

## REFERENCES

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## APPENDIX

APPENDIX A : Machine Description

A-1 : Machine Drawings

A-2 : Machine Manual

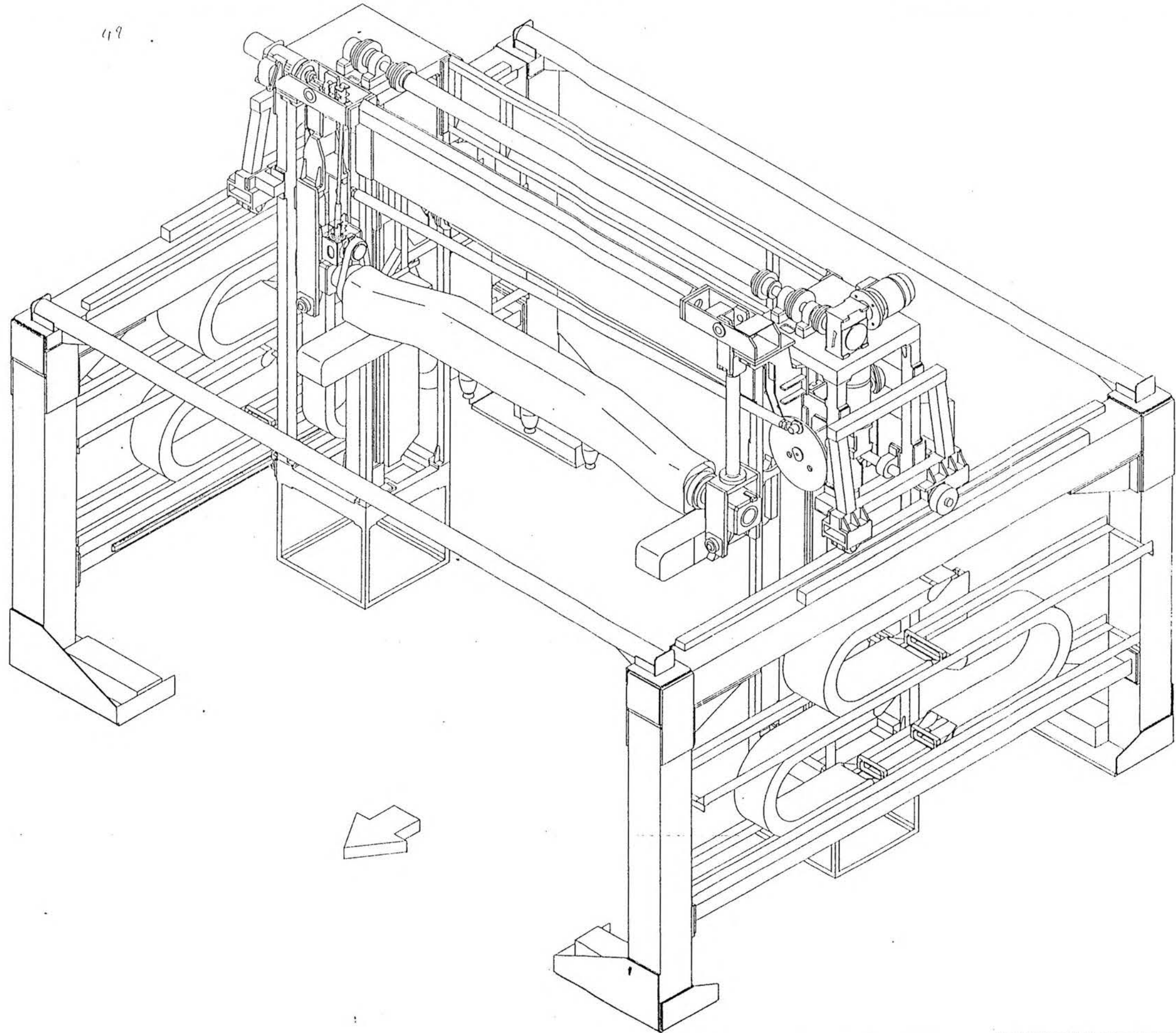
A-3 : Inspection Check Sheet

A-4 : Paint System

A-1  
Machine Drawings

