The Rotation Stabilizer Used For A Gravity Detector With MAB25 Encoder In DRIACS-G2 System

JH1KRC Mike Watanabe, JA6XED Hisao Tsukamoto

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Abstract

To detect the azimuth or elevation angle of an EME antenna, the shaft of a rotary encoder is commonly coupled directly to the rotation axis of azimuth or elevation. In the case of Mike, JH1KRC, it is difficult to couple a rotary encoder directly to the elevation axis of his 4.4m TVRO dish. Using MAB25 a low-cost absolute encoder to detect elevation angle for DRIACS-G2 antenna controller, Mike and Hisao, JA6XED, made up a compensating rotary mechanism using a brass bar and a brass block, a rotary shaft of brass, two ball bearings and a precise shaft coupler for smooth and accurate elevation measurement for the system.

Purpose

A gravity-sensitive elevation detector is useful for an antenna system in which some method of direct detection of the elevation angle is difficult. (Fig. 1)

(Fig.1) 4.4m TVRO dish, a product of Paraclipse, at JH1KRC has no construction that fits for detecting the elevation angle directly at the elevation rotary axis.

Alex, HB9DRI, reproduced and distributed his DRIACS-G2 antenna controller of OE5JFL design, and presented a lecture at the 2010 International EME Conference in Dallas/Fortworth, August 2010. DRIACS-G2 employs an absolute encoder MAB25 to detect either for elevation or azimuth angle in the 0.1 degree order, which is good for microwave EME. It has now become popular and many of JA moon-bouncers are ready to use this control system for their EME antennas.

(Fig. 2) DRIACS-G2 controllers constructed by JA4BLC, left two, and by JH1KRC including DC power supplies for the system and motors.

MAB25 is a good encoder for its low price, sold at approx. 50 EURO or so, and easy to connect with five control wires. But if you use it with a weight bar to detect the gravity of the earth, because of its light and easy construction, the rotary shaft of MAB25 has a possibility to show some sag movement. This sag causes resistance in the rotation of the shaft especially when it is used with a gravity detecting weight. This makes irregular rotation and subsequently causes inaccurate detection of the elevation angle. (Fig. 3)

