0 34		
10 00 a m	2/27/50	24	0 34	0,60	Clear
9 30 a m	3/ 2/50	12	0.40	0 62	Clear — operated after pouring on 30 quarts of water and letting it freeze. Approximately 1/16 inch of ice
1 30 p.m	3/13/50	30	0 30	0 22	Cloudy — soft ice on unit
11 00 a m	11/24/50	14			Unit failed to rise Unit rose, however, when weather became warmer Old fluid was drained and replaced by No. 10 motor oil
9 30 a m.	12/ 7/50	12	0 425	1 2	Snow
9 00 a m	12/ 8/50	20	0.420	1 0	Snow — heavy coating of snow was placed on bottom portion of unit previous night and saturated with water to freeze it solidly Unit stopped several degrees short of the top position due to ice on the mechanical stop See Figs 2, 3 and 4
8 45 a m	12/18/50	4	0 8	0 265	Snow and ice

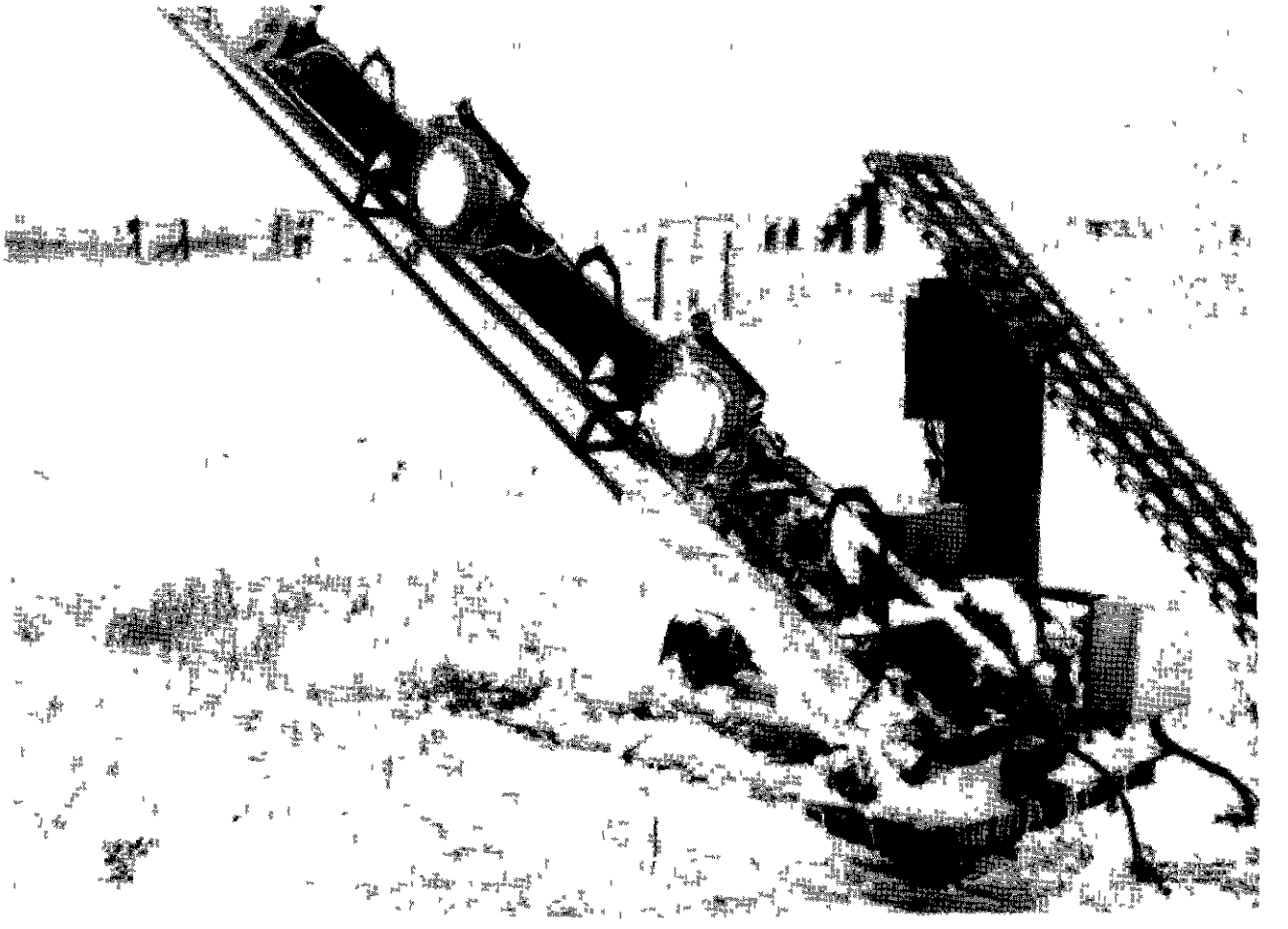

Fig 3 Experimental Retractable Slope-Line Approach-Light (Elevated After Icing)

conditions during which this unit was operated on December 8, 1950. Although the unit elevated itself immediately, a quantity of ice on the mechanical stop prevented it from rising quite to its full height This condition can be corrected readily by a slight modification in the design to eliminate the mechanical stop and to protect the limit switch against ice

