

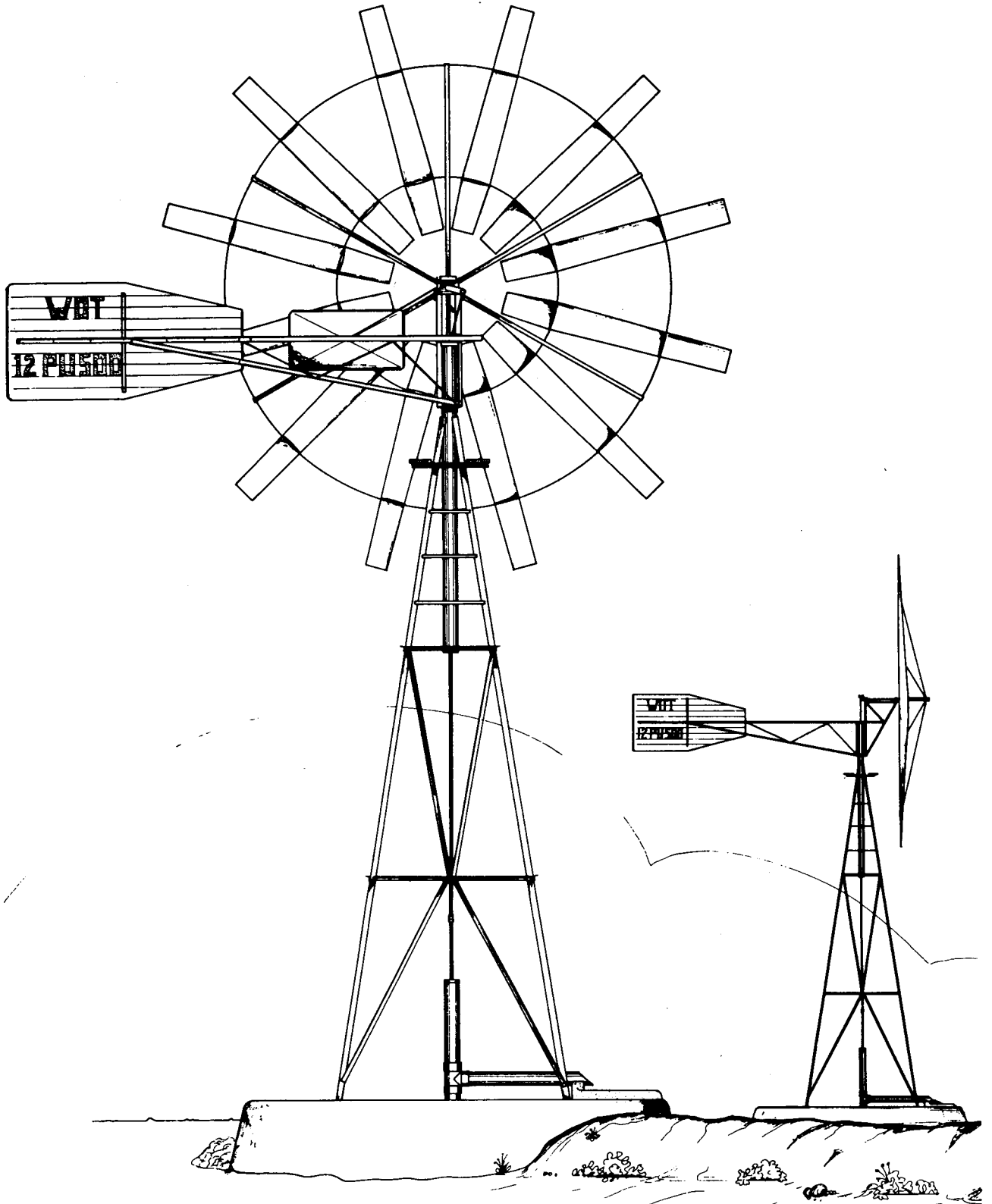
**WOT 12 PU 500 Windmill
Construction Project
Saighanchi Afghanistan**

Australian Council of Churches

let us consider the design, development and production of windmills. The windmills as produced in industrialised countries use high technology, requiring well-developed associated technologies to assist the design. Some of the complex blades used in certain windmills are actually the result of complicated computer programmes, complex materials and sophisticated presses to fashion the shapes. It would be inappropriate to introduce to a developing country a technology which is either static, or too advanced for manufacture in the country. In other words, a starting point has to be established which is compatible with technological skills available in the country at that particular time, so that as and when the country acquires high technology, a linkage can be readily created

whereby products or equipment are naturally and automatically improved through the use of that high technology. The drawings supplied in Figures 6.8 to 6.23 for the manufacture of windmills take into account that 'starting point', fully utilising available skills and technology, while leaving ample room for further development and improvement.

The windmill designated 12 PU 500 Windmill for Irrigation has been designed by Niek van de Ven for the Working Group on Development Technology (WOT), Twente University of Technology, Vrijhof 152, P.O. Box 217, 7500 AE ENSCHEDE, The Netherlands. Any technical assistance or further information needed will be gladly supplied by the Working Group on request.



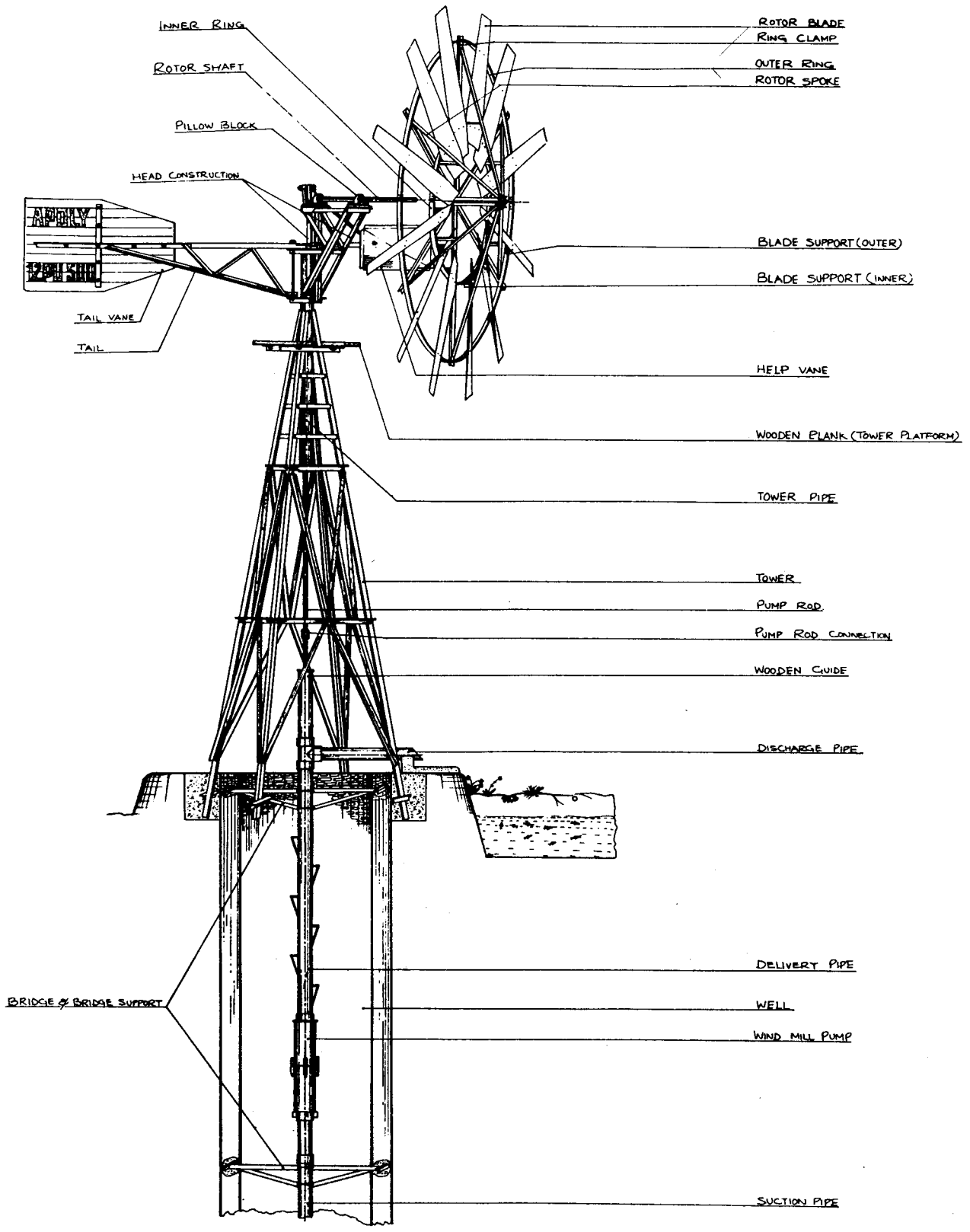
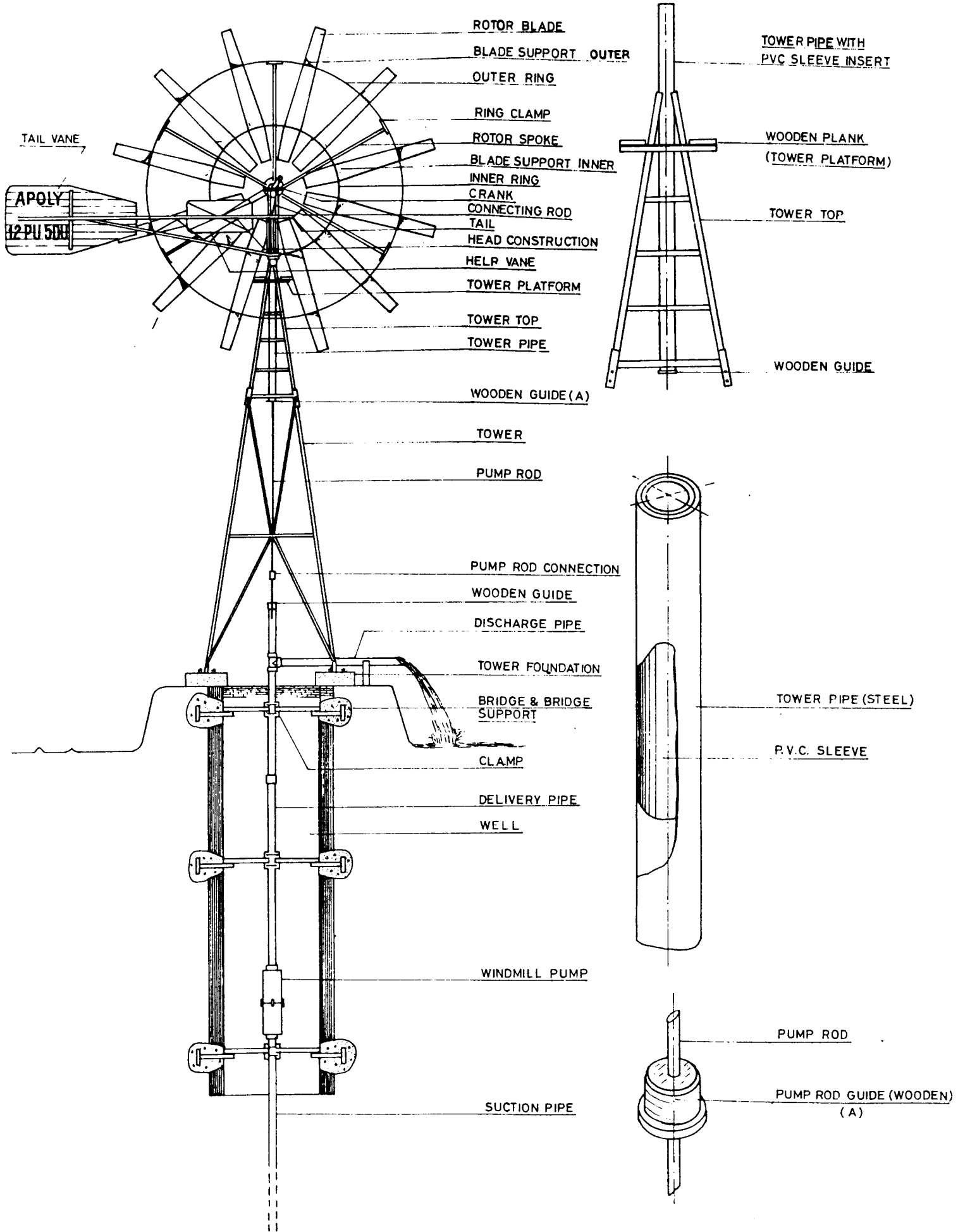
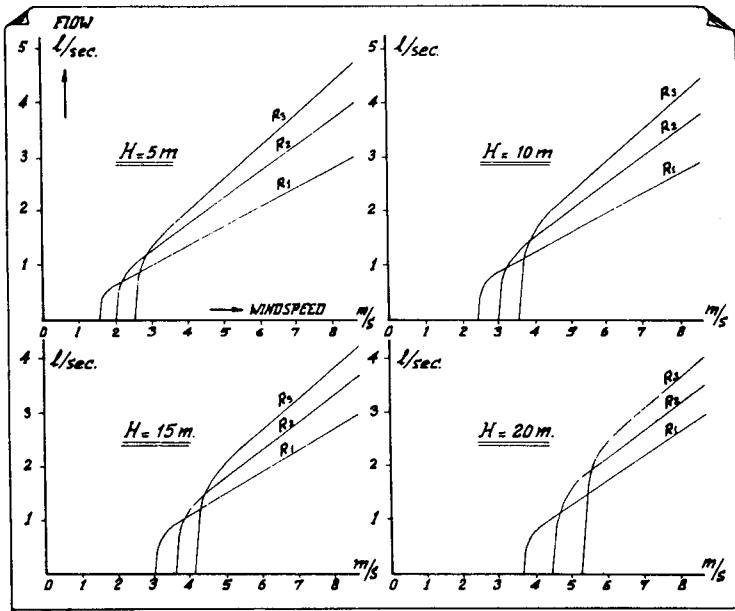