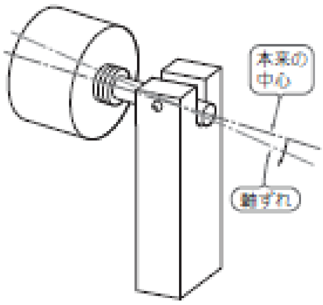


図4　ELエンコーダの軸が錘の荷重のために中心からずれてしまう

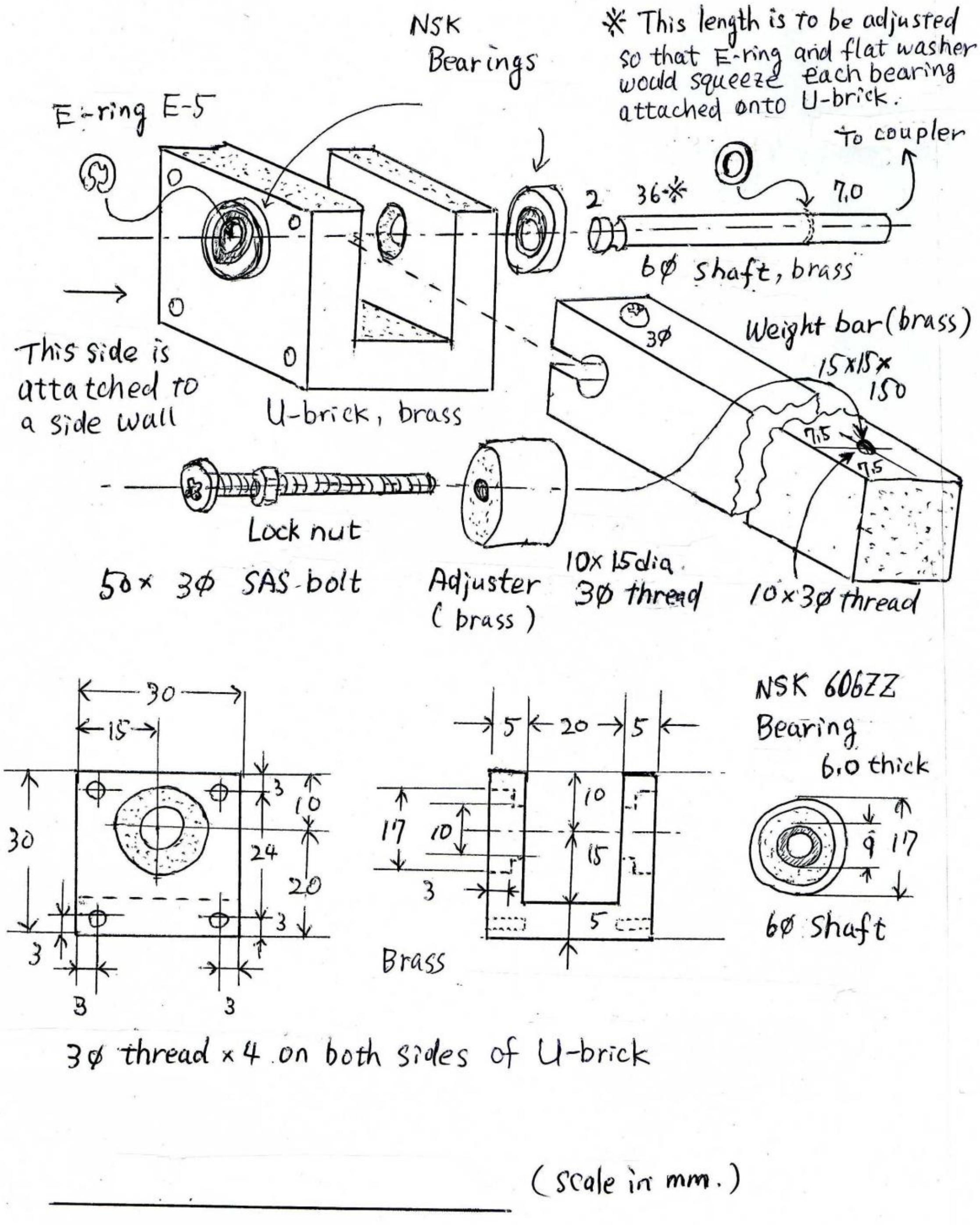
(Fig. 3) MAB25 encoder with gravity detecting bar directly coupled to the shaft. This construction causes sag of the shaft and causes irregular rotation, and subsequently its inaccurate detection of the elevation angle.

To compensate the rotation irregularity of the MAB25 shaft, Mike and Hisao made up a rotary mechanism for its gravity detector.

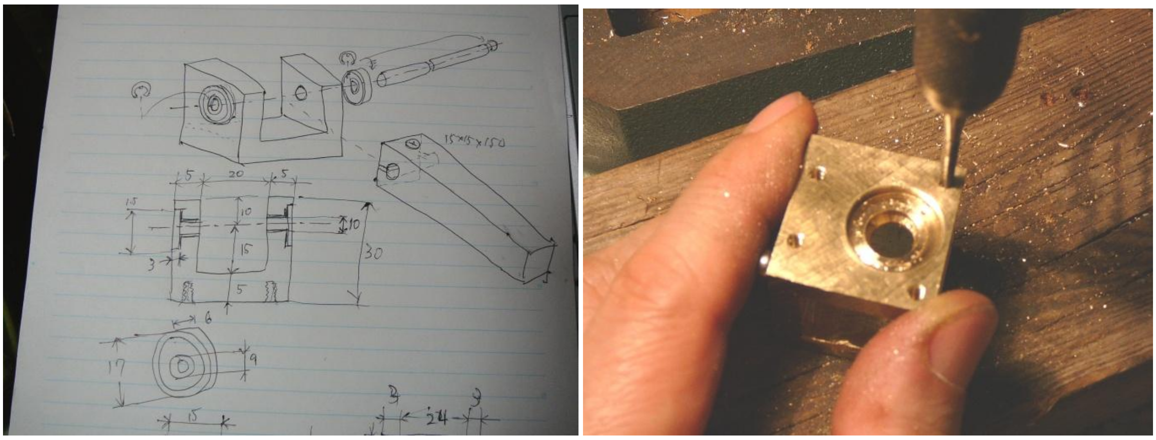
Materials and methods

The materials are a brass bar, 15x15x150 mm, a brass block, 30x30x30 mm, a brass shaft, 6 mm diameter, two ball bearings NSK 606ZZ for 6 mm shaft, an E-ring stopper, a shaft coupler for 6 mm shaft, an aluminum sheet, 2x30x30 mm, two to four metal spacers, 50 mm long, a few flat washers for 6 mm shaft, some nuts and bolts, 3 mm, for fundamental construction. All the parts are easy to find in Japanese market.

