DUNLITE

(& QUIRK'S)

Type BP

DC BRUSHLESS 2KW
WIND DRIVEN GENERATING PLANT

INSTALLATION & OPERATION INSTRUCTIONS

Edited version of the Quirk's 1974 issue

NOTE

This manual was produced by scanning an original Quirk's manual using optical character recognition (OCR) software. It was then extensively edited to correct the OCR, typing, spelling, and other errors, expand abbreviations, add North American terminology to the original Australian terms where applicable, and add some additional notes.

The object was to produce a working manual for those wishing to operate, maintain or re-build a Dunlite type BP wind turbine. Therefore, no attempt was made to retain the original format.

The Dunlite machines were available in 12, 24, 32, 48, and 110 volt DC versions. This manual was for a 110 volt machine.

I have had the opportunity compare the Quirks and Dunlite manuals. The text is essentially the same but the formatting and cover pages are different. If you want a copy of an original Dunlite manual, contact Malcolm Barko at Southwest Solar, RMB 2309, Portland, Vic. 3305, Australia. Phone 03 5526 5329 or e-mail him at barko@iconnect.net.au

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Plant Protection

Your attention is especially drawn to the position of the two 30 amp fuses in drawing 1021. (For 11OV.Plants) These should be fitted in the negative line where marked:

- Between the Generator and the Voltage Regulator, and
- Between the Voltage Regulator and the Batteries, as close to the batteries as possible.

Plants of a Voltage lower than 110 should use fuses of a higher amperage than the above

Lightning

It is recommended that the three wires from the generator be taken in galvanised water pipe, inside the tower and underground, then in either plastic or galvanised conduit to the AVR [Automatic Voltage Regulator], thereby protecting the transistors. The tower itself should be protected against lightning strikes according to local conditions. It is perhaps best to consult local authorities, such as the Fire Department.

Generally speaking, it is sufficient to connect each leg to a galvanised stake by means of a heavy copper wire. The stake should be between 4 and 6 feet from the leg and be driven 4 feet into the ground.

The concrete blocks in which the tower stands may be protected against being smashed by a lightning strike by running a copper wire through each block before the concrete is poured. Insert the wire into the ground in the centre of the hole, connecting the other end to the tower leg.

When erecting the plant, use normal block and tackle with a pulling wire of at least size No.8. Assemble the tower first; either on the ground, or section-by-section, whichever is the more practical. Allow the concrete plenty of time to set. The turntable or head assembly should go up first: fit this to the top of the tower cap, then pull up the generator with the propeller hub attached: fit the generator to the turntable - levelling it is now a simple matter.

Now fit the brake cable and lock the generator firmly.

Attach the three blades then the tail assembly. Release the brake and the plant is ready for operation. After about six weeks of operation, check all nuts and bolts for tightness. Before this is undertaken, the plant must be locked by the brake.

Section A

General Description

Generator

The generator is of the brushless design, being 3-phase multi-polar alternator with silicon full wave rectifying diodes, to give a steady DC output with minimum ripple factor. It is designed with totally enclosed construction, tropic-proofed windings, 5:1 ratio gearbox with helical cut gears running in oil bath.

Performance Specifications

A) Maximum continuous output (CMR)		2 KW
B) Peak output (30 MPH wind speed)		5 KW
C) Maximum excitation power		120 Watt
D) Cut-in speed,	Cold	110 RPM
	Hot	130 RPM
E) Cut-in Wind velocity		8 MPH
F) Maximum output Wind velocity		25 MPH

Head Assembly (Turntable)

The turntable assembly into which the generator is seated rotates on sealed, heavy-duty grease packed bearings. The centre shaft, enclosed in the turntable carries the 3 slip-ring assembly to transfer the generated current and for connection of field control. These rings terminate at a weather shrouded terminal strip at the base of the turntable.

Tower Cap

The tower cap consists of a fabricated steel, 4-stud mounting plate with 3 stub angle legs, conforming to the configuration of the top of the 3-legged tower to which it is bolted. The 4 studs correspond to the hole provided in the base of the turntable assembly and nuts provide a means of levelling the turntable.

Propeller

This consists of aluminium hub assembly, containing the sliding governor, the oscillation of which is smoothed out by a shock-absorber unit. The three blades are mounted on shafts, which rotate on bearings fitted in the hub assembly. These shafts act in unison, under the combined forces of wind and speed of the blades, to move the governor assembly in and out against the action of a central spring and the shock-absorber unit, providing automatic “feathering” of the blades and so preventing excessive generator speeds and strain on the tower.