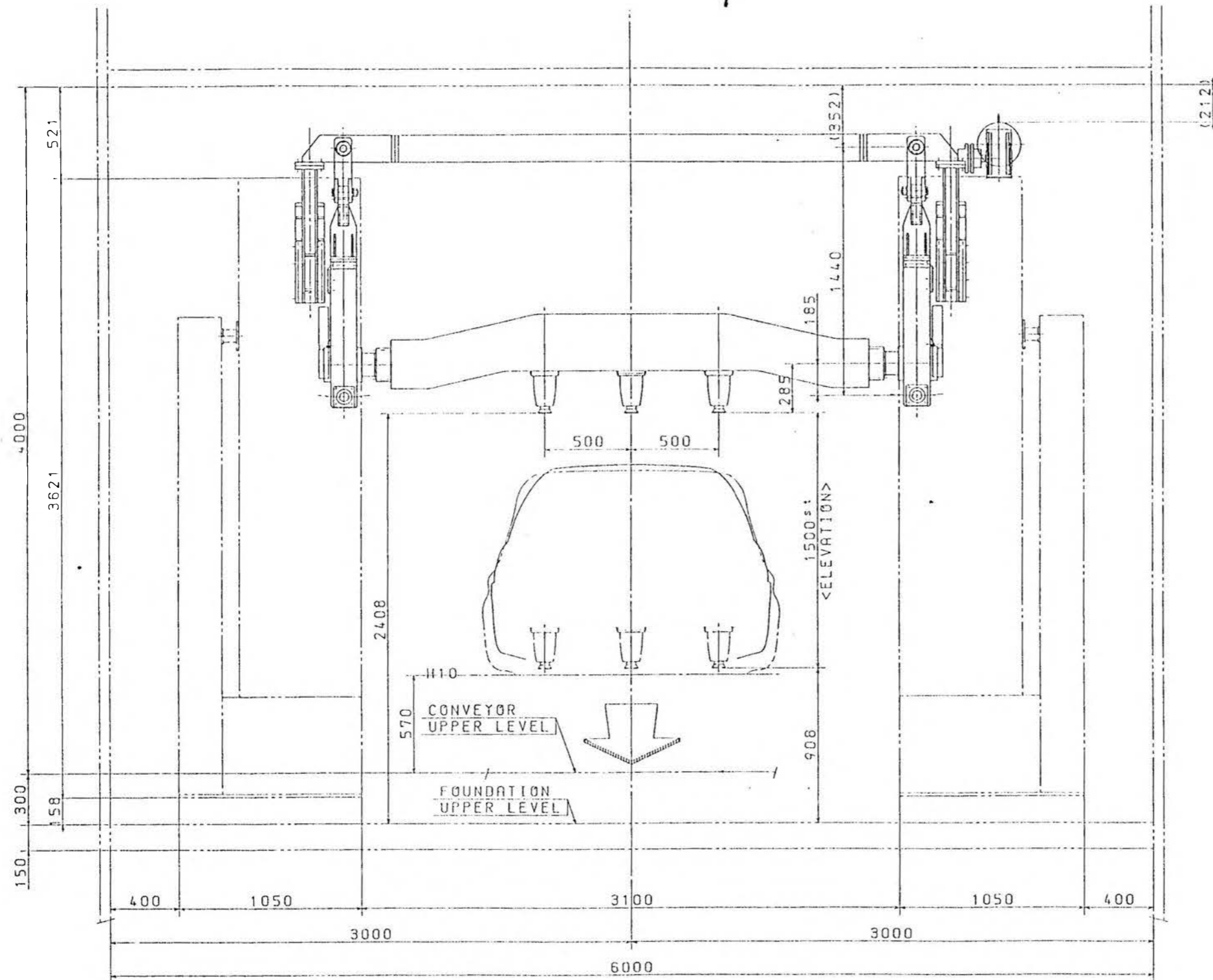
49

A  
B  
C  
D  
E



高さ=3900mm  
 幅=5200mm  
 奥行=4100mm  
 質量=6585.48kg

					品名		規格		単位		数量	
▲												
▲												
▲					92年3月18日	尺						
				承認	トリニティ工業株式会社		品質		38ELL TOP H/C		全体図	
年月日	訂正	理由	承認				図面					



