REFLEX-ROL (UK)
Insulating Solar & Glare Control Systems

Ryeford Hall
Ryeford
Ross-on-Wye HR9 7PU

phone : 01989 750704
fax : 01989 750768

www.reflex-rol.co.uk
info@reflex-rol.co.uk

a division of De Leeuw Ltd. / U.K.
www.deleeuw-ltd.co.uk

RACK ARM SYSTEMS

OVERVIEW

Project: The Morgan Library and Museum
System: 75E panelised system
Architect: Renzo Piano Building Workshop
Completion Date: 2006

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RACK ARM SYSTEMS

OVERVIEW

Rack arm systems are a non-retractable shading solution, ideal for skylights. They comprise a series of support arms (rack arms) onto which slats are mounted. The rack arms incorporate a mechanism to enable these slats to be rotated through approximately 100º, from fully open to fully closed.

Rack arms systems offer many benefits, notably -

- They can be installed internally or externally
- They can be used on horizontal or inclined areas of glazing such as skylights, without an independent support structure that would be necessary with aerofoil fins, or the need to retract them in strong winds as would be the case with façade awnings
- They can be designed to fit almost any sh ape of glazing – rectangular, triangular, trapezoidal and circular. The rack arms can also be curved to fit barrel vaulted skylights.
- They provide effective control of both daylight / glare and solar gain
- Some slat types can be perforated to prov ide some outward vision, even in the fully closed position
- The system can be motorized, and a control system can be employed to provide automated solar control
- Systems are supplied in partly assembled form, minimising installation time and costs on site

This type of system is particularly suited to museums and galleries where high levels of light control and sometimes near blackout are required. The system is also used in many other applications however, including glazed atria, skylights in offices, exhibition halls and conference facilities as well as residential conservatories and sun rooms.

The system has been installed in locations where there is a risk of snow and can cope with an imposed load, but it is not appropriate for areas with regular snow fall, where snow remains on the ground for a period in excess of a few days, or where ice is a significant issue.

RACK ARM SYSTEMS

The key elements in the system compromise -

- Slats
- Assembled rack arms comprising extruded al uminum T bar, pivot arms, slat clips, operating strip and bearing bracket assembly
- Brackets to fix the rack arms to the building structure
- Drive shaft which connects the rack arms and when rotated opens and closes the slats
- Gearbox or motor to drive the system