To ensure that the feathering action of the blades does not occur until the generator is up to full speed and output, movement of the sliding governor is restrained by a series of six magnets, which magnetically latch the governor and only release it at a predetermined point.

Voltage Regulator

The “QUIRK’S” control cubicle, fitted with centre-zero ampere-meter to register charge and/or discharge current, and voltmeter. The cubicle houses the terminal connection-strip and an ampere-meter shunt if the current rating of the generator is in excess of 50 amp. (NOT applicable to 11OV plants) When specified, a reverse blocking diode mounted on a heat sink assembly is also fitted inside the cubicle. (Normally, this is not required as the main rectifier system of the generator precludes discharge from the batteries) The regulator is mounted on the front face of the cubicle for easy access to the setting potentiometer.

Tower

Three-legged, heavy duty galvanised, with twisted, flat steel braces.

Section B

Plant Location

Examine the proposed site to make sure that the plant will receive the maximum force of the prevailing winds for the particular area. Most of the criticism of unsatisfactory operation of a wind plant is due to installation in unsuitable positions, or on too low a tower.

Maximum efficiency is only possible where the plant operates in a clear and steady air-stream. It is essential that the plant is at least 15-20 feet clear of all obstacles (buildings, trees, etc) and the tower is of sufficient height to reduce ground disturbance: a minimum of 40 feet is recommended. Make sure that the plant is placed between the direction of the prevailing winds and any building, etc. Any object higher than the plant will cause a disturbance in airflow for approximately 300 yards in front of the plant and 50-100 yards if behind the plant.

In hilly areas it is better to place the plant 200-300 yards away from the building housing the batteries and control equipment if better wind conditions are thus obtained. The steadier the airflow in which the plant is operating, The higher the average output, and the lower the strain on the plant due to frequent changes in wind direction,

Section C

Tower Erection

The Tower is of three-post construction and can be supplied in 10 ft. multiples from 10 feet to 70 feet high. The base spread increases approximately 2 feet per 10 ft section.

Top of all main angles are ground to fit inside the bottom of the next main angle. The shortest girts and diagonal stays are used at the top of the tower and the longest at the bottom. Girts are bolted outside the main angles and stays are bolted inside the main angles.

First assemble the bottom 10ft of the tower. Use this as a guide to digging anchoring holes to the size recommended on the drawing supplied, to suit the height of the tower being erected. The holes should be larger at the bottom than at the top, providing a wedge form.

Attach anchor posts and plates to the section of the tower, and stand in the anchoring holes. Prop the section up under the bottom girts to allow for at least 6” of concrete under the bottom of the anchor posts. Level the tower section with the aid of a spirit level. Bear in mind that if the tower is not level at the bottom, it will be further out as the height increases. When satisfied the tower is level, pour the concrete. Then check the level again. Allow concrete to set for two days.

To complete the erection depends on the height of the tower and the lifting facilities available. Unbolt the 10ft section of the tower from the anchor posts. Lay it on its side and build the rest of the tower lying on the ground, providing a crane or jib is available for lifting it into position. If there are no such means available, build it vertically by adding the first next three main angles, then girts and stays until the tower is completed. All ladders bolt inside the girts. All bolts should be left loose until the tower is fully assembled and then tightened.

Vee stays or drop stays are provided for girts Nos. 7, 8, 9 and 10. These are used on two faces of the tower only. They are not required for the ladder face. They are bolted to the crossover point of the diagonal stays to the centre of the girt below.

Bolt sizes for the various positions are as follows

1” x ½” hexagon bolts	For all main angle joints and anchor plates
1¼ ” x 3/8” hexagon bolts	Where two stays and girts bolt to main angle.
1” x 3/8” hexagon bolts	Where one girt and stay bolt to main angle and ladder joint
¾” x 3/8” hexagon bolts	For crossover point of diagonal stays and for centre of ladder to girts.

Supplied with the plant are three pieces of 1” x ¾” flat mild steel with a right-angled bend. These are bolted with the angle hanging downwards the top (long) section being secured under alternate bolts on the top girt. These are used for supporting the wooden platform, supplied in three pieces, ready for assembly.