Fig. 5 12 P U 500 Water Pumping Windmill



Water output graphs

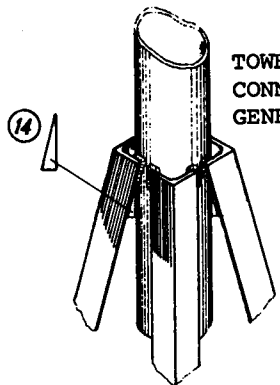


H = elevation head
 R₁ = 60 mm
 R₂ = 90 mm
 R₃ = 120 mm
 for 150 mm piston pump

Materials for a tower

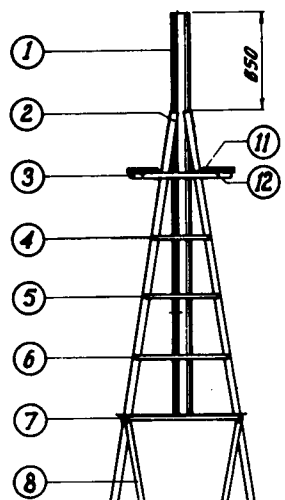
| No Number required | | Materials, particulars and measurements | | |
|--------------------|----|---|-------------------------|---------------|
| 1 | 1 | Tower pipe | 4" gaspipe | × 2650 |
| 2 | 4 | Angle iron | 40 × 40 × 5 (1½" × 1½") | × 6500 ÷ 7000 |
| 3 | 2 | " | 30 × 30 × 4 (1¼" × 1¼") | × 660 |
| 4 | 2 | Flat iron | 30 × 6 (1¼" × ¼") | × 360 |
| 5 | 2 | " | " | × 480 |
| 6 | 2 | " | " | × 600 |
| 7 | 4 | Angle iron | 30 × 30 × 4 (1¼" × 1¼") | × 750 |
| 8 | 16 | " | " | × 2000 |
| 9 | 4 | " | " | × 1350 |
| 10 | 4 | " | " | × scrap |
| 11 | 2 | Plank | 30 × 200 × 700 | |
| 12 | 4 | Bolt, nut, washers | M 8 (W ¾") | |
| 13 | 4 | Flat iron | 30 × 6 (1¼" × ¼") | × 460 |
| 14 | 8 | Flat scrap | | |

TOWERPIPE-TOWERLEG
CONNECTION BY
GENEROUS WELDING

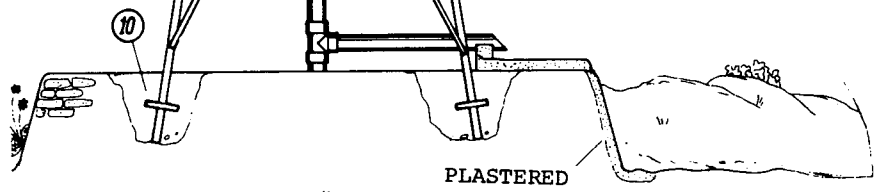
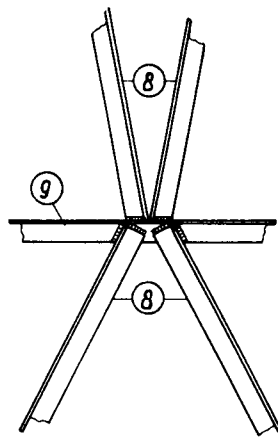
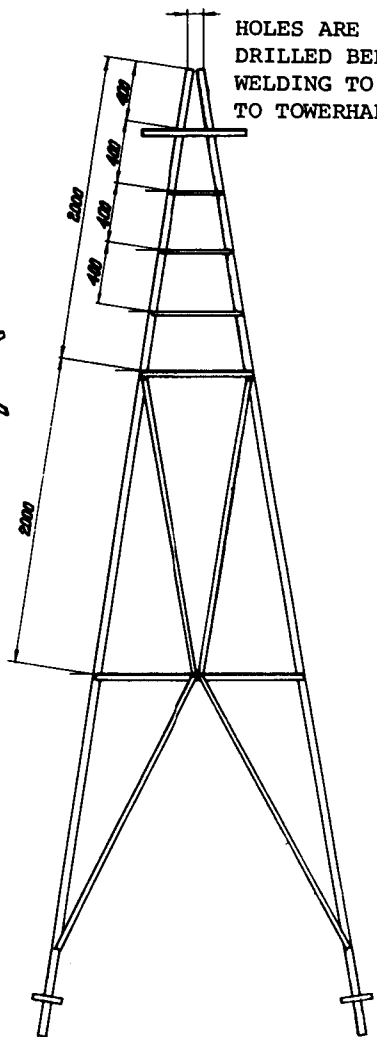
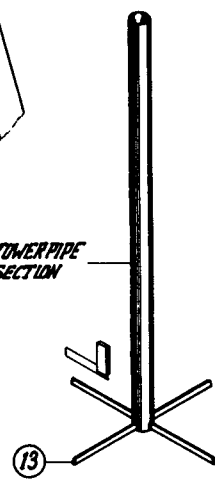


OUTSIDE DIA.
TOWERPIPE

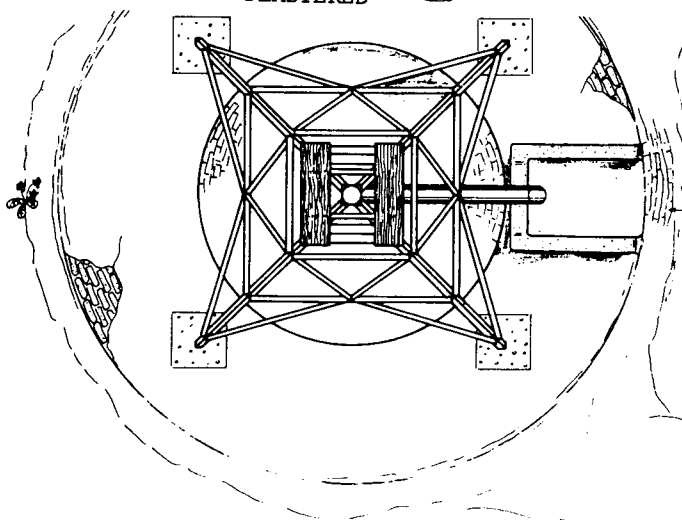
HOLES ARE
DRILLED BEFORE
WELDING TO ③
TO TOWERHALVES



TOWERPIPE
SECTION



FIRST TWO OF THESE TOWER-
HALVES ARE PREFABRICATED
BOTH HALVES ARE COMPOSED
& THE TOWERPIPE SECTION
IS SHIFTED IN AND A
COMPLETE TOWER RESULTS

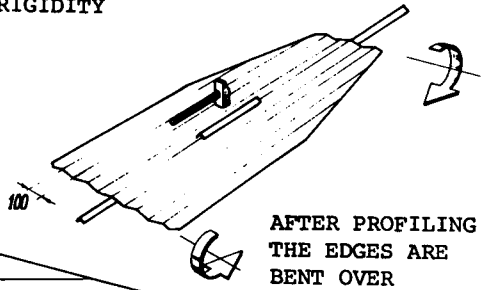
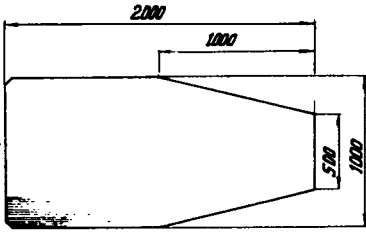