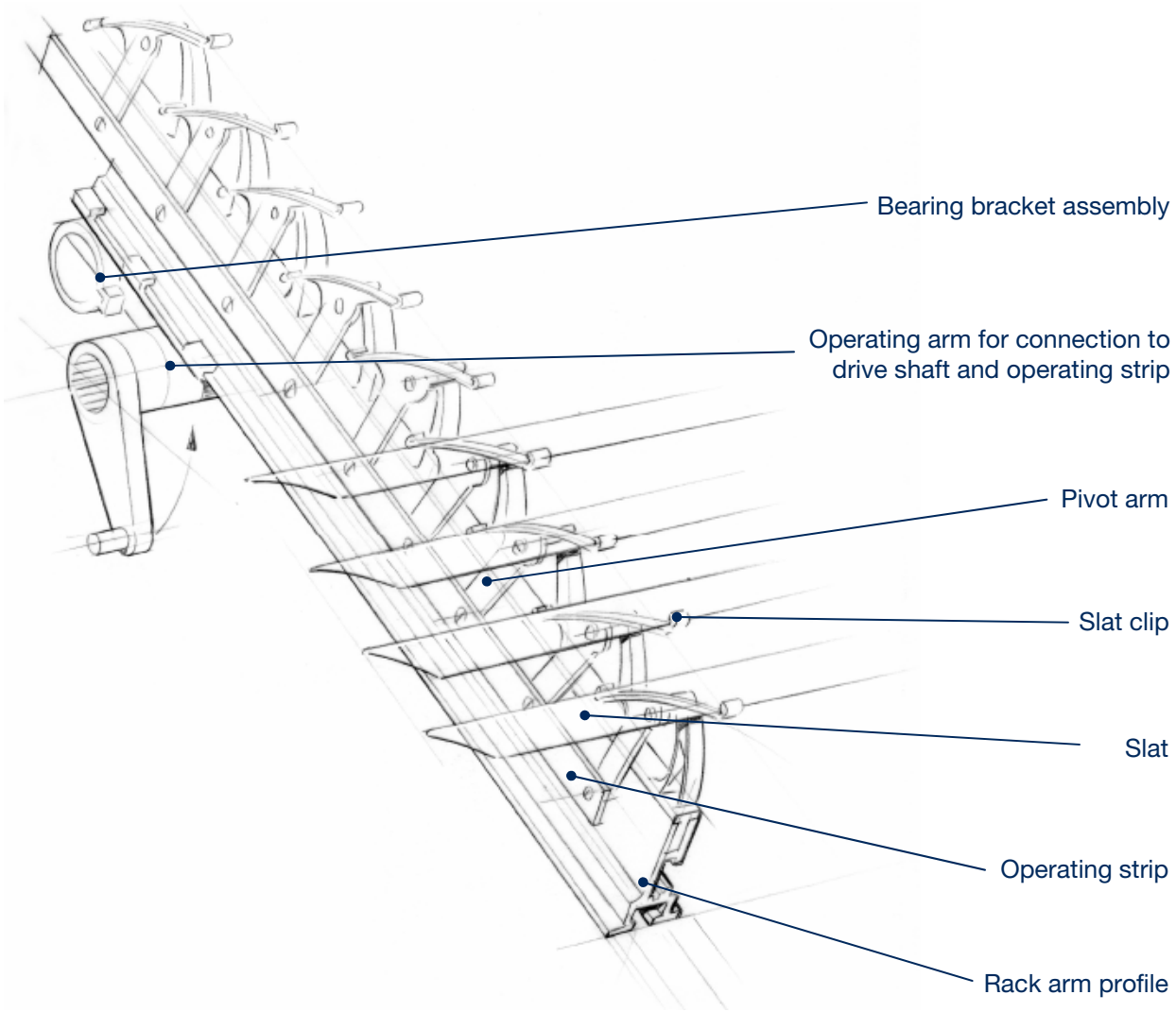

Figure 1: Sketch of 2” (50mm) rack arm system

SYSTEM DESIGN

The system needs to be correctly designed to ensure that it provides a high level of light and solar control. As part of the design, a number of key parameters, as shown in figures 2 and 3 below, need to be respected. This is particularly important for irregular shaped glazing (such as a triangular opening) where the maximum slat overhang needs to be carefully addressed.