Section D

Plant Installation

The top of the tower is capped by fitting the fabricated steel tower cap, which has four mounting studs positioned to suit the four holes in the base of the head assembly (or turntable). See drawing 1076

Turntable (refer to drawings 31448 and 2507)

To fit the turntable assembly to the tower cap, the unbrako type 5/8" nuts and flat washers are removed, and the turntable lowered into position over the studs, positioning it so that the terminal strip at the base is most conveniently placed to run the cables down the tower.

Fit the push rod (item 12) down through the centre hole of the turntable spindle, making sure the bushing is fitted correctly in the rear pivot arm casting. (Item 1)

The U-bolts (item 31) used to secure the generator in position in the turntable are released and lifted out to allow the generator to be placed in the turntable recess, with the gear box hanging vertically downwards.

Generator

The "QUIRK'S" designed lifting clamp (drawing 2946) is attached to the generator, which is hoisted into position over the turntable and then lowered into the recess. In the side of the recess is a locating hole, which accepts the allen-head socket screw in the side of the generator, to prevent possible movement of the generator.

Note: The lifting bracket was discontinued without explanation. I suspect for safety reasons. I use a length of flexible stainless steel wire rope (aircraft cable) wrapped around the generator in such a way that it can not slip off. This is held securely with saddle clamps to prevent any movement. I also use saddle clamps on this cable to prevent the hook on the lifting cable from sliding due to any unbalance in the rigging.

The two U-bolts are then positioned over the generator and securely tightened, after which the lifting clamp may be removed, and the special plug with U-shaped breather tube (supplied as separate item tied to the generator) fitted in its place. The original plug should be retained at the site and conspicuously tagged, as it should be refitted in place should the generator be removed, to prevent oil leakage from the gear box in transit.

(When lifting the turntable, generator and assembled propeller, it is suggested that they each be lifted on the ladder side of the tower, to reduce the possibility of catching in the tower, and guided by means of attached guide ropes)

Levelling The Turntable (refer to drawing 1076)

With the generator in position, levelling of the turntable must be carried out prior to fitting the tail assembly. This is to ensure that the generator has no bias to a particular position. The nuts of the anchoring A-stud are securely locked against each side of the tower cap, to the 30 ft/lb torque recommended. By adjusting the holding nuts on the adjusting studs B, C and D, with the unbrako nuts slackened off, the level of the turntable is adjusted until the generator will remain in any position.

Check that ALL holding nuts bear against the underside of the turntable base, before tightening the lock nuts up against the holding nuts. Finally, tighten down the unbrko self-locking nuts.

If the machine can not be levelled, select the lowest lug bolt as the "A" anchor stud and repeat the above procedure

Brake Fitting and Adjustment (Refer to drawing 3447)

The generator, prior to being placed on the turntable, has the brake hub (item 11) fitted to the gear box lay shaft and the brake band (item 9) with lining (item 10) together with bell-crank (item 18) is fitted in position on the front of the gear box lid.

(Refer to drawing 3443)

When the generator is securely mounted on the turntable, the brake link rod is fitted (item 23). The end with the cotter pin is fitted to the bell-crank on the gearbox. The two nuts (adjusting and locking) are removed from the threaded end, which is passed through the hole in the rear pivot arm (item 1) on the turntable. The nuts are then replaced, adjusted until the brake band just starts to bind on the brake hub, and then looked.

The two front nuts that were not removed from the link rod are then adjusted to within about 1/8" of the rear pivot arm, and locked. This serves to push the brake off when the pull-out handle at the bottom of the tower is released. Use a heavy galvanised wire to connect the bottom end of the pull-out rod (item 12) to the pull-out lever (item 11), which is hinged between the pull-out clamp (item 9) secured to one of the tower legs, and positioned so that with the lever down and held under tension with the pin (item 10) inserted. The brake band prevents the brake hub from rotating. Final adjustment of this cannot be made until the propeller is fitted. (This adjustment needs to be re-checked after 3 weeks when the brake lining has bedded, and then at 6-monthly intervals.)

Re-tensioning is done by loosening the pull-out clamps and sliding down the tower leg and re-tightening.

Tail Assembly (Refer to drawing 3448)

It is necessary to first assemble tail wings and angles and to bolt them to the tail bone. The angle irons of the tail are placed across the tail wings with the flat side of the angle iron out, and are then bolted with ¼" galvanised bolts, after placing a galvanised washer between the wing and angle iron on each bolt. These washers prevent the wings from vibrating against the angle irons. The tailbone is then fitted into the socket provided in the turntable, making sure the anchor set screw will seat into its recess in the pipe. Place the end of the suspension angle against the lug provided on the turntable and bolt in position. Finally, clamp the tailbone securely with the setscrew and lock-nut.