THIS SIDE IS PLASTERED

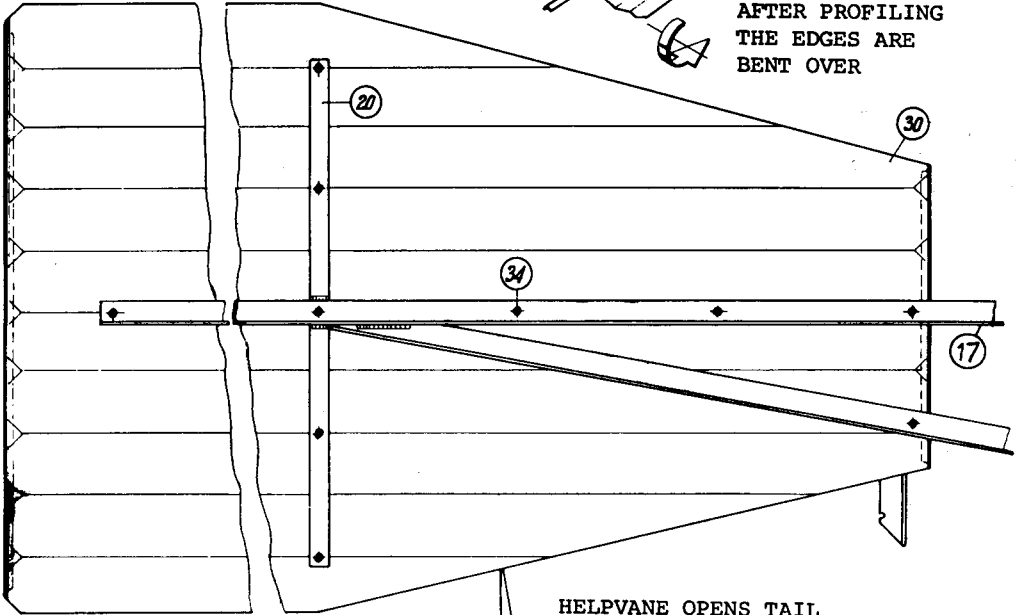
Head Construction

| No | Number required | Materials, particulars and measurements | | |
|----|-----------------|---|--|------------------------------|
| 1 | 2 | Angle iron | $50 \times 50 \times 5$ (2" \times 2") | Length 220 |
| 2 | 1 | " | $40 \times 40 \times 4$ (1½" \times 1½") | 500 |
| 3 | 2 | " | " | 1080 |
| 4 | 2 | " | " | 460 |
| 5 | 2 | " | " | 1000 |
| 6 | 2 | " | " | 550 |
| 7 | 4 | " | " | tower pipe dia. |
| 8 | 1 | " | " | Length 180 |
| 9 | 1 | " | " | 45 |
| 10 | 1 | " | " | 1000 |
| 11 | 1 | " | " | 580 |
| 12 | 1 | " | " | 200 |
| 13 | 1 | " | " | 280 |
| 14 | 1 | " | " | 60 |
| 15 | 1 | " | " | 120 |
| 16 | 1 | " | " | 1500 |
| 17 | 1 | " | " | 4000 |
| 18 | 1 | " | " | 3000 |
| 19 | 3 | Flat iron | 30×6 (1¼" \times ¼") | Length 750 |
| 20 | 1 | " | " | 830 |
| 21 | 5 | " | " | 80 |
| 22 | 1 | " | " | 360 |
| 23 | 1 | " | " | 900 |
| 24 | 1 | " | " | 115 |
| 25 | 1 | " | " | 130 |
| 26 | 2 | " | " | 40 |
| 27 | 1 | " | " | 100 |
| 28 | 2 | Spring | Appr. $\phi 30 \times 1000 \times \phi 4$ | |
| 29 | 1 | Helpvane | 1 mm sheet | 1000 \times 500 |
| 30 | 1 | Tailvane | 1 mm sheet | 2000 \times 1000 |
| 31 | 3 | Washer | $\phi 18$ inside | |
| 32 | 1 | Rod | $\phi 18 \times 650$ | ($\phi 3/4"$ \times 2'2") |
| 33 | 1 | Split pin | $\phi 6$ | ($\phi 1/4"$) |
| 34 | 12 | Bolt, nut, washer | M 6 \times 25 | (W ¼" \times 1") |
| 35 | 1 | " | M 12 \times 100 | (W ½" \times 4") |
| 36 | 1 | " | M 10 \times 150 | (W ¾" \times 6") |
| 37 | 2 | " | M 12 \times 40 | (W ½" \times 1½") |