UNIT:MM

SYM.	CODE NO	ITEM	SIZE	MATERIAL	QTY	REMARK
		T. M. T				
						NO. 3 BOOTH PRIMER GUN MOVEMENT LOCUS OF 3-BELL ROOF MACHINE
		TRINITY INDUSTRIAL CORP.				50-01-20526

ADM. NO	07-50A-3006	B	
DATE	JUL 8. 43	SCALE 1/20 /	
APPD.	CKD.	DRN.	
S. F. FURMAN	M. S. S. S. S.	J. M. M.	
SYM. POSITION	DATE	REMARK	APPROVED

A-2  
Machine Manual

## 1. Outline of equipment

Three units of the turbo painters can be mounted on the 3-bell Roof Machine in order to coat the front area, hood, roof, luggage and rear area of the vehicle body.

The turbo painter is provided on the sliding unit which moves vertically against the body advancing direction, and the bell is elevated throughout 165 steps, being reciprocated leftward and rightward and is tilted an angle of 180° according to the body shape during coating on the front and rear surfaces. Thus, the tracking function makes the bell follow up the body in order to coat the front area, hood, roof, luggage and rear area.

## 2. Specifications of equipment

### 1) Elevation

- |                             |   |   |   |
|-----------------------------|---|---|---|
| Drive source                | : | Explosion-proof motor                         | 2HP×460V×4P                             |
| Stroke, and number of steps | : | 1650 mm, and 165 steps                        | (0 to 164)                              |
| Speed, and number of steps  | : | 3 steps                                       | High speed 200 mm/sec.                  |
|                             |   |   | Middle speed 100 mm/sec.                |
|                             |   |   | Low speed 60 mm/sec.                    |
| Position detection system   | : | 90° phase difference 2-signal pulse generator | .                                       |
|                             |   | Limit switches                                |   |
|                             |   |   | (Upper, Low speed, Low speed and Lower) |

### 2) Reciprocation

- |              |   |   |  |
|--------------|---|---|--|
| Drive source | : | Explosion-proof motor                         |  |
| Cycle        | : | Variable in a range of 15 cycles to 30 cycles |  |
| Stroke       | : | 200 mm  |  |

### 3) Tilt

- |                            |   |   |                   |
|----------------------------|---|---|-------------------|
| Drive source               | : | Explosion-proof motor                                     | 1HP×460V×4P       |
| Angle, and number of steps | : | 180°, 19 steps (0 to 18) and 10° / pulse                  |                   |
| Speed, and number of steps | : | 2 steps   | High speed 5 sec. |
|                            |   |   | Low speed 15 sec. |
| Position detection system  | : | 90° phase difference 2-signal pulse generator             |                   |
|                            |   | Proximity sensor (Out of position × 2, and home position) |                   |



## 4) Tracking

Drive source : Explosion-proof servo motor 2HP×200V×4P  
 Stroke, and number of steps : 2000 mm, and 158 steps (0 to 157)  
 Speed, and number of steps : 6 steps Follow-up  
 Reverse travel  
 High speed 166 mm/sec.  
 Low speed 60 mm/sec.  
 Relative +  
 Relative -  
 Position detection system : 90° phase difference pulse generator  
 Limit switches  
 (Upper, Low speed, Low speed and Lower)

## 3. Adjustment

## 1.) Adjustment of elevation speed

The speed is controlled with the inverter which is provided in the control panel. The speed is changed by changing the frequency with the inverter.

The parameter Nos. 27, 28 and 29 are used to set the speed.

For the operation, refer to the operation manual of the inverter.

The speed ranges max. 200 mm/sec. to min. 60 mm/sec..

## 2.) Adjustment of acceleration/deceleration time

The acceleration/deceleration time can be set by the parameter No. which is provided in the control panel. For the operation, refer to the operation manual of the inverter.

Adjustable range: 1.0 sec. to 600 sec.

## 3.) Adjustment of reciprocation speed

For the speed adjustment, the frequency can be set with the potentiometer which is provided in the control panel.

The speed ranges 10 cycles/min to 30 cycles/min.

## 4.) Adjustment of reciprocation acceleration/deceleration time

The acceleration/deceleration time can be adjusted with the variable resistor which is provided in the control panel.

Adjustable range: 0.5 sec. to 20 sec.