Section E

Propeller

(Refer to drawings 3446 and 2507)

The variable pitch propeller fitted to the plant has been carefully balanced and aligned at the factory and the hub and blades should be carefully inspected to see that they have not been damaged in transit.

The main centre casting of the propeller should be fitted to the brake casting, after making certain that the machined surfaces are perfectly clean. Then tighten the three holding setscrews **evenly** and **securely**. (Torque reading 35-40 ft/lbs) All the blade arms should then be smeared with silicon grease to inhibit corrosion and then the blades can be fitted to the Hub. Check that the blades and the hub each have the same serial number and be certain the No.1 Blade is fitted to the No.1 shaft, and so on. Fitting the wrong blade to wrong hub or shaft will cause the propeller to be out of balance and create vibration. The governor balance weights are also numbered.

When the blades are fitted, the governor balance weights should be bolted to the blade and **tightened securely** (torque reading of 20-25 ft/lbs). Then tighten 5/16" bolt on the side of the clamp to 16 ft/lbs. Check that the shock absorber gland nuts are tight.

The cylinders are filled with Viscostatic 10/30 grade oil. Each shock absorber under 10 lb load, travels 2" in approximately 5 seconds. The shock absorber system is provided to dampen out oscillations, which may occur under conditions of light load and particular wind conditions. It also absorbs the sudden shock of release and restoration of the magnetic latching system incorporated in the propeller design.

Before allowing the propeller to run, move the governor weights to the fully feathered position and rotate the propeller to see that there is ample clearance from the tower in this position. The propeller is so designed that when the maximum desired speed is reached, the centrifugal action of the three governor weights overcomes the tension of the centre spring and move the blades to a coarser pitch, thus tending to slow the propeller. The magnetic latch restrains this action until the speed of the generator is such that full output is obtained, when the force exerted (37-47 lbs) is sufficient to overcome the attraction of the magnets to the back plate.

The movement of the sliding governor is restricted to provide a maximum of 80° feathering. This amount of movement can be reduced, if desired, by loosening the half nuts (item 4 in drawing 3549), and moving inwards along the threaded centre shaft reducing the pre-set distance of 2¼ ", measured from the front of the sliding governor to the nearest face of

the half nuts. As the wind-pressure decreases, the speed will tend to slow, thus reducing the centrifugal force on the weights and the spring will return the blade to the maximum speed position.

Note. The “half nuts” referred to here are not the same as a half nut that a machinist is familiar with. In this case, they are just thin nuts, about half the thickness of a standard (full) nut.

The suggested method for measuring the torque required to initiate feathering of the propeller, is as follows:

Procedure

In the field, when a torque wrench is not available, the following procedure can be used to determine the torque.

A) An iron bar of known length “L”, measured between the points of application of forces is bolted to one blade at the pre-existing bolt as shown in figure1.

B) A spring balance is attached to the other end of the iron bar.

C) A gradual pull perpendicular to the bar is applied to the spring balance “F”. The reading is taken when the propeller shaft begins to turn and just before the magnetic latching system releases. A definite break will be felt when this happens.

D) Resultant torque is given by:

Torque = force x length
(ft/lb) (lb) (ft)