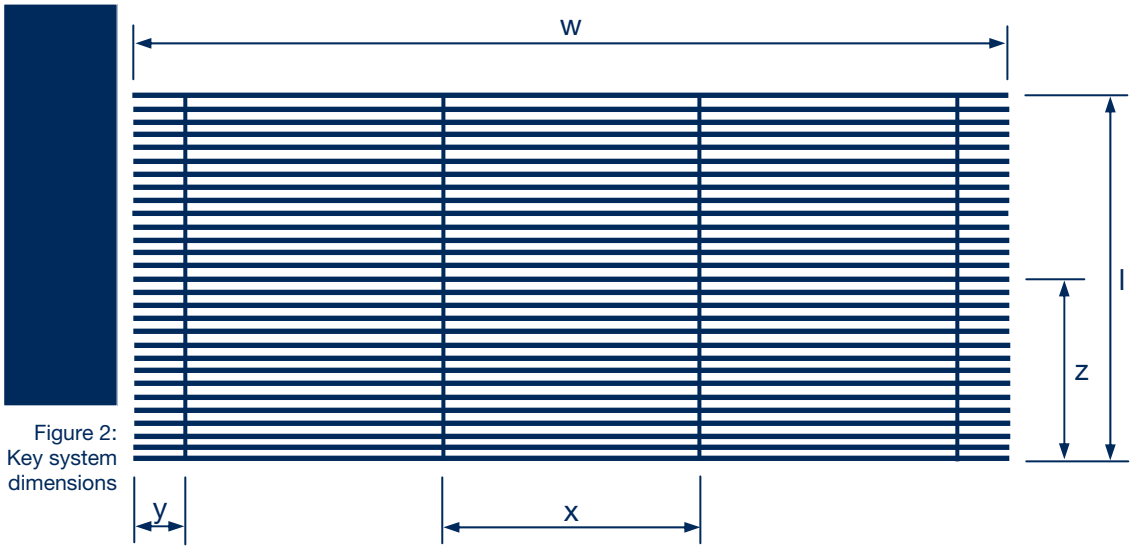

Figure 2: Key system dimensions

	50F internal	50W internal	75E internal	75E external	80R internal	80R external	88E internal	88E external
Maximum slat width (w)	4400mm (173”)	3000mm (118”)	5000mm (197”)	6000mm (236”)	5000mm (197”)	5000mm (197”)	5000mm (197”)	4500mm (177”)
Maximum distance between rack arms (x)	900mm (35”)	650mm (26”)	1400mm (55”)	1300mm (51”)	1400mm (55”)	900mm (35”)	1400mm (55”)	1300mm (51”)
Maximum slat overhang (y)	400mm (16”)	250mm (10”)	400mm (16”)	300mm (12”)	400mm (16”)	300mm (12”)	400mm (16”)	300mm (12”)
Maximum support spacing (z)	2250mm (89”)	1800mm (71”)	3500mm (138”)	2800mm (110”)	3500mm (138”)	2800mm 110”)	3000mm (118”)	2500mm (98”)
Maximum rack arm length (l)	6000mm (236”)	4000mm (157”)	6000mm (236”)	4000mm (157”)	6000mm (236”)	5000mm (197”)	4000mm (157”)	3500mm (138”)
Maximum area (gear operated)	15m^2 (160ft^2)	8m^2 (86ft^2)	16m^2 (172ft^2)	16m^2 (172ft^2)	20m^2 (215ft^2)	16m^2 (172ft^2)	16m^2 (172ft^2)	12m^2 (129ft^2)
Maximum area (motorized)	20m^2 (215ft^2)	12m^2 (129ft^2)	20m^2 (215ft^2)	20m^2 (215ft^2)	20m^2 (215ft^2)	18m^2 (194ft^2)	16m^2 (172ft^2)	14m^2 (151ft^2)

Figure 3: Key design parameters for the different systems

SLATS

The system can be specified with a number of different slats, some of which can be perforated according to project requirements:

- 2” (50mm) aluminium - double stove enamelled and flexible crowned (50F)
- 2” (50mm) timber - kiln dried American bass wood (50W) or similar
- 3” (75mm) extruded aluminium (75E)
- 3” (80mm) rolled edge aluminium - double stove enamelled (80R)
- 3 ½” (88mm) extruded aluminium - designed to interlock in the closed position (88E)

Systems with 2” slats can only be installed internally: the other three systems can be installed internally or externally.