## 5.) Adjustment of tilt speed

For the speed adjustment, the frequency can be set with the low/high speed potentiometer which is provided in the control panel.

The speed ranges max. 5 sec./180° to min. 15 sec./180°.

## 6) Adjustment of tilt acceleration/deceleration time

The acceleration/deceleration time can be adjusted with the variable resistor which is provided in the control panel.

Adjustable range: 0.5 sec. to 20 sec.

## 7) Adjustment of tracking speed

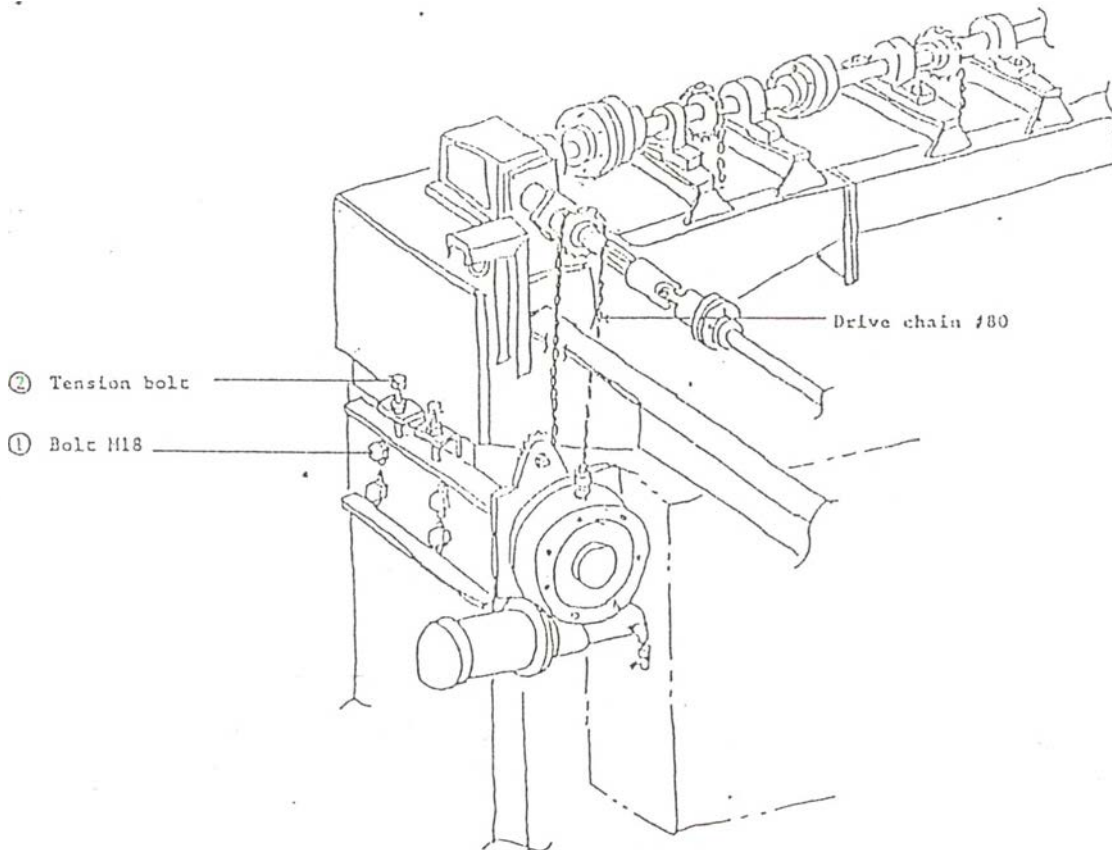
Using the setting panel, the speed can be set to be the low, high and relative speeds.

The speed ranges max. 166 mm/sec. to min. 60 mm/sec.

The conveyor speed + 0.5 m/min. is used as the guideline of the relative speed.