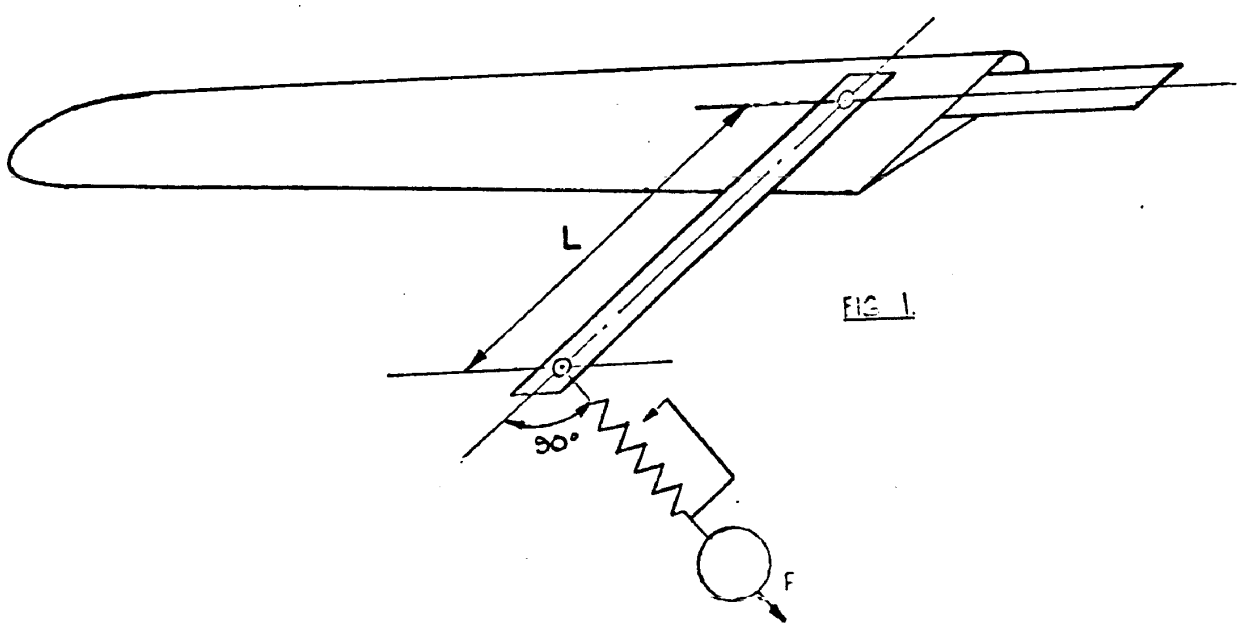

FIG 1.

Torque Required

For wind driven generator, fitted with magnetic latching system and standard spring 4 SWG, the torque required is in the range of 37-45 ft/lb for the following conditions:

Spring length	7”
Number of Magnets	6
Type of Magnets	PM 74 Rola. pull force 40 lbs each.
Torque measured	37-45 ft/lb

Parts Required

1- An iron bar, 24" x l" x 3/8" with a hole at each end. Drill the diameter of the holes to suit bolt and balance hook.
2- Spring balance, 0-25 lbs.

If the torque is outside limits, adjustment is affected by increasing or decreasing the centre spring tension. After checking that the magnets (item 6) are clean, free of iron filings and rust, the lock nut is loosened and the spring retaining washer (item 4) is screwed inwards to increase torque necessary to initiate feathering, or outwards to decrease torque

Section F

Connection Of Plant And Cubicle

Plant

The main generator output leads and control lead are brought out of the generator in flexible conduit and after the generator is fitted to the turntable, these leads are connected to the appropriate terminals on the protected connection strip at the base of the turntable. The flexible conduit is anchored to the turntable after connecting the wires.

Cable coloured RED = POSITIVE
BLACK = NEGATIVE
GREY = FIELD (control lead)

It is suggested that the main generator cables and the field cable interconnecting the plant to the control cubicle be brought down the full length of the tower in plastic or seamless steel conduit or water-piping which can be buried in the ground for the distance between the base of the tower and the building housing the other equipment and batteries. Alternatively, the cables can be brought down to a cross-arm fitted with insulators and taken from this point by aerial cables to a similar set of insulators on the building.

When selecting cable sizes, particularly in regard to the main output leads, one must bear in mind the voltage drop associated with maximum charging currents at the low voltage pertaining to these installations.

Control Cubicle

The meterised control cubicle should be mounted as close as possible to the batteries, thus reducing the length of cable runs and possible voltage drop, as well as possible electrical interference with telephonic circuits.

Conduit entries are provided at the bottom of the cubicle, and a heavy-duty terminal strip is accessible by opening the hinged door.

Section H.

System Operation

The design of plant and tower is calculated to withstand gales up to 100 MPH. The combination of mechanical latch and shock absorber system has proved capable of handling any oscillation, which might occur with batteries or load, connected.

The required setting of the potentiometer to secure correct regulator operation for the site conditions is obtained by switching the regulator OFF, so the maximum charge rate is available to continue until all cells gas freely with fine bubbles (milky electrolyte above the plates), all cell voltages rise to 2.8 volts and specific gravity is 1250, plus/minus 5 points (temperature corrected).

Then switch regulator ON again. Adjust the potentiometer so that under conditions of maximum wind-velocity, the charge rate is reduced to approximately 2-5 amps. Due to variations of voltage drop dependent on lengths of cable-runs and differences in internal resistances of the batteries, it is not possible to factory-set the regulators accurately. If no wind-power is available, initial charging of the batteries would require the use of a portable charging set.