HAMMERING PROFILES INTO
THE VANE SHEET INCREASES
RIGIDITY



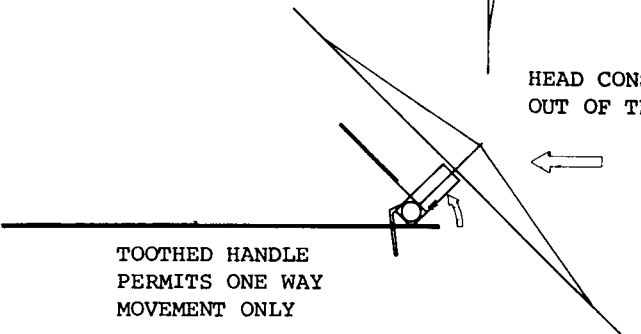
AFTER PROFILING
THE EDGES ARE
BENT OVER



HELPEVANE OPENS TAIL
LOCKS DUE TO HIGH WIND PRESSURE



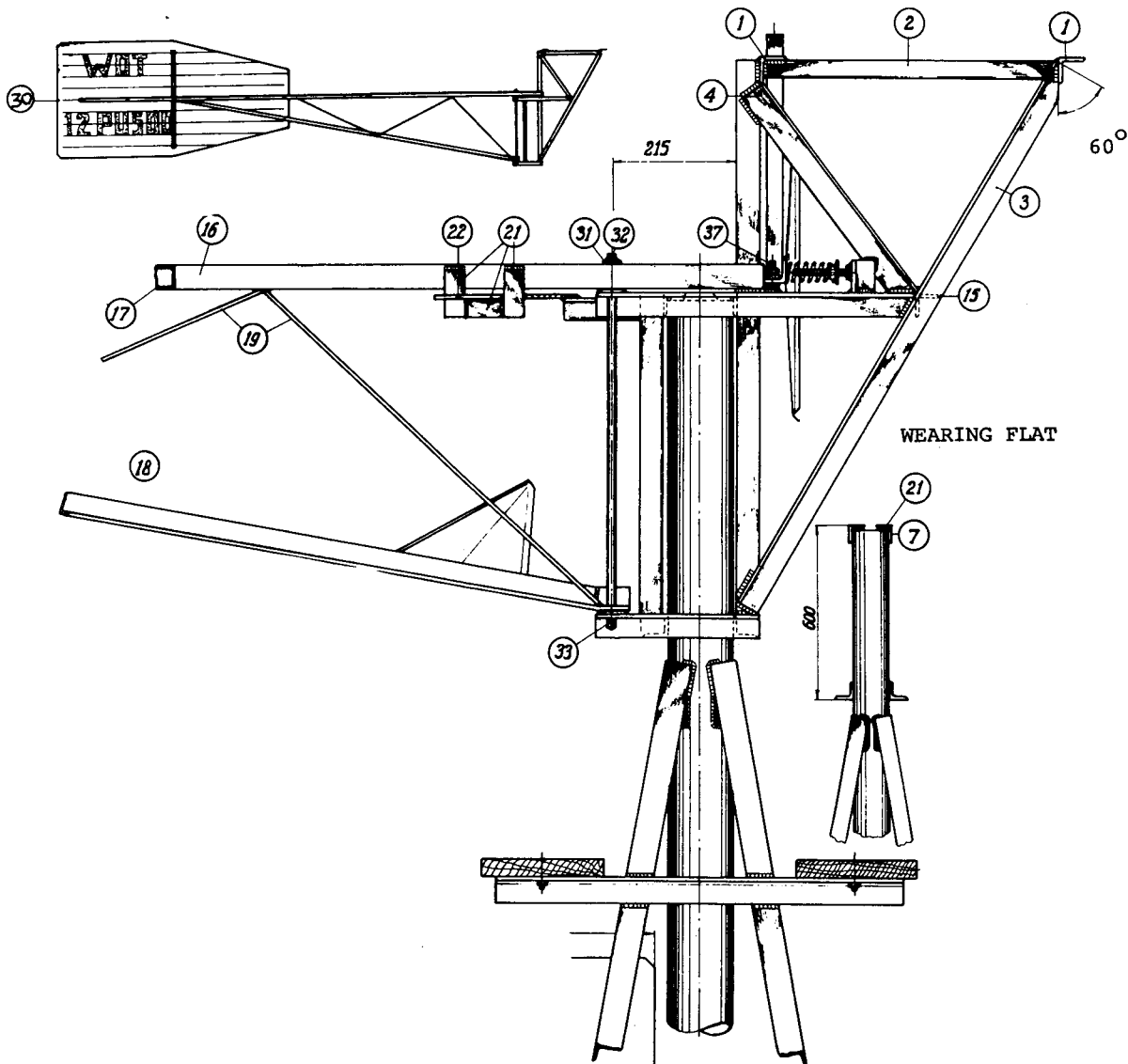
HEAD CONSTRUCTION TURNS BACKWARDS
OUT OF THE WIND

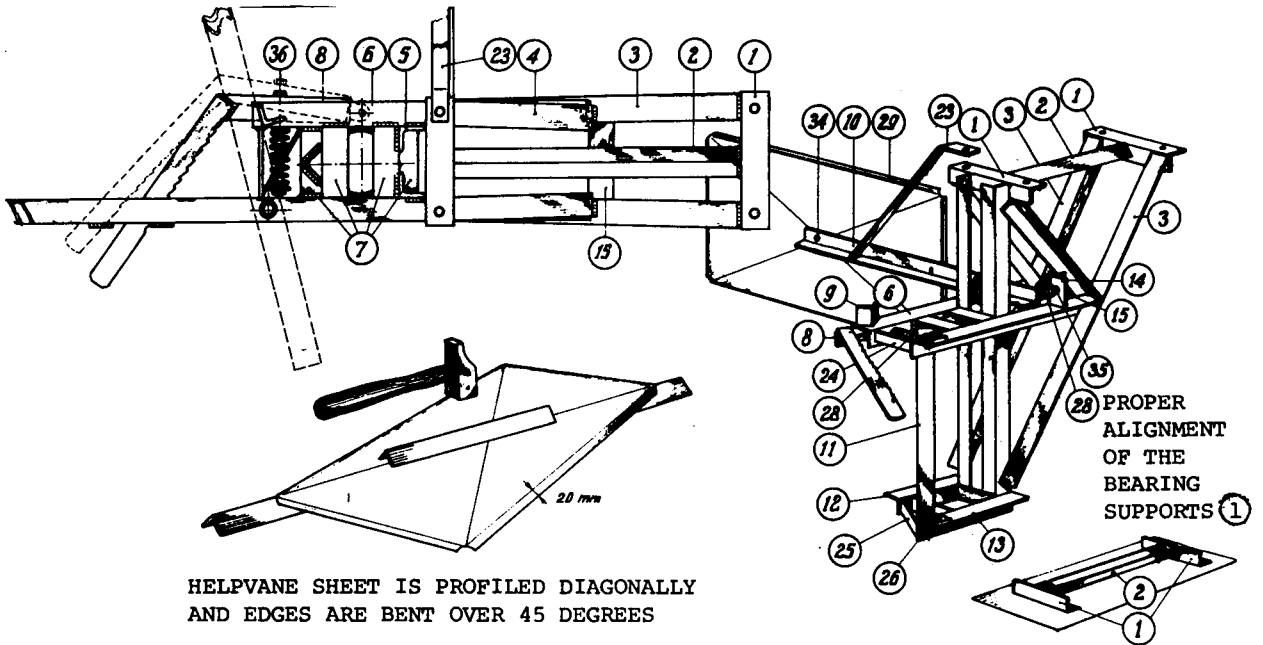


TOOTHED HANDLE
PERMITS ONE WAY
MOVEMENT ONLY

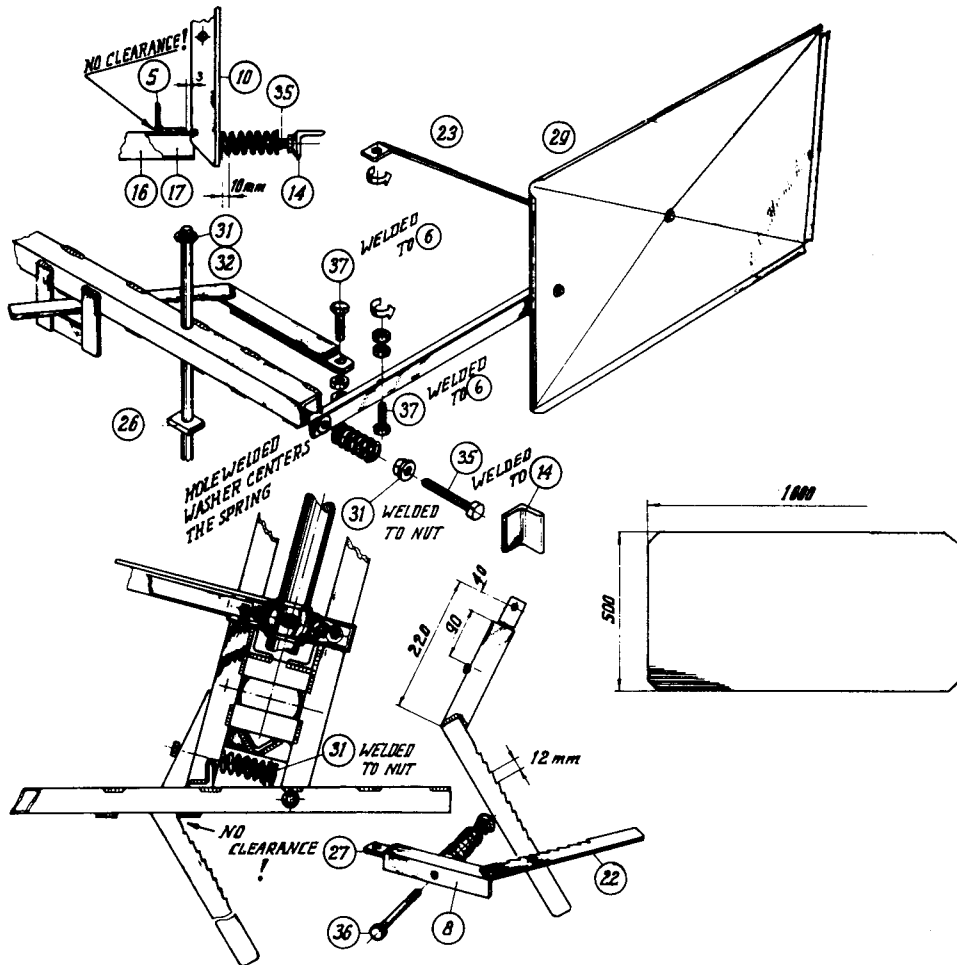
IMPACT IS TAKEN BY
LIMIT-STOP ANGLE ⑨

LOCK MECHANISM KEEPS WINDMILL IN
SECURED POSITION (75° OUT OF THE WIND)





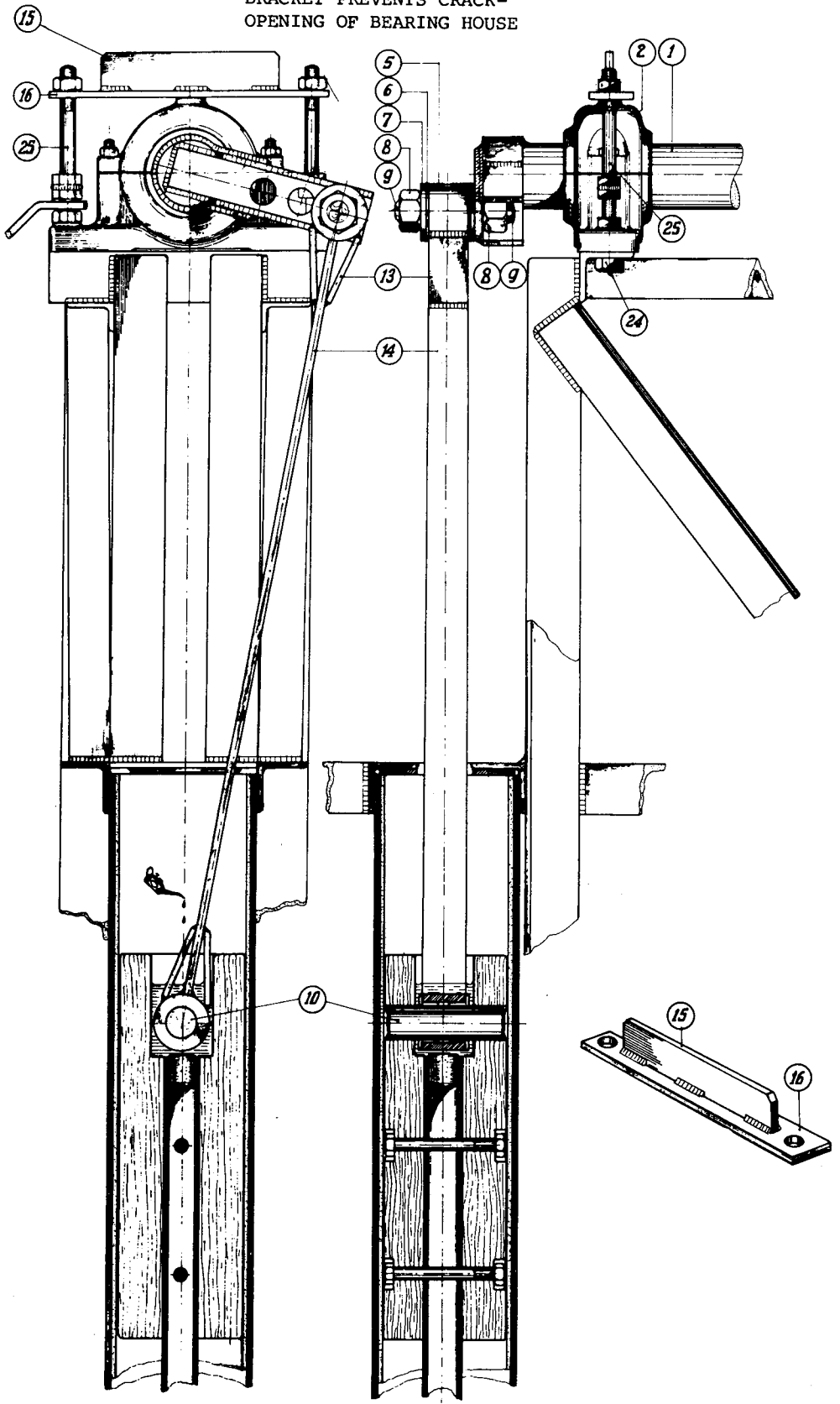
HELPPVANE SHEET IS PROFILED DIAGONALLY
AND EDGES ARE BENT OVER 45 DEGREES

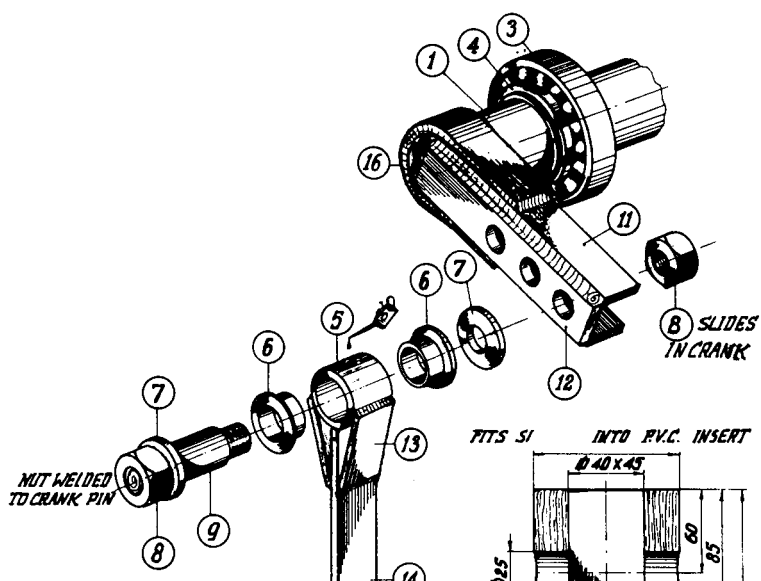


Moving parts

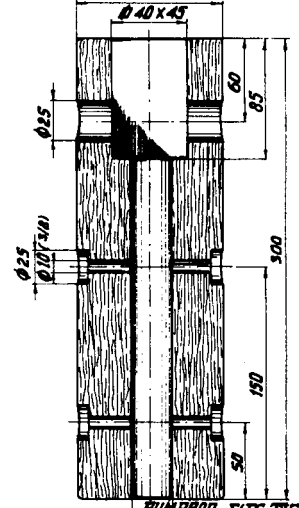
| No | Number required | Materials, particulars and measurements | |
|----|-----------------|--|---|
| 1 | 1 | Shaft | $\phi 50 (\phi 2") \times 1250$ |
| 2 | 2 | Bearing housing | |
| 3 | 2 | Ball bearing (best quality) | |
| 4 | 2 | Bearing bush (best quality) | |
| 5 | 2 | Bearing housing | |
| 6 | 4 | Nylon bearing bush | $\phi 1\frac{1}{2}"$ nylon rod |
| 7 | 2 | Washer | |
| 8 | 3 | Nut M 20 (W $\frac{3}{4}"$) | |
| 9 | 1 | Crank pin $\phi 25 (\phi 1")$ | |
| 10 | 1 | Cross pin $\phi 25 (\phi 1")$ remove sharp edges | |
| 11 | 2 | Flat iron $30 \times 6 (1\frac{1}{4}" \times \frac{1}{4}"$) | Length 120 |
| 12 | 1 | „ | 150 |
| 13 | 4 | „ | 50 |
| 14 | 1 | „ | 600 |
| 15 | 1 | „ | 140 |
| 16 | 2 | „ | 220 |
| 17 | 1 | Cross head | Sesam wood soaked in oil |
| 18 | 1 | Cork | |
| 19 | 1 | Pump rod | Gaspipes $\phi \frac{3}{4}" \times 4700$ |
| 20 | 1 | PVC insert | $\phi 100 \times 700$ |
| 21 | 1 | Thread, stud | M 24 \times 75 (W $\frac{7}{8}" \times 4"$) |
| 22 | 2 | Bolt, nut, washers | M 6 \times 25 (W $\frac{1}{4}" \times 1"$) |
| 23 | 1 | „ | M 10 \times 100 (W $\frac{3}{8}" \times 4"$) |
| 24 | 4 | „ | M 12 \times 50 (W $\frac{1}{2}" \times 2"$) |
| 25 | 2 | „ | M 12 \times 80 (W $\frac{1}{2}" \times 3"$) |
| 26 | 1 | Pump rod guide | Sesam wood soaked in oil |

BRACKET PREVENTS CRACK-
OPENING OF BEARING HOUSE

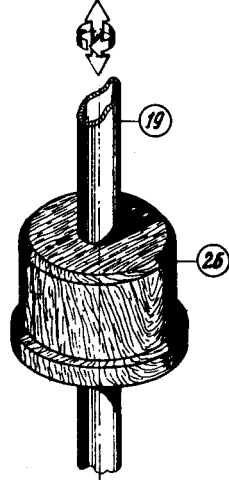
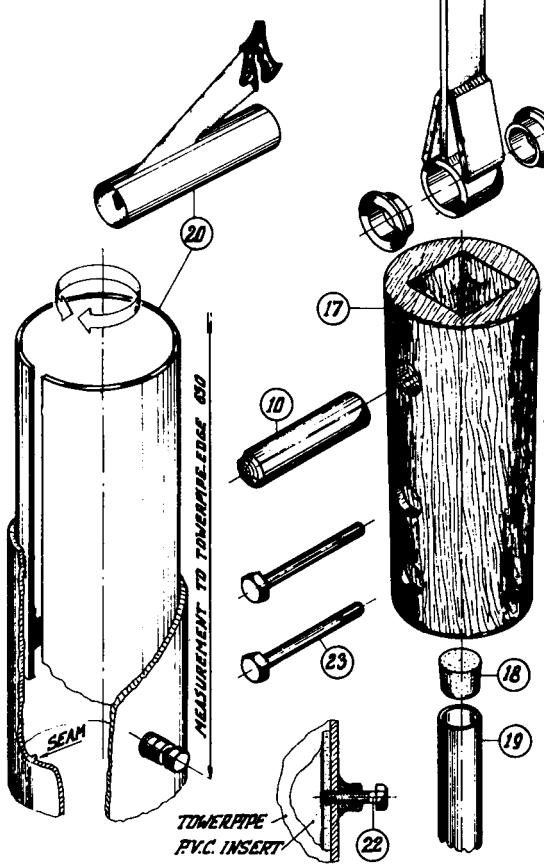
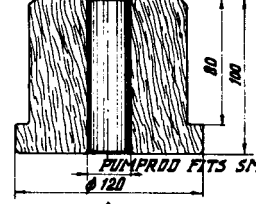