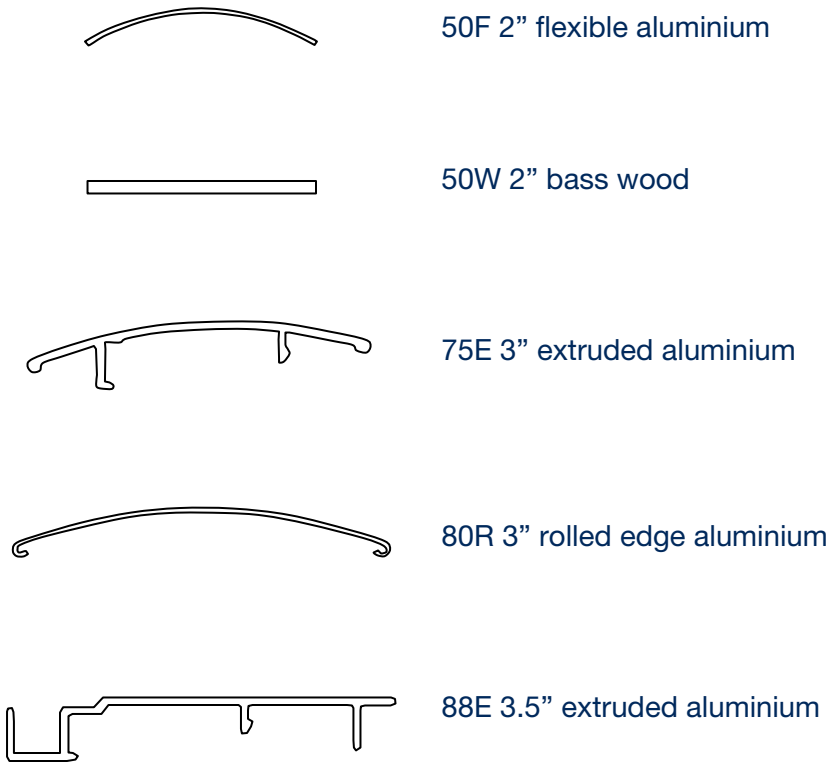

Figure 4: Slat profiles

A system incorporating 145mm (5 3/4”) extruded aluminium slats has been developed and other, custom, slats may be possible if the project is of a sufficient size.

Because the position of the slats is infinitely variable from fully open to fully closed, it means that very precise light control can be achieved. Furthermore the 3 ½” slat is designed to interlock to provide very high levels of light exclusion. It is also possible to install baffles or brushes around the edges of the system, to make it even more effective.

RACK ARMS

The rack arms are manufactured from extruded aluminium and incorporate the following components:

- Extruded aluminium 'T' bar rack arm profile (35mm x 20mm)
- Nylon pivot arms
- Nylon slat clips
- Extruded aluminium operating strip (12mm x 3mm)
- Bearing bracket assembly