Quirk's Voltage Regulator For Brushless Wind Driven Generator

Service And Maintenance Instructions

Description

The circuit diagram includes a block schematic of the QUIRK'S voltage regulator, which shows the essential components. A voltage divider of the two fixed resistors and a potentiometer are connected across the G+ and G- terminals. The slider of the potentiometer is connected via a zener diode to the base of a control transistor as shown.

When the generator begins rotating, a voltage will be generated (due to the residual magnetic flux in the single-phase centre-tapped winding, incorporated in the main stator. This voltage is rectified and applied to the exciter field via the two transistors, connected as a Darlington pair, situated on the regulator case. The transistors receive base current via the resistor, connected between the base wire (BLUE) and the "F-" terminal wire (YELLOW). As the voltage builds up, this base current increases and the transistors are switched on, thus supplying full voltage to the exciter field.

When the voltage, as determined by the setting of the potentiometer setting is reached, there will be sufficient voltage between positive and the slider to cause the zener diode to conduct, and current will flow in the emitter-base junction of the control transistor, which will be saturated. This will bring the collector of this control transistor to near positive and the driver of the Darlington pair will be cut off, thus cutting off the final transistor and open-circuiting the exciter field.

As the generator voltage drops slightly, due to loss of exciter field, the zener diode will cease to conduct and the control transistor will switch off, allowing the Darlington pair to switch on, and once again supply exciter current. This switching is in the form of rapid pulses and the exciter field will be supplied with just sufficient average current to maintain the generator output voltage at the desired level. A control switch is fitted to the panel, to over-ride the regulator as shown, and can be used to "boost" charge the Battery.

Testing

To check the operation of the regulator, stop the generator and disconnect the battery. Start the generator and turn the potentiometer first fully anti-clockwise and then fully clock-wise, The voltage range obtained should be at least 11 to 18 V.

If turning the Potentiometer does not alter the generated voltage, ascertain that the control switch is open-circuited and that switch wiring is not short-circuited. Check all wiring for a breakdown between G+ and F. Check the potentiometer for an open circuit.

The Darlington pair transistors can be checked for a short-circuit between collector and emitter by connecting a jumper wire between the base (BLUE) wire and G+ (RED) wire. If these transistors are in order and all other wiring is correct. The generator output should be zero, the exact voltage being dependent on the value of the residual magnetic field only.

If with the jumper in place, the generator voltage is still high, the transistor will be at fault and both should be tested for shorts between collector and emitter. If the jumper lead reduces the voltage to the residual value and all other wiring is correct, the fault will be in the encapsulated portion of the regulator and this unit should be replaced by one of the same type-number.

A cause of failure of solid-state devices such as voltage regulators is static or lightning discharges. To ensure protection from these transients it is advised that all towers and one side of the wiring be effectively earthed. Dry concrete is an effective insulator and static electricity can build up on towers, particularly in dusty conditions.

It will be appreciated that while the generator is charging the voltmeter will read the battery voltage. If the potentiometer is turned anti-clockwise the charging rate should reduce although no appreciable change in voltage will be noted. If the potentiometer is turned clockwise an increase in charging current will result but no immediate change in voltage will be noted.

The current setting of the potentiometer can be obtained by charging the batteries with the regulator switched off at the toggle (tumbler) switch. When the correct voltage has been reached, switch the Diotran regulator ON and adjust the potentiometer to reduce the charge-current to nearly zero.

Section-J

Maintenance Routines.

1) Apply the brake to prevent the propeller from rotating, and check that position of the pullout lever and pin is correct. Adjust if necessary.

2) Examine the tower and wind driven generator generally for signs of loose bolts or fittings and evidence of damage or deterioration, specially corrosion or rusting. (This can be stopped by application of suitable anti-rust or sealing compounds)

3) Grasp the tower cap firmly and use body weight to shake the tower and machine. Lack of tower springiness may indicate slack tower bolts. A significant relative movement between the fixed and rotating portions of the head base assembly may indicate a damaged bearing or broken shaft. The head base rotates on a 2" ball bearing, and general stability should be appropriate to this class of bearing.

4) Check the cables and terminals (generator to turntable, main leads from turntable). Remove the pickup brush plate assembly to check condition of brushes, slip rings and brush tension. Check that the U-bolts securing the generator to the turntable are tight. Examine all bolts & nuts, etc. for signs of corrosion.