The drawing is shown in Fig. 4, and the construction procedures are in Fig. 5 and Fig. 6.



(Fig. 4) Drawing of the rotation stabilizer



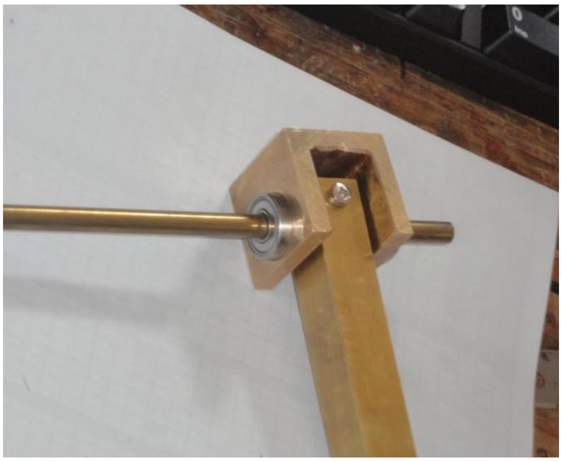
(Fig. 5)　A brass bar and a brass block are processed manually on the work bench.

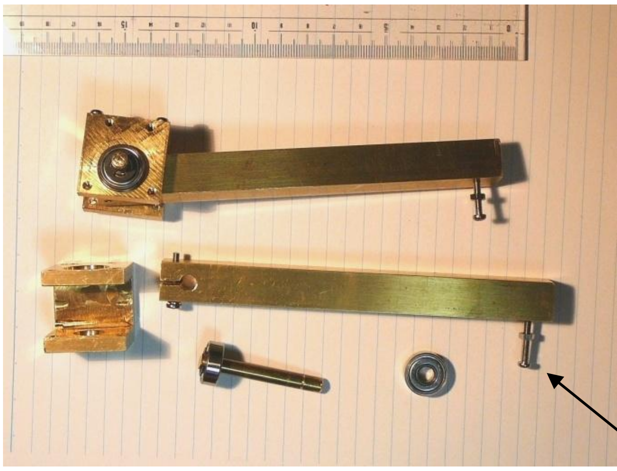
A 30mm brass cube was precisely engraved on a machine for the ball bearings on the two sides, and threaded for screws, as shown in the Fig. 4 and Fig. 5.

First two dimples of 17mm diameters were made precisely for NSK ball bearings. Four of 2.5mm holes were placed and then 3mm threads were made on the two sides of the brass cube, the same surfaces of the bearings, one side for attachment screws and another side for spacers to attach an aluminum plate and MAB25 encoder.

Two bearings were placed, and a brass shaft of 6mm diameter was put through the bearings.　One end of the shaft has a ditch for E-ring stopper, and another side of the bar is left, approximately 7mm long, for a shaft coupler and an encoder. The shaft coupler, with simply a few pieces of flat ring washers, should be attached at a proper position with some tightness to the bearing. This method provides stable rotation of the shaft.

At the beginning of this experiment, two E-ring stoppers were used to fix the bearings on the both sides. This method allowed slight gap remain between the E-rings and bearings, and could not control the tightness to fix the bearings to the brass block. Putting only one E-ring at the end of the shaft seemed to be a better method.





(Fig. 6) Place a weight bar into the brass block between the bearings. The weight bar may have an adjustable sub-weight on the swinging side of the surface. (the right photo does not show it but a screw only.)

Before you put a shaft through into the bearings, do not forget to place a weight bar into the brass block between the bearings. Tighten the screws so that the weight bar does not slip around the shaft. (Fig. 6) The brass bar has its size of 15x15x150 mm, and a weight of 150g. This seems to be heavy enough to rotate the encoder shaft very smoothly by the gravity, following the elevation angle slowly changes.

The weight bar may have an adjustable sub-weight on one swinging side of the bar surface. This could adjust the tiny amount of angle change when you fix this sensor at a certain elevation angle precisely. If it is abbreviated, you just fix the rotation angle of the bar very carefully by loosening and tightening the screws of the shaft coupler in front of the encoder, repeatedly with trial and error method for the correct position for the angle indication.

