INTRODUCTION

The PEM Mount is a new concept in Telescope mounts being an ENGLISH MOUNT of novel design. Traditionally these were large bespoke mounts, fitted in large observatories. The mount itself is substantial and is not designed to be used on a tripod in the field. This new design brings the North and South pillars close together and tied together with 'C' shaped metalwork. This new compact design is portable because it does not needed to be made bespoke, therefore it can be fitted in to any observatory in the world. So we have named it the PORTABLE ENGLISH MOUNT. The huge benefit is that you have the telescope load and DEC axle supported between two bearings and so the stability cannot be improved. There is no overhanging weight so no problems with flexure in the shafts. Many traditional GEM installations have been seen where the payload is more than the recommended value for the mount. We now provide a larger mount, more than capable, at an affordable price.

Moreover the telescope sits on a cross axis with an offset balance weight. This keeps the 'C' part relatively shallow and aids the stability. The downside is a torque introduced in the RA shaft between the DE axle and the DEC counterweight bar but the heavy duty axles are only lightly loaded.

Unlike the fork mount the arms are kept short and so increasing stability and reducing flexure. A much greater payload is sustainable for similar cross section materials. Full sky access is achieved and the telescope control system by AWR Technology ensures that the telescope does not stray outside its movement envelope, all programmable by the user.

The BASE ADJUSTER is also a precision piece of kit necessary to hold the PEM at the correct angle with enough resolution in the azimuth and altitude adjustments to make it easy to set up on the pole. It has much finer adjustments than equivalent mounts in this price and size bracket.

The concept and design details were worked on jointly by Matt Armitage of ASTROMOUNT and Alan Buckman of AWR Technology. The design aim was to bring stability to large telescope at an affordable price with British design and manufacture throughout. Implementation of the design was by Alan Buckman using CAD software for modelling and engineering drawing. Metal is expertly cut by Skip of RKD Machine Shop Services.

VARIANTS

The mount is built to order and different variants can be included at build time:

- Worm and wheel can alternatively be Aluminium / Brass. The softer material is not a problem as there are slipping clutches on both axes which act as torque limiters. This reduces the weight of the main assembly by 5kg.
- 20cm wheels can be fitted instead of 15cm

- Encoders can be fitted. Normal operation the pulses sent to the motors are counted (virtual encoders).
- Different Latitude operation by adjustment to the design of the Adjuster Base.
- 200Ncm motors can be fitted with consequent increase in phase current and Microstepping system changes. This provides increased torque and is recommended for more than 50kg payload.
- The drive system can be configured to run at higher voltages. Normally 12 volt DC at 2.5 amp but can be 24 volt. This can run the motors 80% faster.

SPECIFICATIONS

PEM MOUNT

Loading capacity	TBA but designed for 100kg OTA
Main shafts	Stainless steel 45mm dia thick wall shaft
Bearings	45/75mm taper (2) and ball (1) per axis
Grease	Ambersil EXL Ambergrease
Materials	Stainless steel 304
Worm wheel sets	15 cm Phosphor bronze on Aluminium boss 25mm dia stainless steel worm
Periodic error	TBA approx 5 arcsec rms
Mechanical reduction ratio	200:1 and timing belt reduction 34/14
Torque using MOTOR/85	1.3Nm at the worm
Torque using MOTOR/200	3.1Nm at the worm
Balance arm	25mm diameter
Weight	35kg
Size	36 x 20 x 48cm

BASE ADJUSTER

Observatory Location	Latitude 0 degrees to 70 degrees*
Latitude adjustment range	+/- 1.5 degrees
Latitude adjustment scale	1 turn is 11 arc minutes at mid-point
Azimuth adjustment range	+/- 2 degrees
Azimuth adjustment scale	1 turn is 12.5 arc minutes
Weight	12kg
Recommended fitting	20cm diameter pier

DRIVE SYSTEM

Drive System	AWR Technology Microstepping system
Stepper motors	Sanyo-Denki 80Ncm
Tracking rate	microsteps per second
Operating Voltage	12V DC
Operating Current	2.5 Amp
Default speeds:	
- GUIDE	30% Sidereal
- CENTRE	2x sidereal
- MOVE	32x sidereal
Maximum SLEW rate	Typically 0.8 degree per second

* CUSTOM MADE TO FIT

For further details see websites

AWR Technology	www.awrtech.co.uk
ASTROMOUNT	www.astromount.co.uk
Machining	www.rkdmachineshopservices.co.uk
Technical	alan@buckman-hardy.co.uk

WARNINGS

WEIGHT

The PEM is around 35kg fully assembled. It breaks down into smaller lumps

- RA and DEC lump with 6" PB wormwheels 29.5kg
- Motors and brackets 2kg
- 'C' bracket 6kg
- Balance weight and shaft 4kg + balance weights
- Mounting Base 12kg

Telescope optical tube assemblies are heavy and the payload can be three or more times heavier than the mount. It is most important that the mount is stable, the telescope is in balance and the centre of gravity runs vertically through the centre of the mount, down the pier if it has one, or near the centre of the tripod if it is on legs. If it is knocked and the centre of gravity goes outside the support of the legs then it will fall over and damage your precious instrument. These are not designed to survive a drop test.