   While the tower is in motion, check the tail for general movement, particularly the pipe where it sockets into the head-base anchoring points. Telltale rust stains emanating from these points may be an indication of a slack fitting. The setscrew on the tail pipe socket should seat solidly on the inside bottom of the pipe.

6) Carefully examine each mill blade in turn, paying particular attention to both faces of each blade about 12 to 15 inches out from the governor balance weight for signs of creasing or fatigue cracking. These blades can flex considerably in adverse weather conditions. Instances have been seen where blades have struck the tower or its attachments even though a considerable static separation was provided. Therefore, any small dents on the inside of the blades should be carefully related to the tower for signs of tower impact. Some denting of the outside faces of the blades particularly may occur due to bird or bat strikes. Unless this damage is substantial, the overall performance of the machine will not be affected. Check that the bolts securing the housing to the brake hub are tight (35-40 lbs)

7) Examine the three blade shafts at the base of the taper-section for signs of fatigue cracks. Some moderate stressing of the blades by hand may help to reveal such damage. Corrosion at the point where the blade casting is fitted to the shaft can be reduced by the re-application of silicon grease, as required.

8) Grasp each governor balance weight in turn and determine how much free movement there is in each blade. If this is more than 3/16" at the trailing edge of the blade, it could indicate a worn or damaged nylon roller in the feathering mechanism. Failure of the nylon rollers can be initiated in some cases by maladjustment of the feathering angle limit nut on the centre shaft. If this is not properly adjusted to give around 80° feathering, the nylon rollers can be pounded against a part of the governor casting to cause distortion and eventual failure. 80° feathering is equal to 2¼" between the limiting nut and the sliding governor in the un-feathered position.

   Remove the nose cone and examine the centre shaft and the two damper shafts for signs of rust. Fully feather the blades by pulling on a governor balance weight, then ensure the blades fully restore without signs of binding. Some sluggishness can be expected due to the correct operation of the dampers. A 'snap" action may indicate a dry or other wise faulty damper (shock-absorber). After any rust has been removed by means of a rag soaked in paraffin (kerosene), the shafts can be smeared with silicon grease or sprayed with a lubricating rust retardant. If a grease-nipple is fitted to the sliding governor, silicon grease can be applied if it appears necessary.

   During feathering of the blades by hand, the operator should be aware of the correct operation of the magnetic latch. The magnets in the feathering device will prevent any feathering until a certain minimum force is applied. After this point is reached, a lesser force is required to hold the blades feathered. Accordingly, two quite distinct actions should be detected as follows:

(A) At the snap action of the magnets lifting.
(B) The continuing drag as the blades feather.

10) The brake mechanism should be inspected for a serviceable brake-band and proper adjustment of the lever system. With the brake fully applied, none of the components of the leverage-system. i.e. bell-cranks, rods, etc. should be near "bottoming".

Refer to "Brake Fitting and Adjustments" for further information on brake adjustment

11) Allow the Machine to run. Gear noise is quite normal, but it should be even and depends largely on the load. Experience is the only means of determining if noise is excessive. The gear oil used in very heavy or very cold conditions will not run out when the level bung is removed. Although oil leaks may occur, it is unlikely that the gearbox will run dry. Therefore, exercise care in judging the level of oil in the Gearbox, as overfilling will cause leaks.

Check for signs of oil leakage indicating failure of oil seal, overfilling, or blockage of the breather. Check that the flexible conduit enclosing the generator leads is secure. Remove the rear cover to check that the connections of the main generator leads clean and secure. Check the condition of the generator leads and replace if necessary. Tighten the studs securing the gearbox lid.

Note: The original specification was for 80W90 gear oil. This oil becomes extremely thick in very cold weather and may inhibit operation of the plant. The solution is to use synthetic gear oil, which does not stiffen in the cold.

To Install Generator

1. Winch Generator Assembly up to a position where the Brake Rod is clear of the Tower Cap.
2. Lower the Generator onto the Bolts and tighten down.
3. Detach guide ropes.
4. Connect Brake Cable.
5. Connect electrical Cables.

To Fit Hub Assembly

1. Attach wire rope or winch cable, and guide ropes. to the Blade Assembly.
2. Raise Blade Assembly until Propeller Hub lines up with the Brake Hub.
3. Line up Bolt Holes.
4. Lock on brake.
5. Tighten up bolts and disconnect Cables and Guide Ropes.