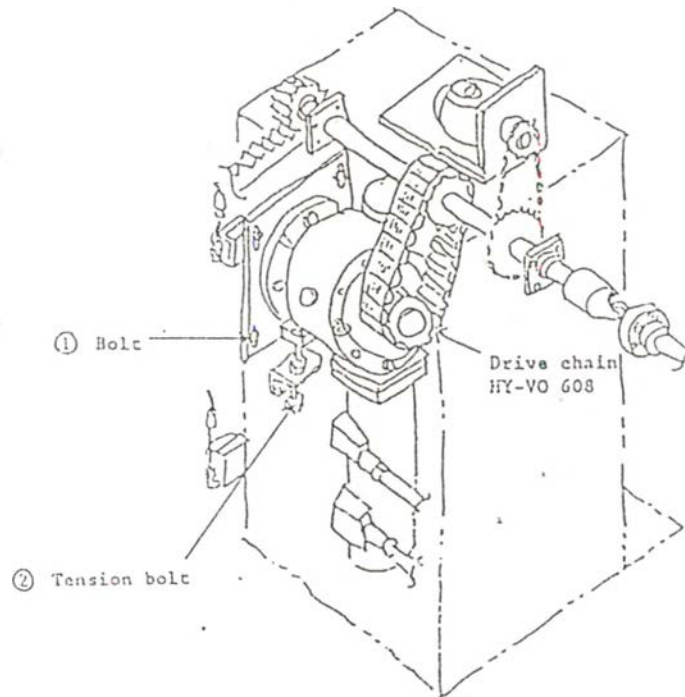
## 8) Adjustment of drive chain in the elevation section

Loosen four M18 bolts ①, and adjust the tension of the drive chain with two M12 tension bolts ②.



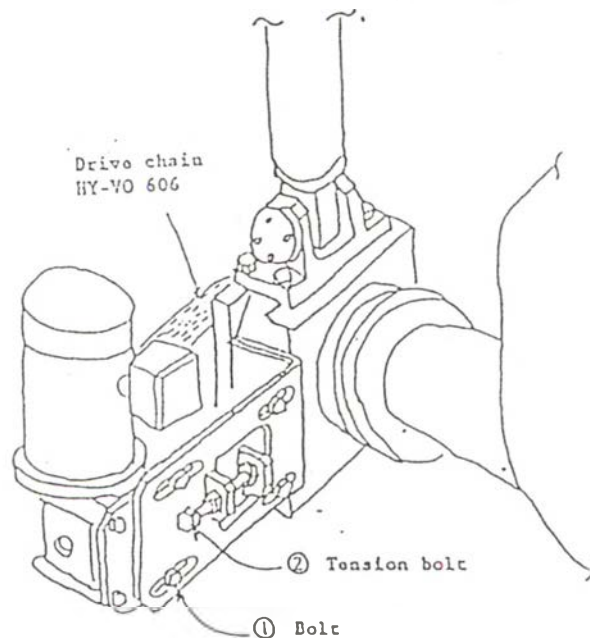
## 9) Adjustment of tracking drive chain

Loosen four M16 bolts ①, and adjust the tension of the chain with the M16 tension bolt ②.



## 10) Adjustment of drive chain in the tilt section

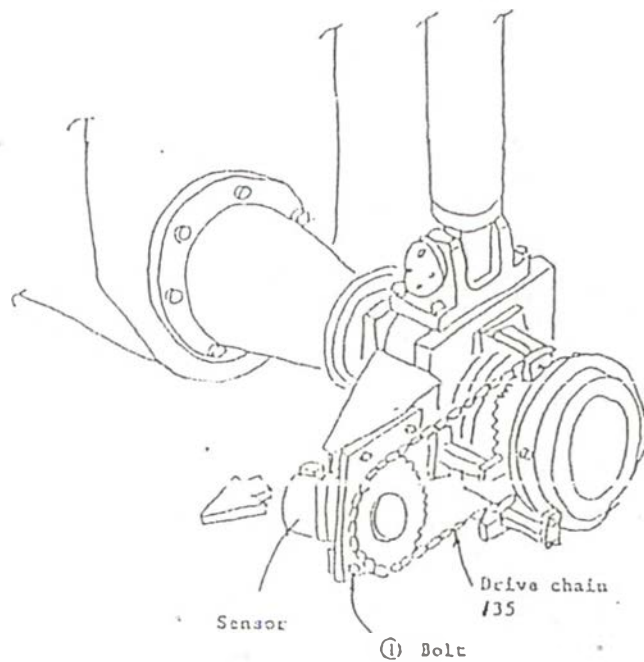
Loosen four M12 bolts ①, and adjust the tension of the chain with the M10 tension bolt ②.