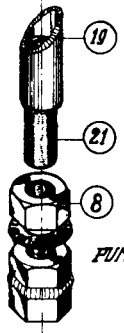
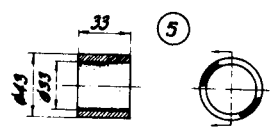
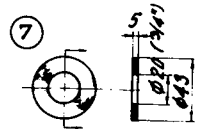
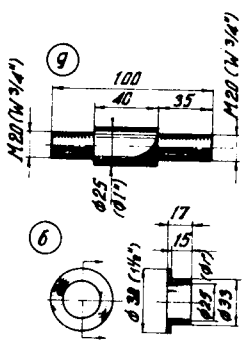
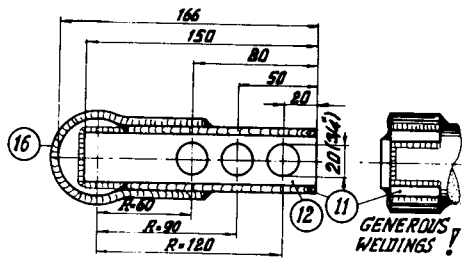
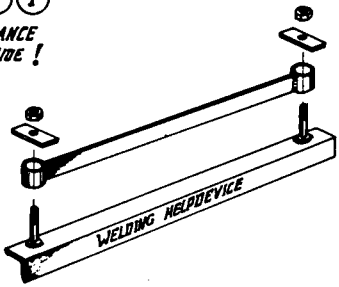
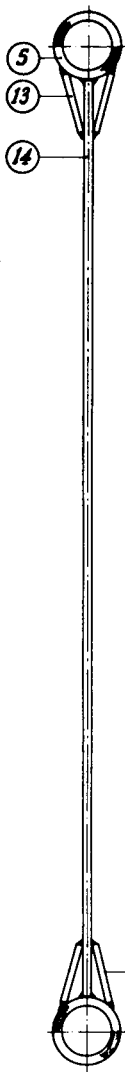
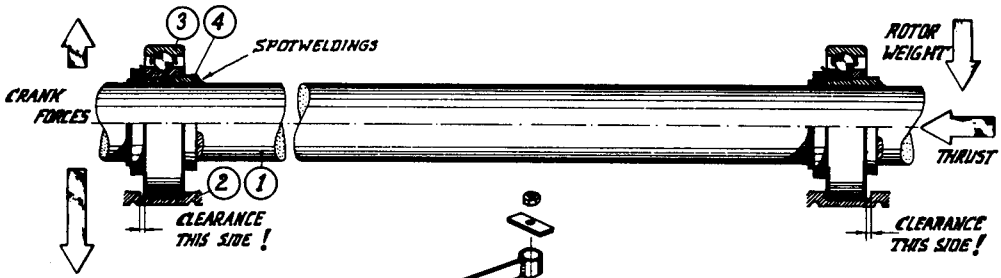


FITS SI INTO P.V.C. INSERT



FITS BY HAMMERING INTO BOTTOM END OF TOWER PIPE





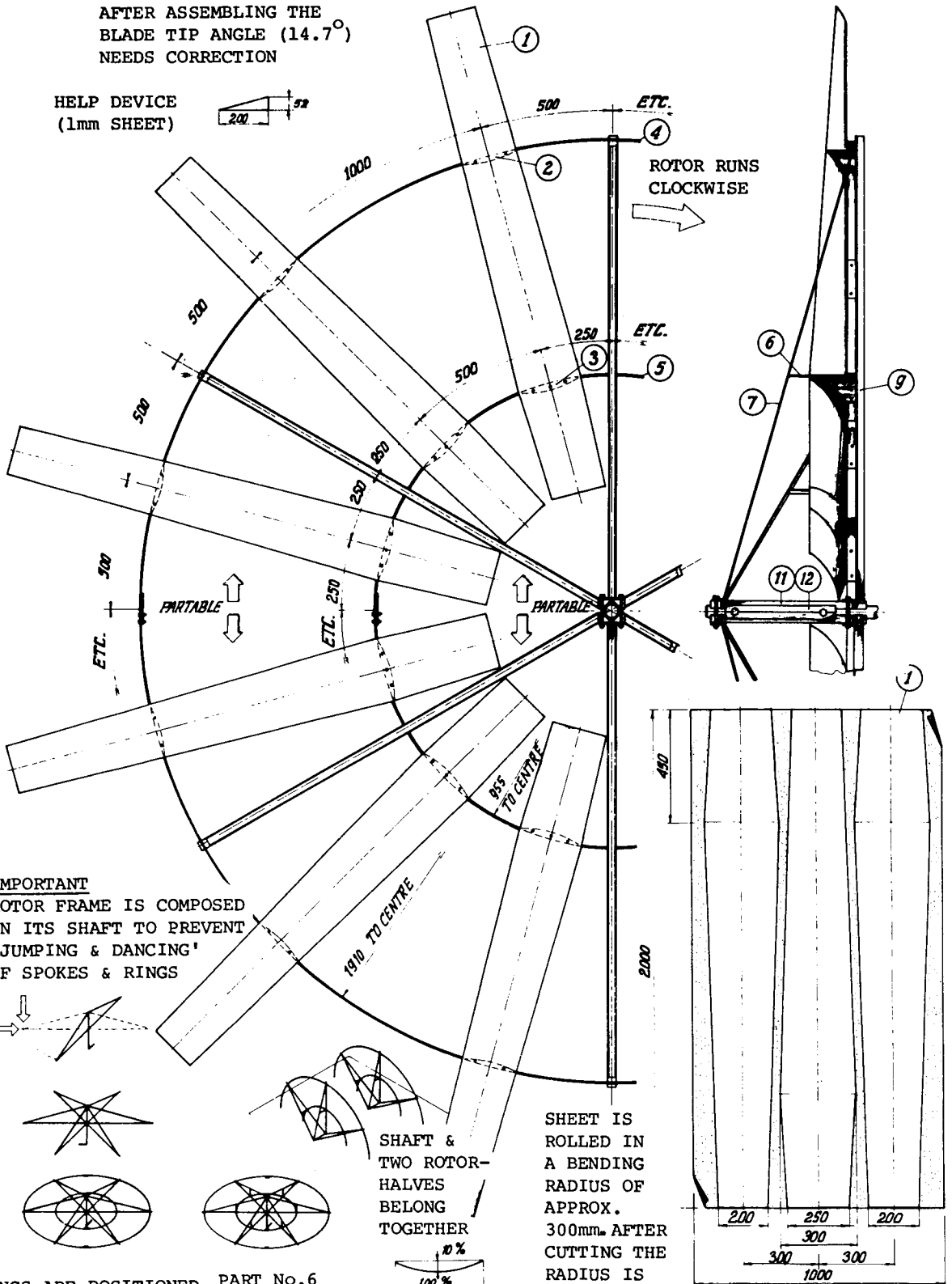
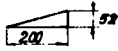
PUMP ROD CONNECTION

Rotor

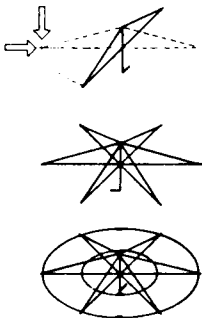
| No | Number required | Materials, particulars and measurements | | |
|----|-----------------|---|-----------------------------------|----------|
| 1 | 12 | Blade | 4 standard sheets 1000 × 2000 × 1 | |
| 2 | 12 | Blade support | 2 mm sheet | |
| 3 | 12 | „ | „ | |
| 4 | 1 | Flat iron | 30 × 6 (1¼" × ¼") | 2 × 6000 |
| 5 | 1 | „ | „ | 2 × 3000 |
| 6 | 6 | „ | „ | × 250 |
| 7 | 6 | „ | „ | × 1900 |
| 8 | 4 | „ | „ | × 120 |
| 9 | 6 | Angle iron | 40 × 40 × 4 (1½" × 1½") | × 1900 |
| 10 | 4 | „ | „ | × 100 |
| 11 | 2 | „ | „ | × 625 |
| 12 | 2 | „ | „ | × 350 |
| 13 | 2 | Bolt, nut, washer | M 12 × 125 (W ½" × 5") | |
| 14 | 4 | „ | M 12 × 100 (W ½" × 4") | |
| 15 | 120 | „ | M 6 × 20 (W ¼" × ¾") | |

AFTER ASSEMBLING THE
BLADE TIP ANGLE (14.7°)
NEEDS CORRECTION

HELP DEVICE
(1mm SHEET)