Head And Tail Assembly 3448

Item	Part Nr.	Material	Qty	Description
1	210	Malleable iron	1	Rear pivot arm
2	211	Mild steel	1	Rear pivot arm pin
3	273B	Mild steel	1	Tail suspension angle
4	276B	Mild steel	1	“U” bolt front
5	255	Zinanneal	1	Tail wing top (galvanized sheet steel)
6	275B	Mild steel	1	Rear tail support
7	276B	Mild steel	1	“U” bolt rear
8	255	Zincanneal	1	Tail wing bottom (galvanized sheet steel)
9	1090	Cast Iron	1	Brake clamp 2¼” angle tower
10	334	Mild steel	1	Pullout lever pin
11	1079	Mild steel	1	Pullout lever pin
12	212B	Stainless Steel	1	Centre pullout rod
13	1986B	Mild steel	1	Tower cap
14	3103	Cast Iron	1	Head base complete with stub shaft
15	194	Mild steel	1	Bottom grease retainer
16			1	Bearing SKF 6210-2RS
17	3205		1	Slip ring assembly complete
18		Steel	1	Set screw 5/16 UNC x 2 ½ chcp
19	1113B	Gal water pipe	1	Tail bone
20	275-1	Mild steel	1	Front tail support
21	2408	Bakelite	1	Terminal strip assembly
22	1105	LM4 Alum.	1	Terminal cover
23	1973	Mild steel	1	Brake lever
24	196	LMC Alum.	1	Terminal cover
25	2409		3	Brush spring assembly
26			1	Bearing SKF RLS8-2RS
27	193	Mild steel	1	Top grease retainer
28	219	Mild steel	1	Top grease retainer cover
29	209	Spring Steel	1	Pivot arm spring
30	1963	Cast Iron	1	Head body
31	1968	Mild steel	2	“U” bolts
32	3066	Mild steel	1	Clamp bar
33	318	Steel	2	Pivot pins
34		Steel	2	Split pin 3/32” x ¾” long
35				
36		Mild steel	2	Split pin 3/32” x ¾” long
37		Mild steel	2	Flat washers 5/8” zinc plated (galvanized)
38		Mild steel	2	Screws 3/8” x 1 ¾” UNC hex head
39		Steel	2	Unbrako nuts 3/8” UNC zinc plated (galvanized self-locking)
40		Spring steel	2	Spring washers 3/8” zpl (galvanized lock washers)
41		Mild steel	4	Nuts 5/16 hex
42		Mild steel	4	Flat washers 5/16”
43		Mild steel	4	Bolts ¼” mushroom head x ½”
44		Mild steel	4	Nuts ¼” nuts zpl (galvanized)
45		Mild steel	4	Flat washers ¼”
46		Mild steel	4	Bolts ¼” mushroom head x ½”
47		Mild steel	4	Nuts ¼” zpl (galvanized)
48		Mild steel	4	Flat washers ¼”
49		Steel	1	Set screw 5/16” x 2 ½” UNC
50		Steel	1	Set screw 5/16” x 2 ½” UNC

Head And Tail Assembly Continued

Item	Part No.	Material	Qty	Description
51		Mild steel	2	5/16 hex nuts
52		Mild steel	2	5/16' flat washers
53		Stainless steel	4	3/8” set screw
54		Mild steel	4	5/8” self lock nut
55		Stainless steel	4	5/8" nut zpl (galvanized)
56		Stainless steel	4	5/8” half nut zpl (galvanized)
57		Mild steel	8	5/8" fiat washer zpl (galvanized)
58		Mild steel	1	5/8" leveling washer zpl (galvanized)
59		Mild steel	1	5/16" star washer zpl (galvanized)
60		Mild steel	1	5/16” half nut + star washer
61		Mild steel	2	3/16" round head screws x ½”
62		Steel	2	3/16" star washers 3/16” round head screw x ½”
63		Mild steel	2	3/16" flat washer
64		Steel	2	3/16” round head screw x 5/s~
65		Brass	2	3/16” spring (lock) washer
66		Spring steel	2	3/16” round head screw x 1¼”
67		Brass	2	3/16” star washer
68		Spring steel	2	3/8" hex lock nut
69		Mild steel	4	3/8” hex lock nut
70				
71		Mild steel	1	3/8” flat washer
72		Mild steel	1	3/32” split pin x ¾” long
73		Mild steel	2	½” hex self-locking nut
74		Steel	2	½” flat washer