## 11) Adjustment of chain in the tilt sensor section

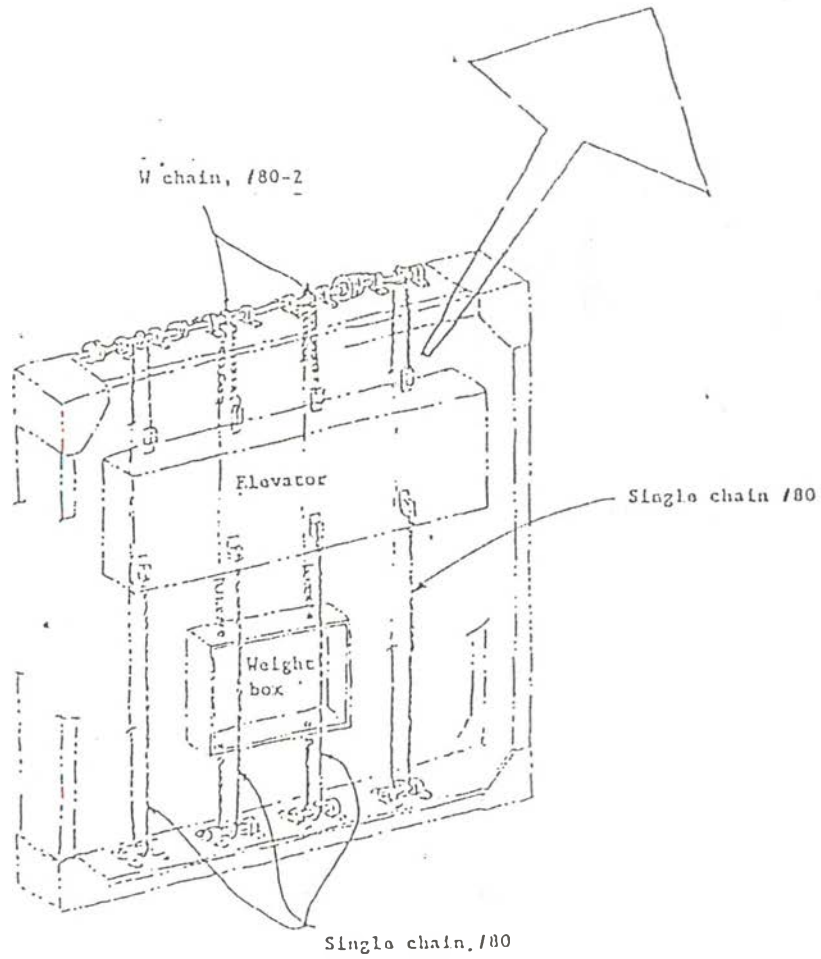
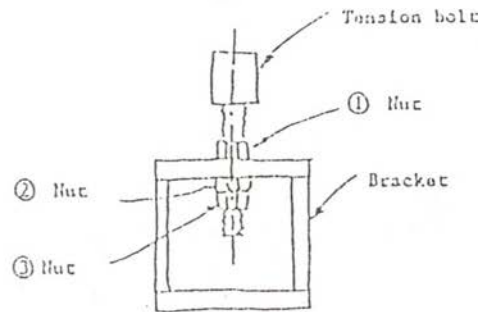
Loosen four M8 bolts ①, and tighten the chain by moving the main body of the sensor in the arrow direction.

Take care not to tighten the chain excessively.



## 12) Adjustment of elevation chain

In order to tighten the elevation chain, loosen the nuts ① and ③ and screw in the nut ②.