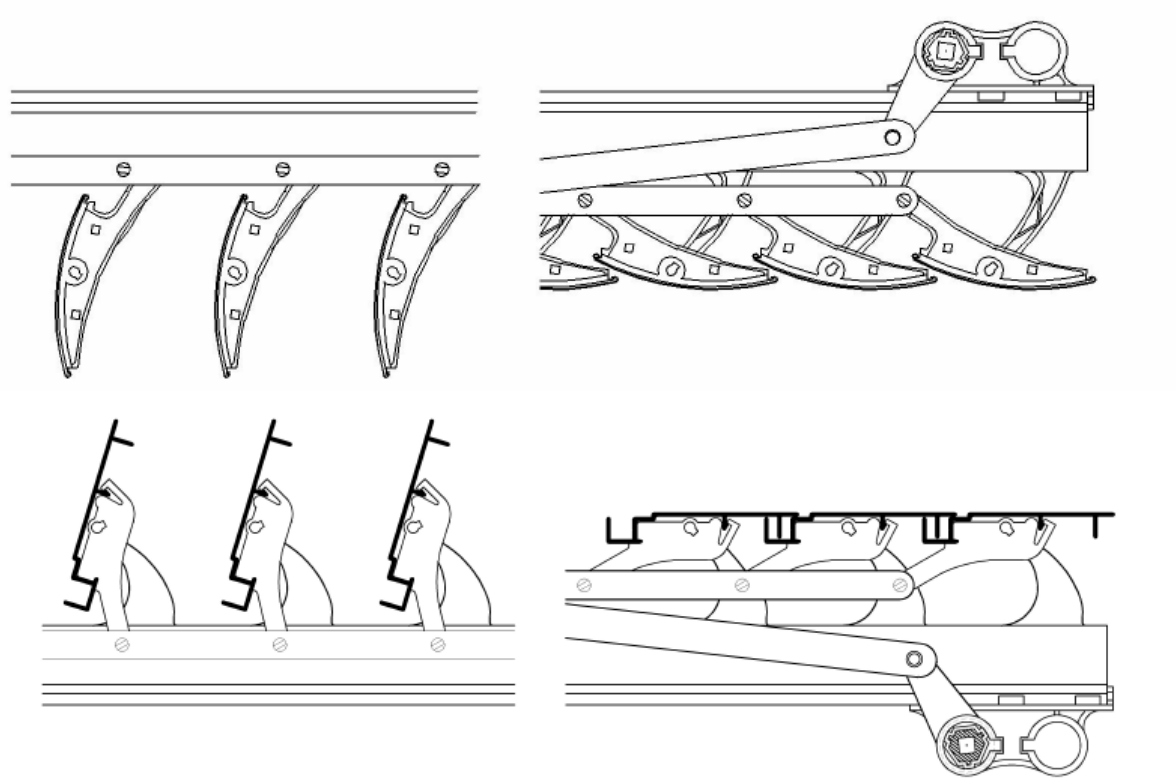

Figure 5: standard rack arm assemblies -80mm slats for internal installation and 88mm interlocking slats for external installation

The system can use two different rack arms – a standard version which is suitable for most applications, and a heavy duty one that can achieve larger spans and reduces the number of fixings that are required.

The rack arms incorporate standard spacing between slats - 45mm for the 50mm systems, 70mm for the 75, 80 and 88mm systems, and 140mm for the 145mm system. This is particularly important when the system is being installed inside an opening and may mean that baffles are required to close off gaps at each end of the system.

BRACKETS

Brackets are generally aluminium angles that fix to the rack arm extrusion and incorporate ¼" stainless steel studding to allow alignment on site. The studding fixes to a second aluminum angle or plate for installation to the glazing structure. Custom brackets can also be designed if required.

DRIVE SHAFT

The drive shaft is manufactured from extruded aluminium with a hexagonal profile, 14mm across flats. An internal 7mm square cavity accepts the shaft for coupling of adjacent systems.

OPERATION

A metal 4:1 reduction gearbox (and fixing components) can be specified with either a detachable, articulated crank handle, or a hand wheel. Alternatively a motor can be installed and the system can be automated, using a solar control system.

MATERIALS AND FINISHES

Materials and finishes have been selected to ensure long product life and minimal maintenance.

Aluminium:
All aluminium components use 6063-T5 or T6 quality aluminium. A range of finishes are available -

- Mill finish aluminium
- Clear anodized finish according to AA-M12C22A31
- Polyester powder coated finish to a standard RAL colour

Steel:
All steel components use mild steel Fe 230G, or stainless 18-8, and are hot dip galvanized or zinc plated.

CONTROL OPTIONS

A wide variety of control options are available from manual switching (single or grouped systems) to fully automated control that takes account of the actual sun conditions and adjust the slats to one of a number of preset positions to ensure that there is no direct sun penetration into the building. As an alternative, a control system can be used which manages light levels inside the building. This is very important for museum and gallery installations where the control of natural daylight is critical.

In this case, the control system uses one or more interior photocells that are installed underneath the slats and read the light levels coming through them. The control system is programmed with three light levels – a maximum light level, a minimum one and an optimum one. These light levels are calibrated to reflect the required levels in the key locations inside the building, for example where the artwork is installed.

When the light level measured by the photocell(s) exceeds the maximum level, the slats are closed until the optimum level is achieved. When the light levels are too low, the slats are opened until the optimum level is achieved or until the slats are fully open (when there is insufficient natural daylight available). The system can also be programmed to incorporate delays (if required) as well as other features such as a dawn / dusk sensor, time clock etc.

Because the system can withstand very significant wind speeds when installed externally, no specific controls are required to address this. It is recommended, however, that a wind sensor is installed and that this automatically opens the slats if the wind speeds become very significant. Additionally, if the system is installed in a location where there is a risk of ice and snow, a temperature and humidity sensor can be connected to the control system to ensure that the slats are moved to the open position and switched off when there is the possibility of these conditions arising.