A decimal degree of the shaft rotation may be achieved using a long screw driver for adjusting the shaft rotation between the coupler and the weight bar.

The model of the shaft coupler in use is MST 16-6x6, made from aluminum, 6mm holes on the both side. This precise coupler costs more or less 2300 Yen each. (Fig. 7)

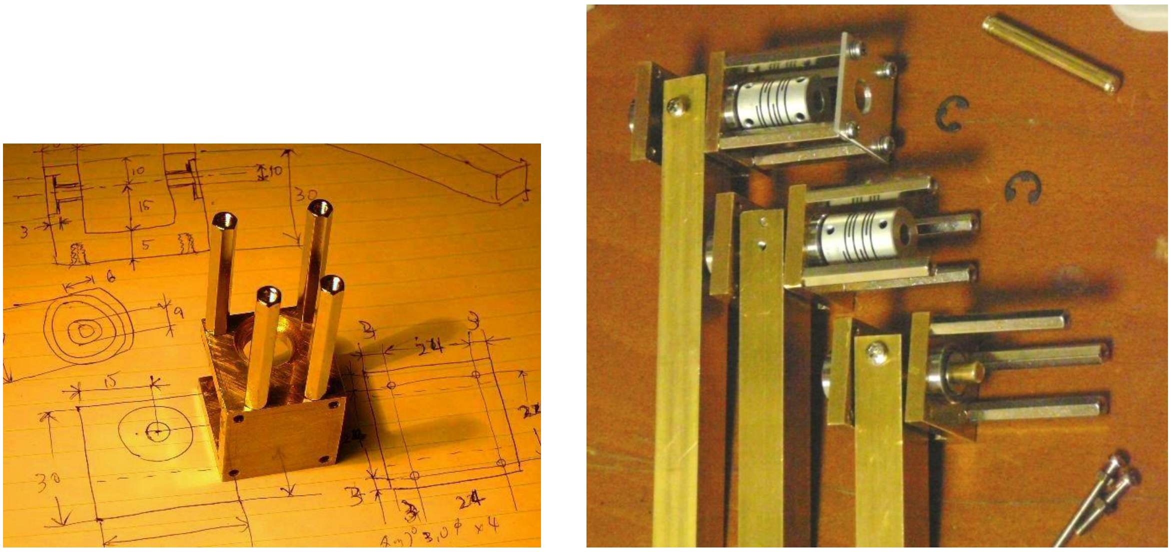


Fig. 7　Four (or at least two) spacer posts are used to hold an aluminum plate on which an encoder MAB25 is attached.　MST 16-6x6 a precise shaft coupler is used to place the bearing in position, and to couple the encoder.

Four (or at least two) spacer posts are used to hold an aluminum plate on which an encoder MAB25 is attached.　Since only a very light force is needed to rotate the shaft of MAB25, it seems strong fixation of the encoder is NOT necessary.　To ensure smooth rotation of the encoder shaft, instead of the locking nut, just putting an amount of silicone glue seems to be enough to keep this encoder in position. This method absorbs the roughness and irregularity in the shaft rotation which is undeniable in our handcraft.　(Fig. 8)

If the manufacturing is exactly done, and strait axis is ensured, the encoder is attached with its lock nut onto the plate, of course.

Fig. 8 Instead of locking with a nut, just putting an amount of silicone glue seems to be enough to keep this encoder in position.

The weight bar and MAB25 encoder rotate quite smoothly just like a traditional clock of Swiss-made. This gravity detecting unit must be installed in a water-proof box. An aluminum plate of 2mm thick is used for the base plate, and an L-shaped aluminum material was attached for enforcement to the base plate, and the gravity unit is attached on the base plate with four of 3mm screws. Be careful in the direction of the rotation as your antenna is elevated upward/downward. The size of the box must have an enough space for the gravity bar to swing.

Screws of the shaft coupler would be loosen and the indicated elevation angle should be adjusted approximately, possibly within a few degrees. The DRIACS-G2 shows the elevation angle ranges from 0 to 90 deg./90 to 0 deg./0 to -90 deg./-90 to 0 deg., respectively as the MAB25 encoder shaft rotates. Choose the preferred range.