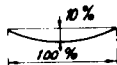


IMPORTANT
ROTOR FRAME IS COMPOSED
ON ITS SHAFT TO PREVENT
'JUMPING & DANCING'
OF SPOKES & RINGS

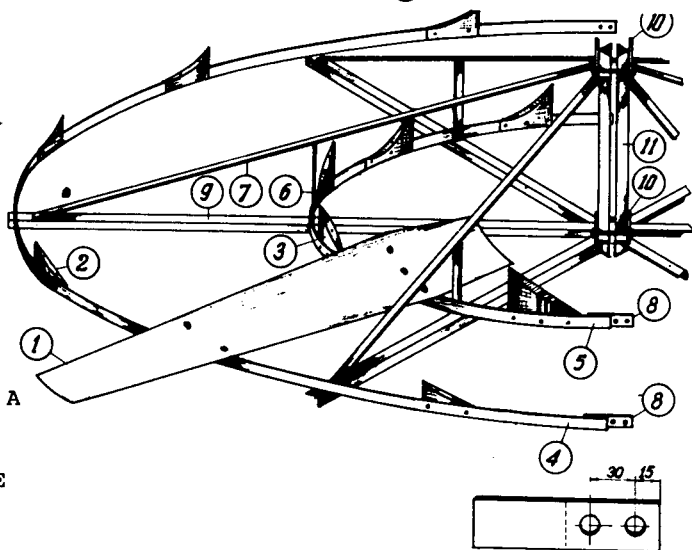
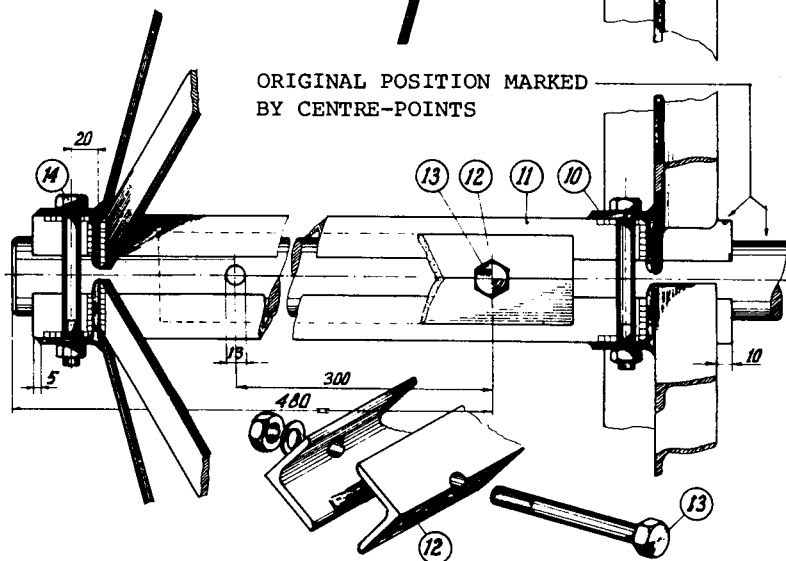
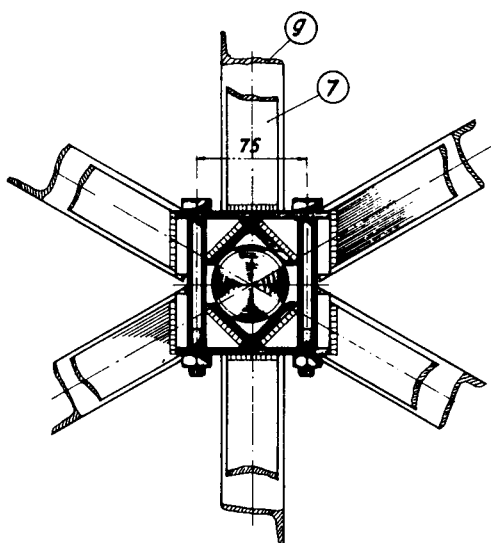
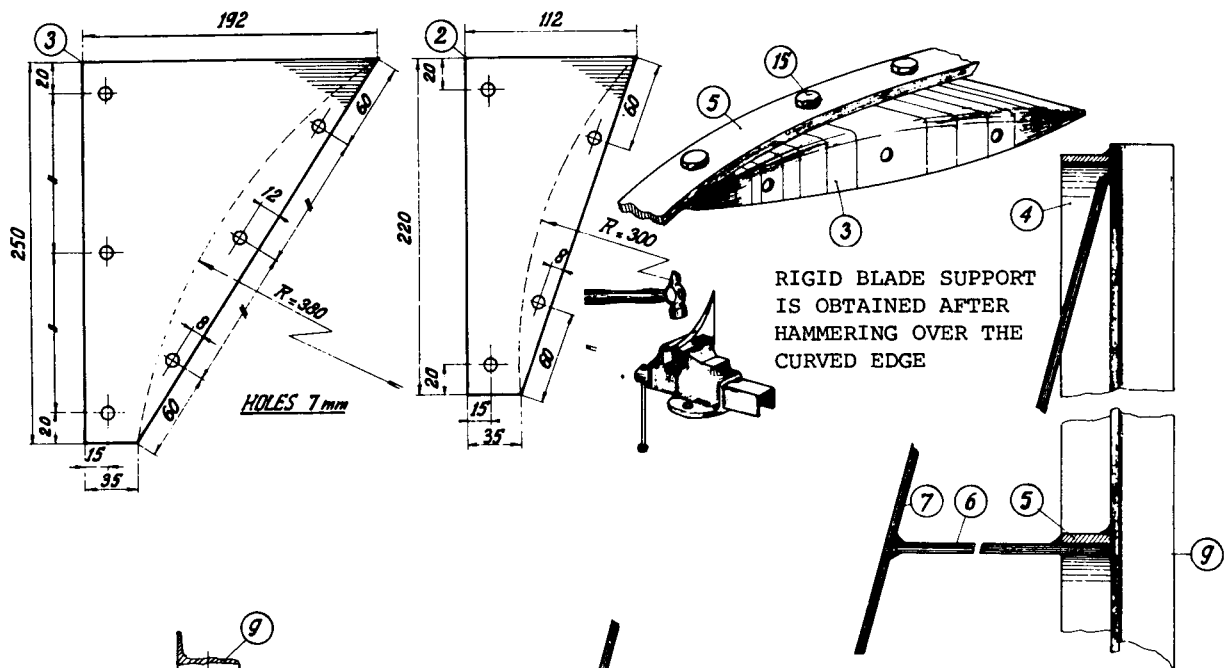


RINGS ARE POSITIONED, PART No. 6
CENTRED AND WELDED IS WELDED

SHAFT &
TWO ROTOR-
HALVES
BELONG
TOGETHER



SHEET IS
ROLLED IN
A BENDING
RADIUS OF
APPROX.
300mm. AFTER
CUTTING THE
RADIUS IS
CORRECTED SO
THAT 10% CURVED
AIRFOILS WILL
RESULT

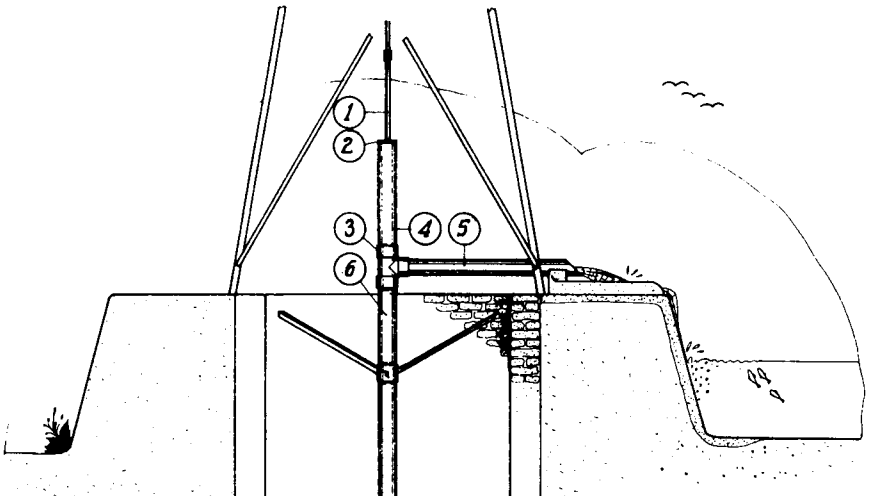


ONE OF THE BLADES IS MOUNTED ON A WELL POSITIONED SET OF SUPPORTS (AVERAGE MEASUREMENTS) AND IS USED AS A DRILLING MOULD FOR THE OTHER 11 BLADES

Piston pump

| No | Number required | Materials, particulars and measurements |
|----|-----------------|---|
| 1 | * | Pump rod extension $\phi 3/4"$ gaspipe * |
| 2 | 1 | Wooden pump rod guide: 26 in Fig. 6.14 |
| 3 | 1 | T-socket 4" gaspipe Length 750 |
| 4 | 1 | Delivery pipe " |
| 5 | 1 | " 4" gaspipe or PVC pipe * |
| 6 | * | " " |
| 7 | 1 | PVC pipe $\phi 4" \times 700$ |
| 8 | 1 | Gaspipe (threaded) $\phi 4" \times 800$ |
| 9 | * | Steel socket G 4" |
| 10 | 1 | PVC end cap |
| 11 | 2 | Flange (blind): four 12 mm holes at 190 mm pitch |
| 12 | 1 | PVC pipe $\phi 150 (\phi 6") \times 1250$ |
| 13 | 1 | " " $\times 740$ |
| 14 | 1 | Piston teakwood |
| 15 | 1 | PVC socket |
| 16 | 1 | Foot valve teakwood |
| 17 | 3 | Flat iron $25 \times 5 (1" \times 1/4")$ |
| 18 | * | " $30 \times 6 (1 1/4" \times 1/4")$ |
| 19 | * | Angle iron $40 \times 40 \times 4 (1 1/2" \times 1 1/2")$ * |
| 20 | 2 | Sole-leather valve $\phi 150 \times$ at least 6 mm |
| 21 | 4 | " packing $\phi 140 \times \phi 200 \times 4$ |
| 22 | 1 | Steel bush |
| 23 | 1 | Nylon bearing bush |
| 24 | * | Pump rod gaspipe $\phi 3/4" \times 1300$ |
| 25 | * | Thread stud M 24 (W $7/8"$) $\times 75$ |
| 26 | * | " " $\times 150$ |
| 27 | * | Nut |
| 28 | * | Spring washer |
| 29 | 4 | Rod $\phi 12 (\phi 1/2") \times 2100$ |
| 30 | 1 | Bolt, nut, washer M 12 (W $1/2"$) $\times 150$ |
| 31 | * | " " $\times 30$ |
| 32 | 1 | Bicycle tube valve (apply rubber washers) |
| 33 | 1 | Distancer steel $\phi 50 \times 50 (\phi 2" \times 2")$ |

* Amount and size depend upon total elevation head



EXISTING BRICK WELL

'UMBRELLA' STRUCTURE CENTRES DELIVERY PIPE (ANGLES ARE APPROX. 10% LONGER THAN THE RADIUS OF WELL)

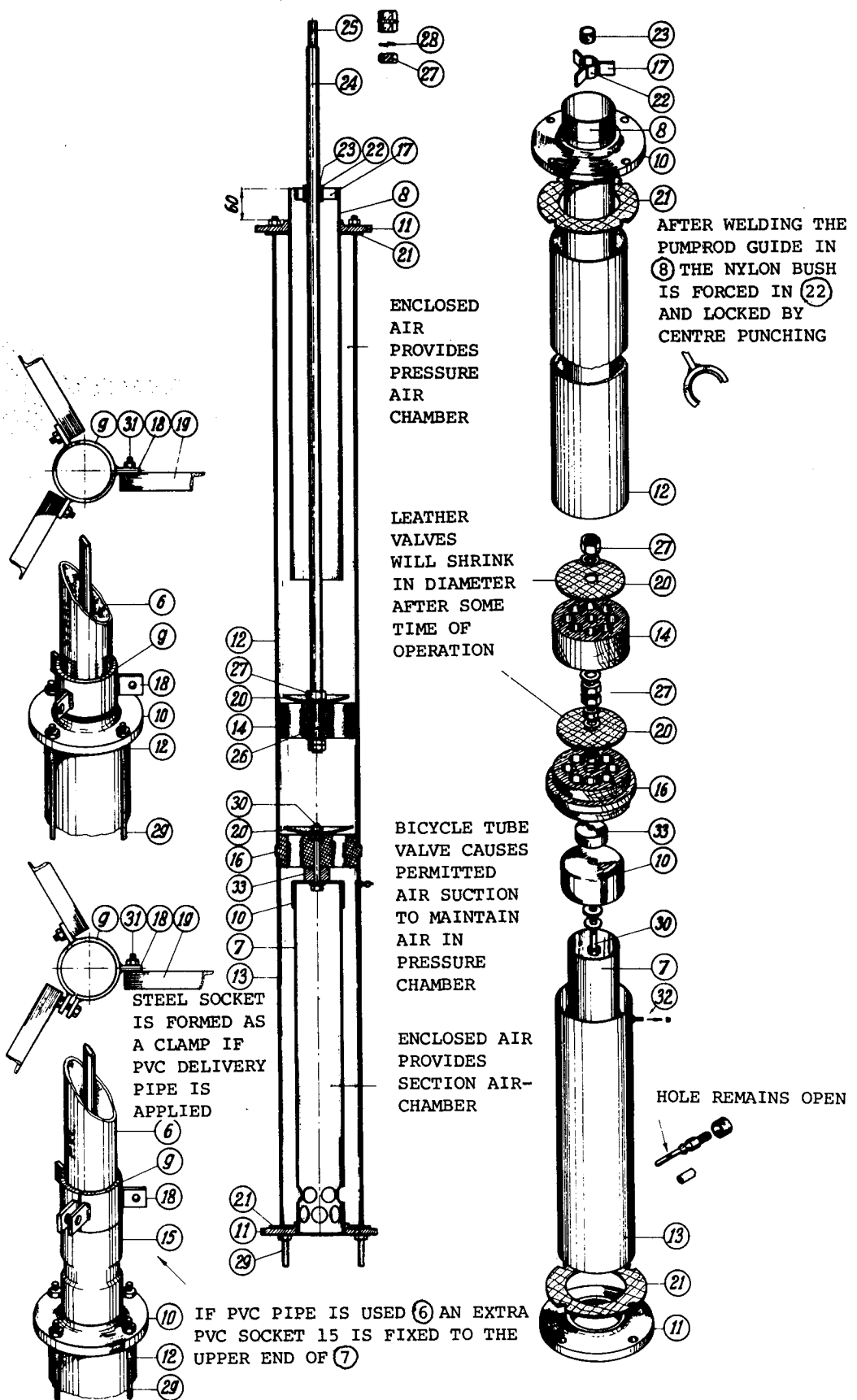
PRESSURE SECTION

SUCTION SECTION

4" TUBEWELL INCREASES WELL CAPACITY (MIN. APPROX. 30M³/H)