In all cases (apart from the ones where only basic switch control is required), the control system is based around SC2 controllers, each of which can operate two motors. These controllers can be programmed to provide the required functionality and to take an input from relevant sensors. The controllers can also communicate with the Building Management System (using the BACnet protocol) and, if connected to the building network, can be remotely configured and maintained via a virtual personal network (vpn) link.

SYSTEM DRAWINGS

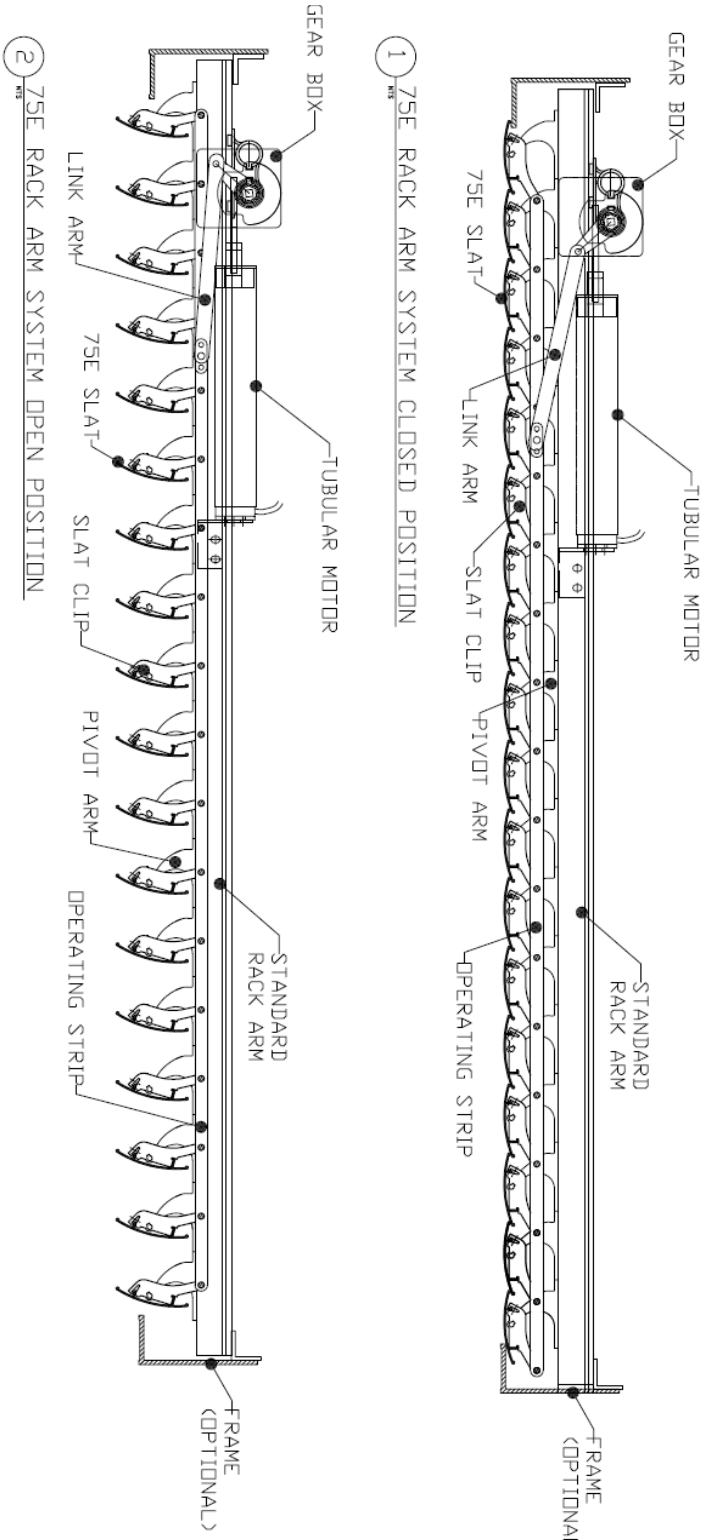