Elevation detector was installed onto an aluminum bar of 20x40x2000 mm to examine elevation angle detection. One end of the bar is settled on a concrete terrace and the other end is lifted to a certain elevation angle. An arc of 35mm at the elevated end of the bar makes 1 degree of elevation change. The bar was slowly lifted up, and how the elevation indication change was carefully observed. (Fig. 9 and 10)

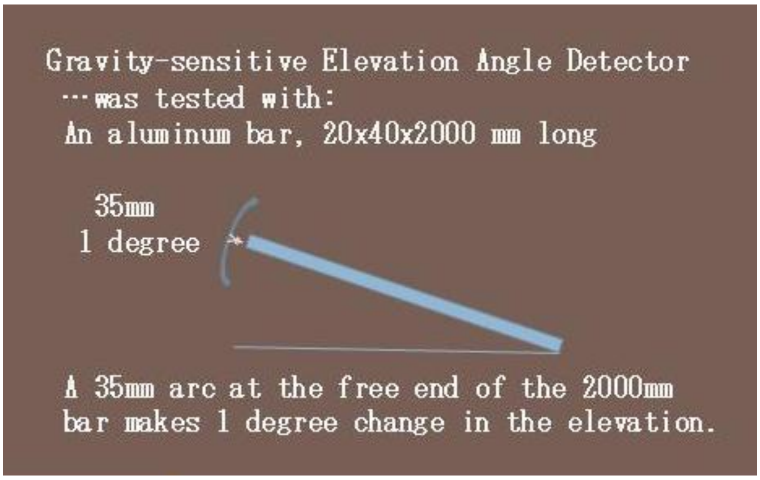


Fig. 9

Fig. 10　Elevation angle detection was tested with an aluminum bar of 20x40x2000 mm long.　A 35mm arc at the free end of the 2000mm bar makes 1 degree change in the elevation.　This inclination was detected with the gravity-sensitive method.

When a 150g weight bar was directly installed on MAB25 encoder shaft, the unbalanced load made the encoder shaft sag. This makes resistance to the shaft thus causes irregular rotation of the shaft.　In this situation the elevation angle was not followed smoothly, and was detected every 1 to 5 degrees even in the 0.1 degree resolution range of DRIACS-G2 controller.　It should not be satisfactory.

When the same weight bar was installed onto the shaft of the rotation stabilize, and precisely coupled to MAB25 encoder shaft. The sag of the encoder shaft was then negligible, and the elevation angle was followed every 0.1 to 0.2 degrees at most in the 0.1 degree resolution range of the DRIACS-G2.

This accuracy in the detection of elevation angle seems to be well enough for amateurs microwave EME antenna such as on 5.7GHz and 10GHz bands.

The swinging speed of the weight bar, along with the slow elevation change, well followed the movement, and it did not make any vibration swinging of the weight bar.

Discussion

A brass block, two ball-bearings, 6mm shaft and a few other components make up a useful rotation stabilizer for MAB25 absolute encoder in the gravity sensor. With this smoothing mechanism, MAB25 encoder can precisely detect the gravity for the antenna elevation indicator following the elevation change in 0.1-0.2 degrees order. For further more accurate detection of the elevation angle, you might use a longer weight bar like PA7JB in his antenna, or use a heavier weight bar, for gravity sensing. A weight bar of 150g, 150mm long seemed to be well enough for 0.1 degree resolution in this system.

The possible influence of the horizontal rotation of the antenna was not tested yet. Toshio JA6AHB tells, on his evaluation, it does not make any problem to its gravity sensor in his antenna system. (See the photo in the later page.)

Most of the procedures in the construction were performed by Hisao, JA6XED, who is well experienced in milling machine.

The ideas of a gravity sensor to detect the antenna elevation came from these OM's below. They explain their methods and write their opinions to our method, too. Many thanks go to JA6AHB, PA7JB, JA4BLC, JA4HZN, and JA6CZD for their ideas and lectures on the elevation detector mechanisms in use.

Our idea of the rotation stabilizer for MAB25 encoder is scheduled to present in the slide show at the International EME Conference in Cambridge, U. K., August, 2012.