CONCLUSIONS

1 The use of any approach-light system entails the erection of structures in the approach zone which are potential hazards to aircraft landing or taking off over them

2 Under certain operating conditions the hazard can be reduced by use of a retractable unit such as the one described in this report

3. Except for minor mechanical difficulties, which can be corrected readily, the experimental model was found to be satisfactory

4 A unit which could be withdrawn axially into an underground casing offers a more complete answer to the problem, but lacks the mechanical and operating simplicity of the unit tested Such a unit has been designed but has not been built

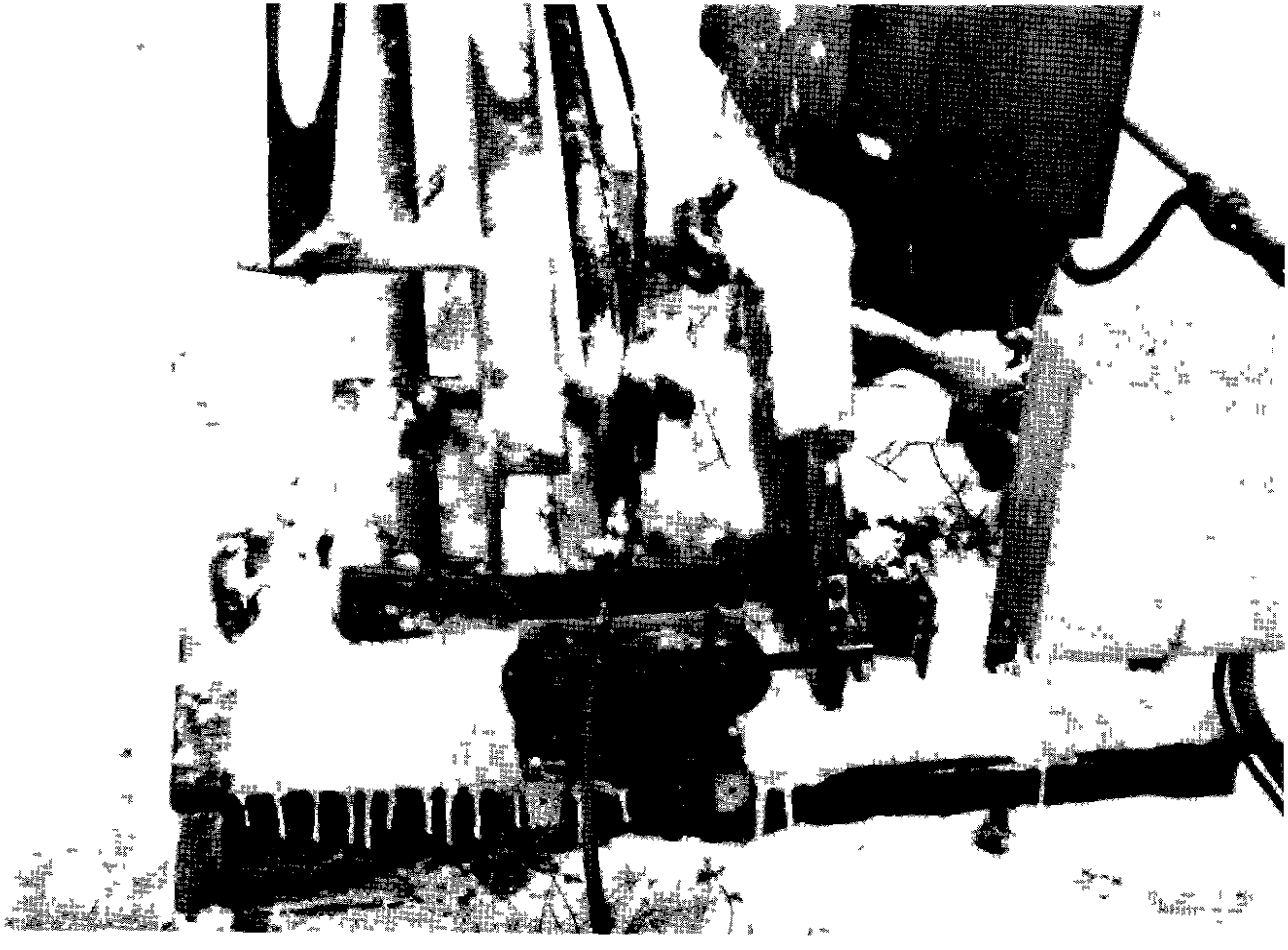

Fig 4 Experimental Retractable Slope-Line Approach-Light (Close-up View Ice on Mechanism — Unit Elevated)