Figure 6: Rack arm side elevation in open and closed positions

System Drawings

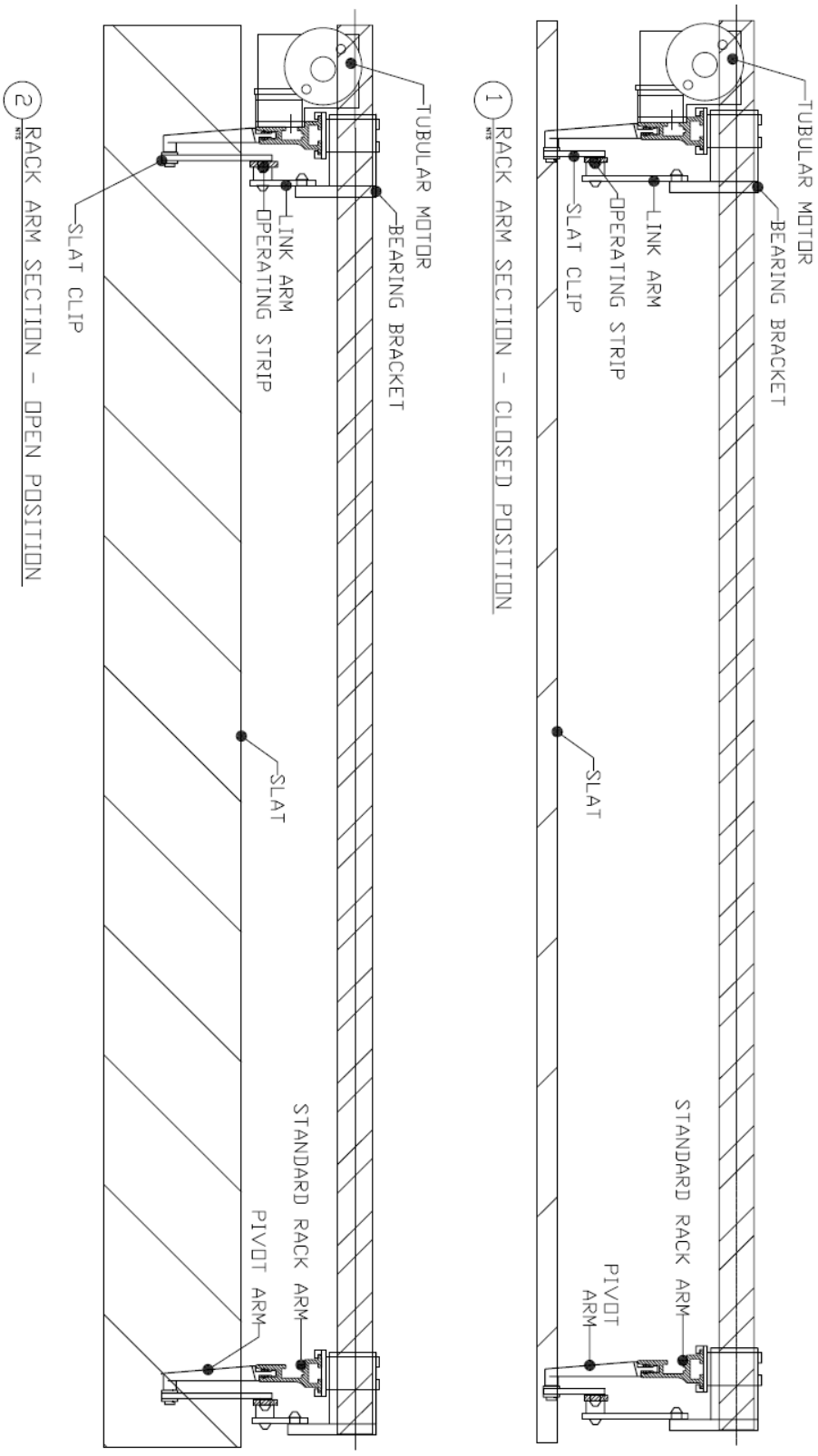

Figure 7: Rack arm front elevation in open and closed positions

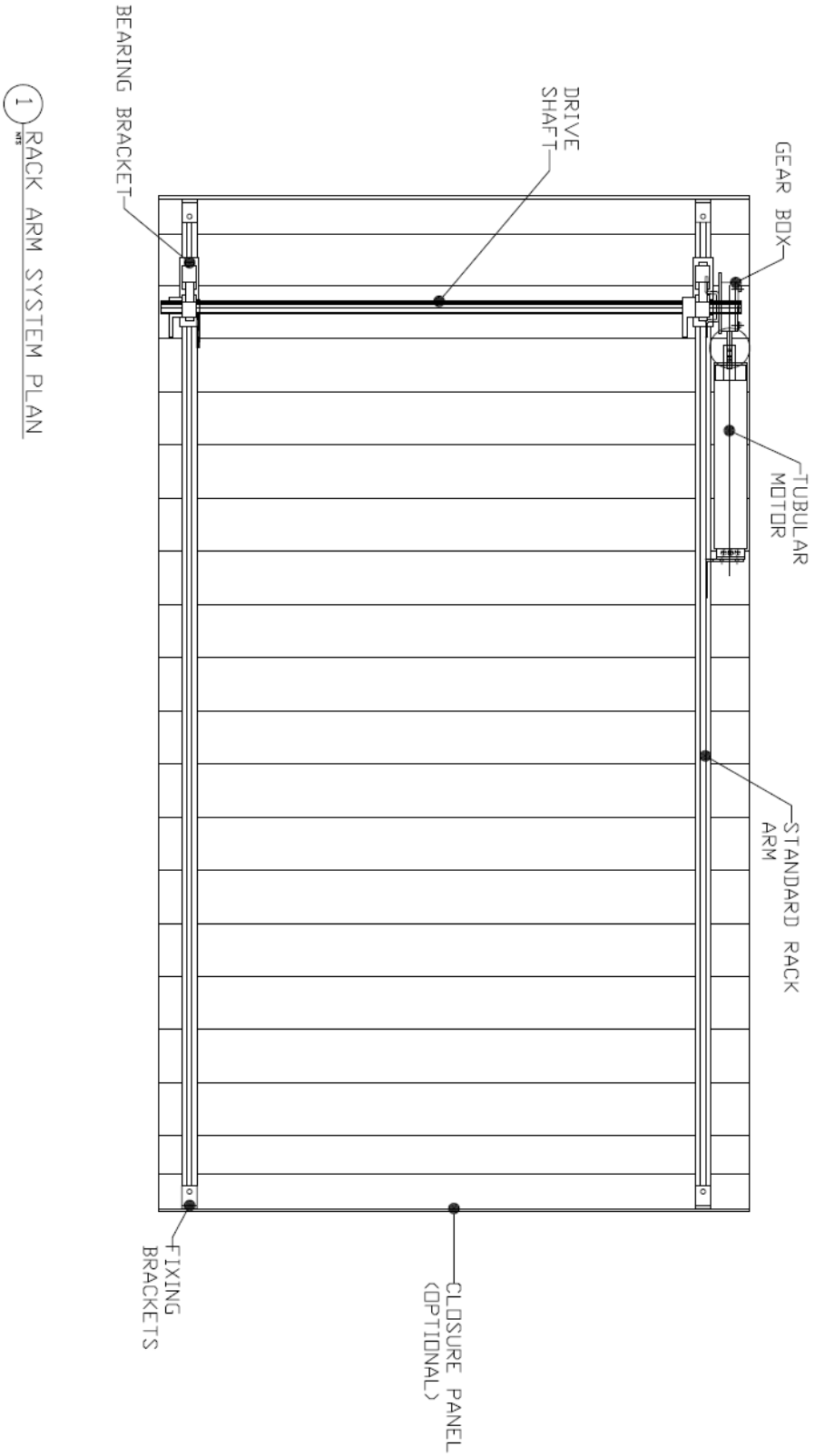

Figure 7:
Rack arm
plan view