Be careful when adding weights to the balance arm. The arm should ideally be horizontal and may need supported to stop the slipping clutch operating.

ROTATING MACHINES

Telescope are designed to run slowly at very slow rates but the motors are capable of moving the telescope about 1 degree a second. There is at least 300x gearing with worm and wheel so huge forces are generated. Most of the moving parts (the gears and timing belts) are covered but still be aware that loose clothing can be trapped. Take care when near the mount

The worm wheel sets have a slipping clutch arrangement which can be set so that it does not normally slip in normal operation but will when knocked or it comes up against a hard object.

GREASE

The worm wheel sets and bearings are greased to maximize the operational life. Be aware that not all the motion is enclosed and grease and oil can come off. It is not harmful but is mucky. Re-greasing should be with the same product but should not be necessary for at least five years.

HEAT

The motor assemblies will generate heat. It is necessary to operate both coils with some power to hold a mid position between full steps, or full power when moving the motor to get out full torque to turn the telescope.

SHARP EDGES

The Adjuster base has many laser cut and machined aluminium parts and so has sharp edges. Please be careful. Burrs should already have been removed.

SETUP

ASSEMBLY – BASE ADJUSTER

The base adjuster has a plate to fix on the pier, a PTFE layer, and a rotating plate on a pivot bolt. The angle adjustment is integrated with the side plates and the PEM 'C' section with a moving plate on a pivoting joint and an extending rod adjust. This means that a heavy load is held securely on a wide base to increase stability.

When the base is all secure the PEM should be lifted into place. This will require two people. There are 4 x M12 bolts to add to secure the PEM 'C' within the side plates. There is a welded plate at the right height for the bottom end to nestle into whilst the top end bolts are added. Make sure all the bolts are in before they are done up tight.

Finally there are grub screws in some bearing blocks on the base adjuster which stabilize the axles and these should be done up when utmost stability is required. This would be done after the latitude and azimuth adjustment has been done.

ASSEMBLY and ADJUSTMENT - MOUNT

The M44 axis nuts are done up to a torque of 100Nm with Loctite 243 Thread Locker to stop them coming undone in normal use. There are two holes in the nut for ¼ inch bars to be fitted and then a 600 x 50 x 6mm aluminium bar is used as a lever to do the nut up to the correct torque.

Each wheel is mounted on an aluminium boss and is free to rotate on the shaft, held in place by torque adjusting HEX grub screws. There are three per boss. To increase the slipping torque all three should be done up by exactly the same amount until the right level of slip is required.

Worm setting. The worm brackets have sliding adjustments with slotted mounting holes which allows you to change its aspect against the wheel in all dimensions including rotation. So it is possible to fit it in the exact place needed by the worm to fit on the hobbing properly. Once this is done and locked down you can test it by rotating the large pulley to test that it does not bind. Under full telescope load with correct balance it may be necessary to adjust this.

Once the worm settings have been achieved then the motor bracket positions can be adjusted to provide the correct belt tightness.

Finally check with motor power that everything is running smoothly. Then lock down the moveable plates with the additional M4 Set screws used as grub screws. These will stop any movement in th sliding plates.

Balance is achieved by undoing the three large torque adjuster screws on the boss of each wormwheel. This allows the shaft to rotate freely without having to undo the worm assemblies. Then a spring balance is recommended to equalise the rotational force required to turn the axis in both directions. If you are in doubt about this process contact Alan Buckman of AWR Technology. Remeber to tighten up the torque so the motor can turn the axes. It must be tight enough for the motor to turn it with a slight imbalance - for example when an eyepiece is changed, but it is recommended you re-balance if you add a camera or another fixed lump on the optical tube assembly.

AWR have further instruction sheets on balancing. Both RADIAL and AXIAL balancing is required.

DISASSEMBLY - MOUNT

The first job is to loosen the main axle nuts, to break the Loctite glue. There are two holes in the nut for 6mm rod to be inserted, then a long lever can be used to rotate the nuts anti-clockwise to undo.