TO AQUIFER





ENCLOSED AIR PROVIDES PRESSURE AIR CHAMBER

LEATHER VALVES WILL SHRINK IN DIAMETER AFTER SOME TIME OF OPERATION

BICYCLE TUBE VALVE CAUSES PERMITTED AIR SUCTION TO MAINTAIN AIR IN PRESSURE CHAMBER

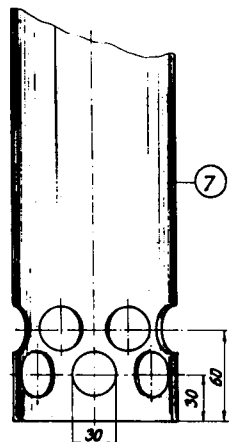
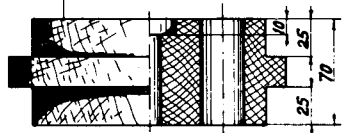
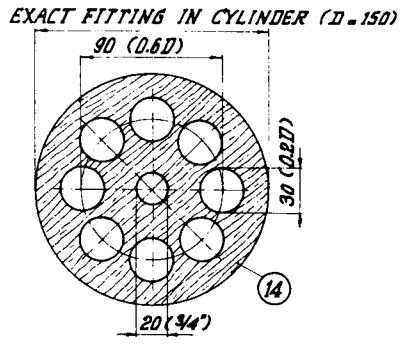
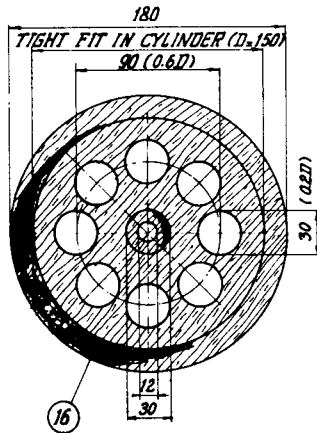
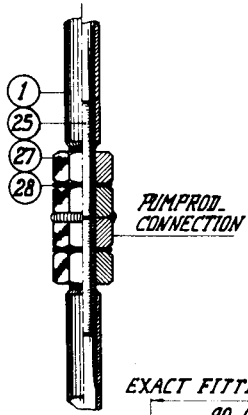
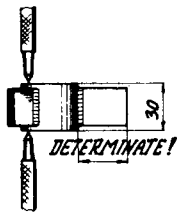
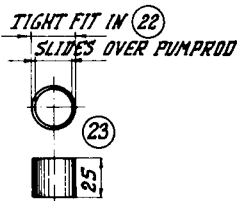
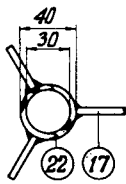
ENCLOSED AIR PROVIDES SECTION AIR-CHAMBER

AFTER WELDING THE PUMPROD GUIDE IN (8) THE NYLON BUSH IS FORCED IN (22) AND LOCKED BY CENTRE PUNCHING

STEEL SOCKET IS FORMED AS A CLAMP IF PVC DELIVERY PIPE IS APPLIED

IF PVC PIPE IS USED (6) AN EXTRA PVC SOCKET 15 IS FIXED TO THE UPPER END OF (7)

HOLE REMAINS OPEN



TWO ROWS OF 6 HOLES FOR WATER ENTRANCE.

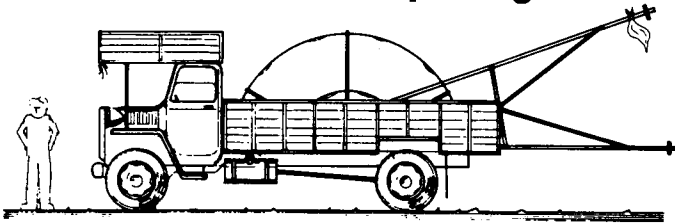
AFTER SOAKING THE WOOD IN WATER FOR AT LEAST ONE WEEK, THE PISTON IS MACHINED TO A PERFECT SLIDING FIT.

THE SEALINGLESS PERFORMANCE DECREASES STARTING TORQUE REQUIRED DUE TO ACCEPTABLE LEAKAGE SO THE WINDMILL BEGINS TO MOVE AT LOW WIND SPEEDS

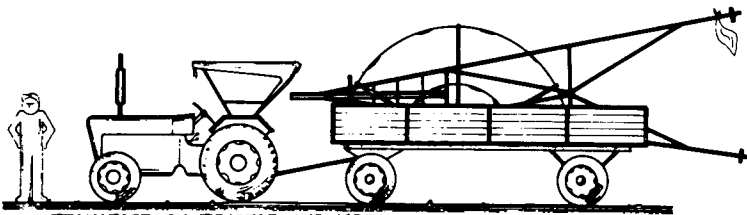
Installing the windmill

| No | Number required | Materials, particulars and measurements |
|----|-----------------|---|
| 1 | 1 | Pulley shaft and rope or steel cable (30 M) |
| 2 | 1 | Gaspipe $\phi 3'' \times 4500$ |
| 3 | 2 | Angle iron $40 \times 40 \times 4 (1\frac{1}{2}'' \times 1\frac{1}{2}'')$ $\times 2000$ |
| 4 | 3 | „ „ $\times 750$ |
| 5 | 1 | „ „ $\times 800$ |
| 6 | 1 | „ „ $\times 200$ |
| 7 | 1 | „ „ $\times 550$ |
| 8 | 3 | Flat iron $30 \times 6 (1\frac{1}{4}'' \times \frac{1}{4}'')$ $\times 200$ |
| 9 | 1 | „ „ $\hat{=}$ tower pipe dia. |
| 10 | 1 | „ „ $30 \times 6 (1\frac{1}{4}'' \times \frac{1}{4}'')$ $\times 100$ |
| 11 | 1 | Rod $\phi 10 (\phi \frac{3}{8}'')$ $\times 200$ |
| 12 | 2 | Bolt, nut, washer M 12 $\times 50$ (W $\frac{1}{2}'' \times 2''$) |
| 13 | 1 | „ M 12 $\times 150$ (W $\frac{1}{2}'' \times 6''$) |
| 14 | 2 | „ M 12 $\times 75$ (W $\frac{1}{2}'' \times 3''$) |

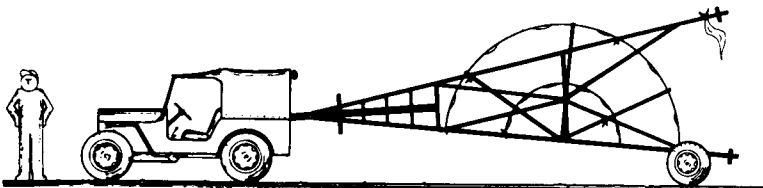
Three methods of transporting the windmill



TRANSPORT BY TRUCK

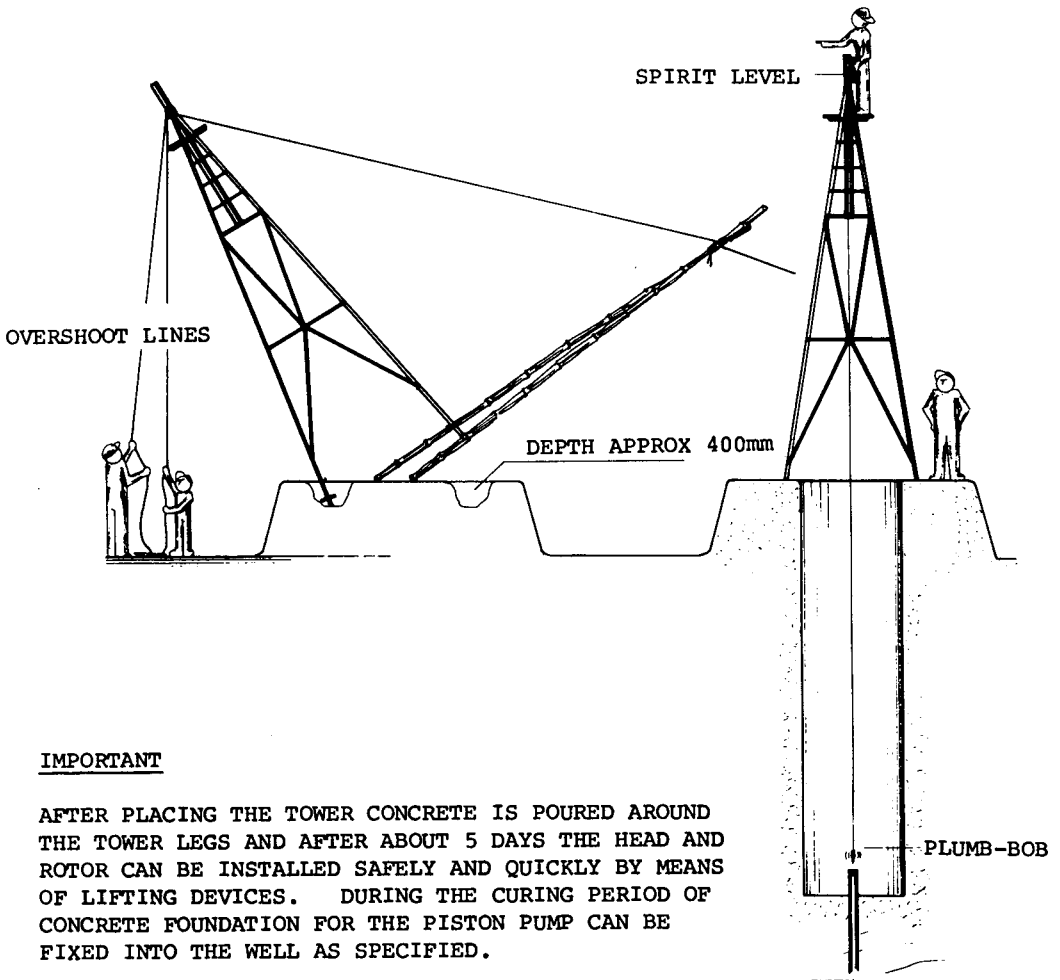
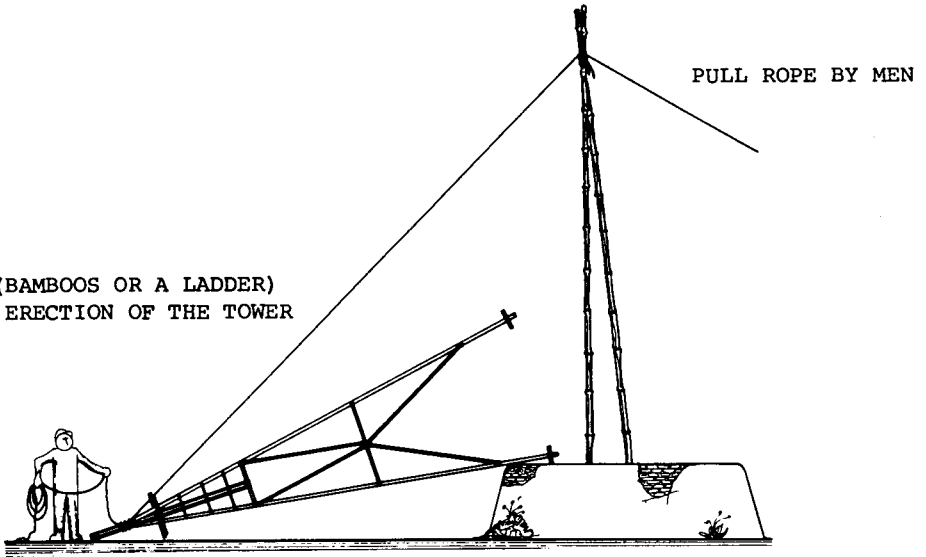