At JA6XED

Photo album

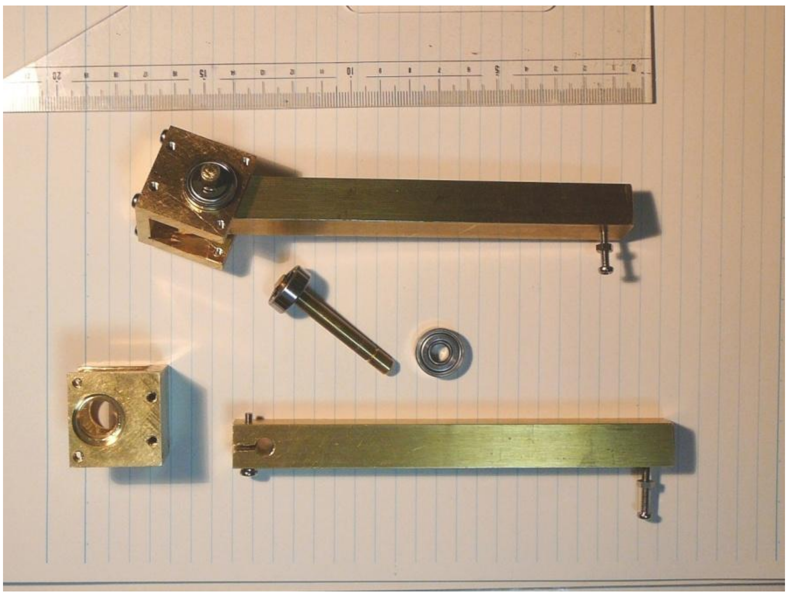
These are some photos of gravity sensors and a virtual axis method, used by moon-bouncers for their elevation detection.

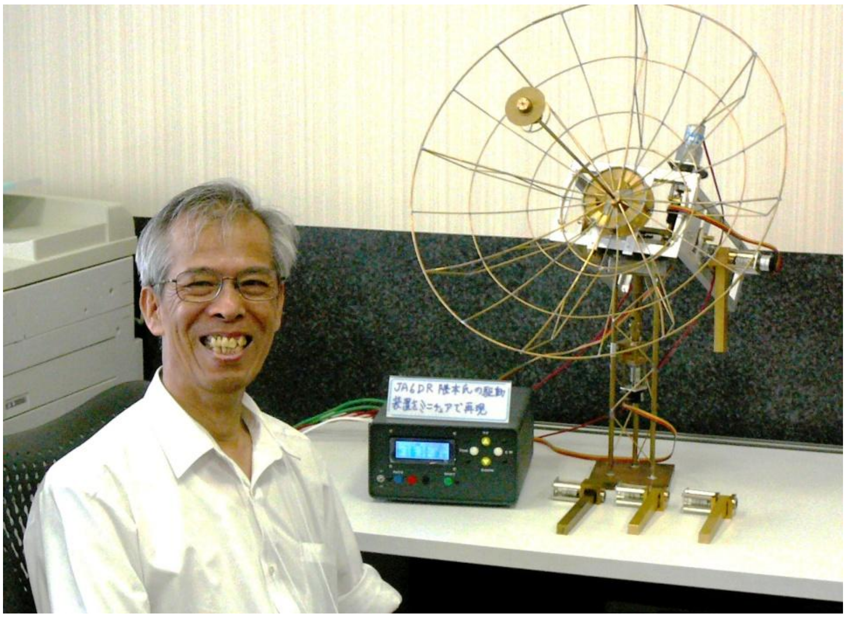
PA7JB puts a long steel bar to an encoder in a water-proof housing, mounted to the frame behind his 2.4m offset dish. John works not only on 23cm but also 6cm and 3cm very successfully with this system.

JA6AHB uses a 150g fishing weight for his gravity detector. Toshio runs an absolute encoder along with an incremental encoder on the same axis.

JA6XED uses a traditional sel-syn motor for his AZ/EL detectors. The direct connection of the gravity weight bar in this construction makes no problem to his sel-syn motor for elevation control.

JA4HZN uses a virtual axis to detect the elevation. A 6mm bolt attached to an L-angle shows the virtual elevation axis of this antenna, which rotates the encoder shaft. This absolute encoder is fixed onto an aluminum plate bolted to the mast clamp, and is wrapped in a poly pack for water-proof.





JA6XED Hisao pauses with a scaled model of JA6DR’s 12m dish of mid-1970’s. This antenna is motorized by DRIACS-G2 controller with MAB25. (At JA-EME national meeting in Kurume, June, 2012.)