Remove the telescope, the counterweights and bar and any other additions that could get damaged. The motors should also be removed to reduce the weight.

It is advisable that two people lift the mount onto and off the BASE ADJUSTER. This will be the maximum weight around 37 kg having removed the telescope and the balance weight arm.

Disassembly of the main lump from the ‘C’ is necessary to gain access to the RA bearings. This is done on the workbench with the lump sitting on a 45 x 70 x 200mm block of wood and the ‘C’ horizontal. The wood conveniently sits flat on the square central box in-between the edge screws. So the heaviest part is directly supported. Then the M8 nuts holding each end onto the ‘C’ can be undone and then pulled away. You will see 12mm diameter pegs locating the 'C' top plates onto the bearing housing blocks. These pegs are to ensure correct location on return. Make sure that you assemble the ‘C’ back the same way round. The RA motor will have to be refitted to ensure the setting is correct.

There are two taper roller bearings in the bottom end RA bearing housing. Once this is off the ‘C’ and the main nut is undone, it will all slide off the shaft. Do not reverse the order of anything. The roller bearing cages fall out and can be serviced as necessary, do not mix up the two cages. Replacing the grease in the roller cages may be necessary, please use the recommended grease.

The DEC bearings are also difficult to get at. The DEC wormwheel needs to come off needing the Wheel Cage to come off. Then the wheel cage back plate comes off. Then there are 12 x M6 bolts holding the outside plate on the central lump around the DEC shaft to come off. You may need to loosen the rest of the bolts on the cover. Be careful that all the 50 and 70 mm diameter washers and fittings can go back the same way round they came out. Some labeling with marker pen may be necessary. Then you have access to the two taper roller bearing cages for re-greasing.

Assembly is the reverse of disassembly.

RUNNING IN

During production it is not possible to load up the mount with the payload so the worm wheel sets are virtually as machined. Burrs created at manufacture will have been removed but it will be advantageous to run the wheel sets for a reasonable time to take down any high spots.

Using AWR drive equipment means you have computer access to the drivebox with direct commands. You need the special serial cable DRIVEBOX-PC and the AWR software 'Windisp' downloadable from the web site. Running the CONFIG file 'win_ustep.cfg' will allow you to control each motor independently, set it going and then let it run for hours.

The DEC axis is easy to run in as the motor stays fixed, the top rotates. So set the speed to SLEW then command to move UP. The motor will stay at maximum speed until you send the command to stop DEC. It is recommended to do this under full load. If you watch it for one revolution you can make sure nothing is going to foul up and the motor completes without stalling. Then it is safe to leave for hours. At 1 degree per second it does 10 complete revolutions per hour. Through an observing session you may do up to three complete revolutions in 5 hours so it is accelerating the wear by a factor of 10 to 20 times. This makes it worth doing.

If at any point the worm is reset against the wheel then it may be necessary to do another run-in period.

The RA axis is a bit more difficult. It can be arranged that the moving parts (the DEC axis) can pass through the 'C' but it will be unbalanced and unloaded. So adding the telescope and balancing also means it will swing no more than +/- 150 degrees or thereabouts before the scope hits the sides of the 'C'. To run it in like this means setting it going in one direction, coming up to the physical stop, stopping it by the computer, reverse direction until it gets to the other side then stopping etc. It is still worth doing even just to make sure the worm is not too tight and the motor does not stall in any position.

OPERATIONAL NOTES

The RA wheel needs to move only a certain amount from the rest position. The rest position is defined by the marking 'TDC' on the RA Wheel and this should be at the worm when the balance weight is directly vertical pointing downwards. This position has been measured as the best fit for backlash.

If left unattended for long periods it would be advisable to put a cover over the whole mount to stop dust sticking to the grease on the wormwheels.

If the dome is unheated it is advisable to remove the electronics boxes when not in use.

Rusting can occur mostly on the connectors and the drivebox end plates. The Intelligent Handset is fairly well protected and the only major corrosion issues have arisen when water has leaked into the dome and onto the handset and left unnoticed for long periods of time.

The Intelligent Drive System by AWR Technology has its own manual and there are other supporting documents in the website.

See www.awrtech.co.uk/ih/ih_dl.htm

SERVICING

A regular dust down with a brush will remove dust. Grease / oil / fingerprints can be removed with Iso-Propyl Alcohol on a kitchen towel. Lens cleaner wipes for glasses contain the correct solvent. Everything is stainless steel apart from the motor brackets and wheels. Fingerprints can leave marks if left for long periods of time. The majority of the stainless steel is grade 304 but even this can be subject to certain types of corrosion. Corrosion is not entirely eliminated.

Contact Alan Buckman if any issues arise. 01304 365918