TRANSPORT BY TRACTOR AND LORRY



TRANSPORT BY JEEP AND ROLLING HELPDEVICE

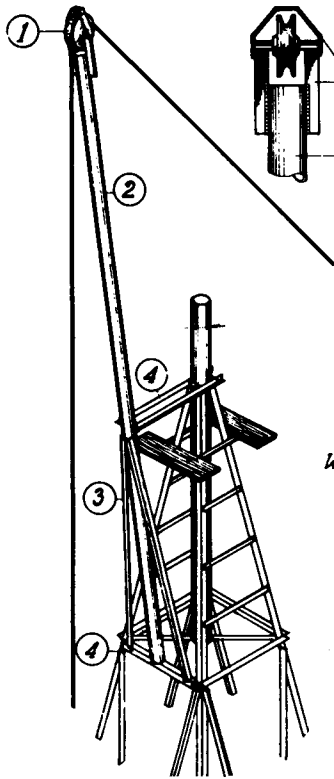
TWO POLES (BAMBOOS OR A LADDER)
FACILITATE ERECTION OF THE TOWER



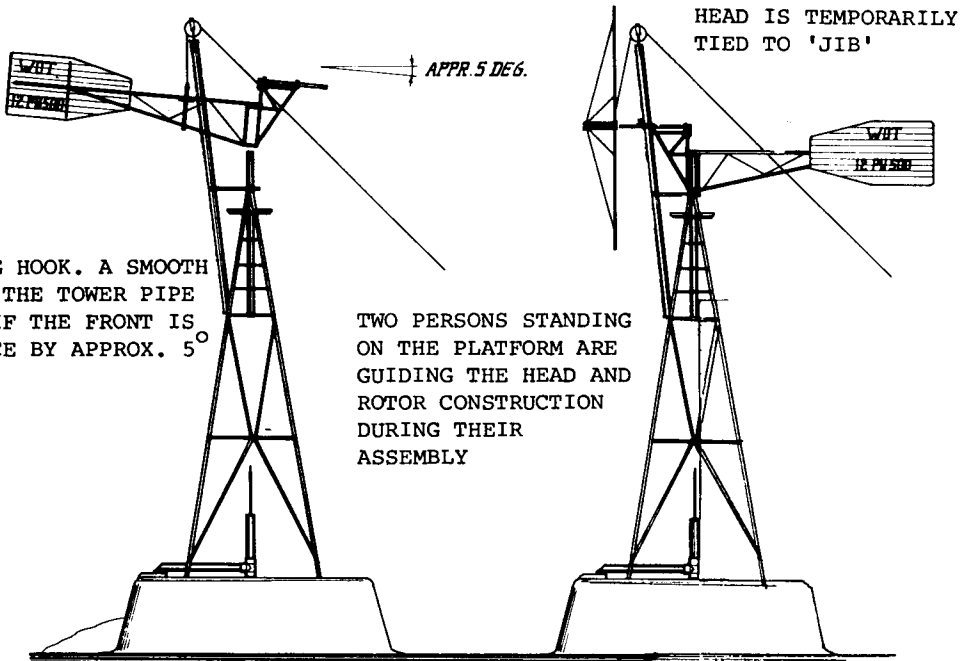
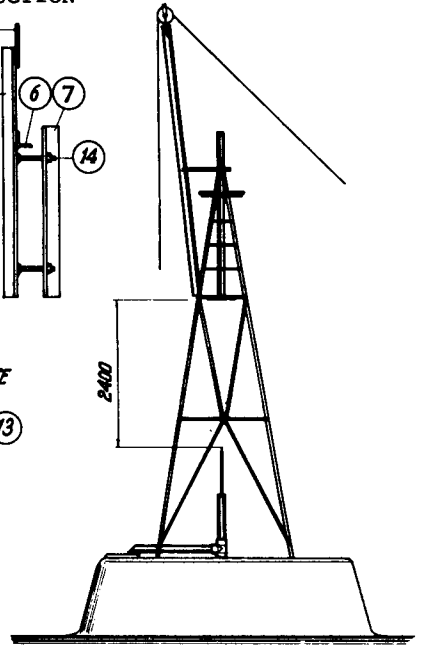
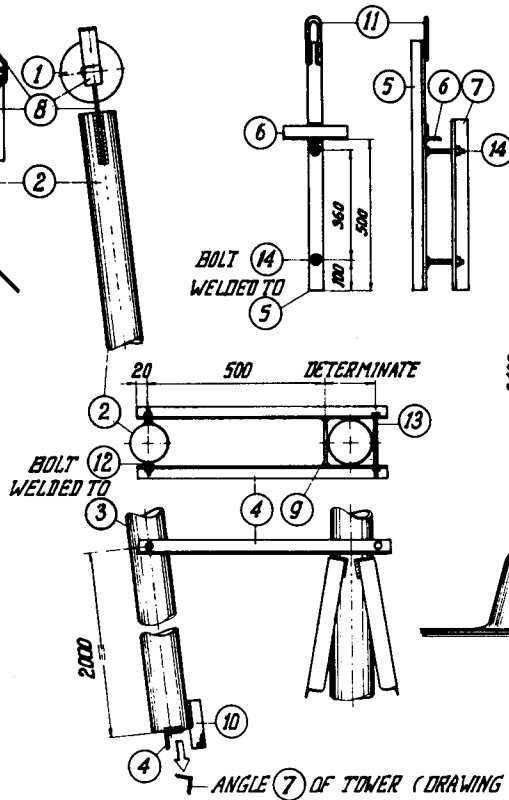
IMPORTANT

AFTER PLACING THE TOWER CONCRETE IS POURED AROUND THE TOWER LEGS AND AFTER ABOUT 5 DAYS THE HEAD AND ROTOR CAN BE INSTALLED SAFELY AND QUICKLY BY MEANS OF LIFTING DEVICES. DURING THE CURING PERIOD OF CONCRETE FOUNDATION FOR THE PISTON PUMP CAN BE FIXED INTO THE WELL AS SPECIFIED.

'JIB' LIFTING HELP-VANE



LIFTING HOOK FOR HEAD CONSTRUCTION



USE A LIFTING HOOK. A SMOOTH SLIDING OVER THE TOWER PIPE IS ACHIEVED IF THE FRONT IS OUT OF BALANCE BY APPROX. 5°

TWO PERSONS STANDING ON THE PLATFORM ARE GUIDING THE HEAD AND ROTOR CONSTRUCTION DURING THEIR ASSEMBLY

ROTOR IS LIFTED AND POSITION AT THE TOP OF ITS SHAFT AND SHIFTED IN ITS ORIGINAL POSITION AND FIXED. REMOVE 'JIB' AND ASSEMBLE BLADES, SAFETY DEVICE AND MOVING PARTS.

Irrigation in Saighanchi

Irrigation of reclaimed land near Saighanchi consists of the following:

Windmill constructed in Saighanchi

Australian Southern Cross Pump with check valves and air chambers. Type: Piston, Capacity: 4 litres

Pipeline from the well to the fields, approximate distance 1000 metres. Diameter 50 mm

To irrigate land there has to be an adequate supply of water available. After finding a drinking water supply in the village, we then had to find water for irrigation outside the village. Instead of using drilling rig, we decided to dig a well by traditional methods. The position of the well was determined and a team of professional well-diggers was hired to do the job.

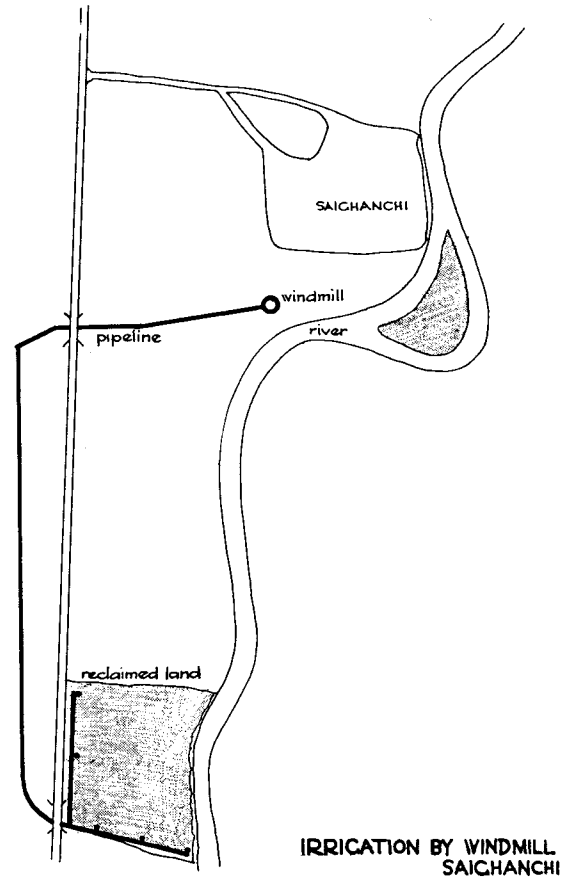
The diggers continued digging for a few days and, at about three metres below the ground, water began to seep through the walls of the well. Once the water was discovered, the diggers did not dig any deeper. However, for our purpose, the water discharged was not sufficient, so we obtained a motor-driven pump to enable us to dig deeper. As the villagers dug deeper, the pump kept the well dry enough to enable them to dig to a depth of six metres. At this point the inflow of water was so great that the motor pump could not keep up with it. We now had sufficient water to irrigate as much land as we wanted to, and our only limitation was that we had only one windmill and pump.

The walls of the well were secured by lining it with concrete pipes of 900 mm diameter which were manufactured on the site.

The windmill was sited adjacent to the well with the tower located above the perimeter of the stone wall housing the pump, which was located directly under the windmill. The pump inlet consisted of a 50 mm diameter galvanised iron pipe with a check valve at the bottom end. The pipe reached a depth of five metres into the well.

The piston pump was fitted with two air chambers, one on the inlet side and the other on the outlet side, to ensure maximum water output. The outlet was then connected to the pipeline with a check valve in between.

The pipeline, 50 mm in diameter, was buried underground and climbs to a height of eighteen metres within a length of about 350 metres. From that point onward the pipeline was laid on a slope of about two metres in 650 metres, being the remaining distance to the fields. The total length of the pipeline was about 1000 metres, mostly buried underground with a minimum depth of one metre. Where the pipeline could not be buried, when crossing the road through a bridge and a culvert, galvanised iron pipes were used. The remaining pipeline was made from PVC with a diameter of 50 mm. At the terminal, on the edges of the fields, there are five outlets to enable controlled irrigation of plots as required.



IRRIGATION BY WINDMILL
SAIGHANCHI

Fig. 6.24



Plate 51 Laying the pipeline