	Check point	Check item	Check method	Check interval	Criterion	Countermeasure for abnormality		
D	Reciprocation drive section side	Abnormal noise and heat of motor	Hearing and hand-touch	1/M	Abnormal noise or backlash is not observed.	Replace		
		Abnormal noise and backlash of reduction gear	Hearing and hand-touch	1/M	Abnormal noise or backlash is not observed.	Replace		
		Oil amount of reduction gear	Visual check	1/M	Oil level stands above the half of the scale.	Refill oil.		
		Backlash of crank bearing	Visual check and hand-touch	1/M	Backlash is not observed.	Refill oil.		
		Looseness of ETP bush in the crank arm section	Visual check and hand-touch	1/M	Not loose	Retighten or replace the part.		
		Breakage of pinion gear teeth	Visual check	1/M	Not broken	Replace the part.		
		Breakage of rack teeth	Visual check	1/M	Not broken	Replace the part.		
		Motor cable breakage	Hand-touch and tester	1/M	Cable is not broken.	Replace the cable.		
		Cableveyor breakage	Visual check	1/M	Not broken	Replace		
E	Swing arm	Kink and breakage of air hose in the cableveyor	Visual check	1/M	Not kinked or broken	Replace		
		Wear and backlash of L/M rail and block	Visual check	1/M	Wear or backlash is not observed.	Replace		
		Cracks of welded section	Visual check and hand-touch	1/M	Not cracked	Replace		
		Abnormal noise of bearing	Hearing	1/M	Not abnormal noise	Grease up or replace		
		ETP bush looseness	Visual check and hand-touch	1/M	Not loose	Retighten or replace the part.		
		Shear pin is broken.	Visual check and hand-touch	1/M	Not broken	Replace		
		F	Tilt drive/driven section	Abnormal noise and heat of motor	Hearing and hand-touch	1/W	Abnormal noise or heat is not observed.	Replace
				Abnormal noise and backlash of reduction gear	Hearing, hand-touch and visual check	1/W	Abnormal noise or backlash is not observed.	Replace
				Oil amount of reduction gear	Visual check	1/M	Oil level stands above the half of the scale.	Refill oil.
Motor cable breakage	Hand-touch and tester			1/M	Cable is not broken.	Replace the cable.		
Elongation of BV chain	Visual check			1/M	Not elongated	Tension adjustment		
Working state of tilt pulse generator	Visual check			1/M	No improper operation	Replace		
G	Tilt section	Shock absorber distortion	Visual check	1/M	Not distorted	Replace		
		Kink and breakage of hoses and so on	Visual check	1/M	Not kinked or broken	Replace		
		Optical fiber cables breakage	Visual check	1/M	Not kinked or broken	Replace		
		Abnormal noise and seizure of air motor	Hearing and visual check	1/D	Abnormal noise or seizure is not observed.	Replace		
H	Others	Deviated light beam of photo-eyes	Visual check	1/D	Not deviated	Readjust the light beam.		
		Looseness of bolts and other fasteners	Visual check and hand-touch	1/M	Not loose	Retighten		
		Heat and wire breakage of solenoid valve	Visual check and hand-touch	1/M	Heat or wire breakage is not observed.	Replace		
		Paint leakage from CCV	Visual check	1/D	Leakage is not observed.	Replace		
I		Looseness at joint of junction plate	Visual check and hand-touch	1/M	Not loose	Retighten		

## 3-bell Roof Machine, 1 unit

	Lubrication point	Number of points	Recommended lubricant	Check interval	Lubrication interval	Lubricant amount	Filling method
1	Reduction gears (For tracking) (For reciprocation) (For elevation)	One for each	Nisseki Donnock SP/220 220 cSt	1/2 W	1/3 M	4 t	Pouring
2	Gear box	2	Mobil Gear 629 150 cSt	1/2 W	1/3 M	2 t	Pouring
3	Roller chain		Nisseki YBK Oil RO 100 100 cSt	1/1 M	1/1 M	Suitable amount	Oiler
4	Linear guide (L/M guide)	8	Nisseki Donnock Grease AP-1	1/3 W	1/1 M	Suitable amount	Grease-up
5	Rod end bearing	2	Nisseki Epinock Grease AP-1	1/3 W	1/1 M	Suitable amount	Grease-up
5	Rack & pinion	2	Nisseki Epinock Grease AP-1	1/3 W	1/1 M	Suitable amount	Grease-up

Viscosity division Gear oil: cSt (40°C)

Troubleshooting for 3-bell Roof Machine

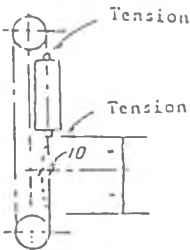

	Phenomenon	Possible cause	Check content	Countermeasure
A	Reciprocation is not smooth.	1. Gears are worn in the reduction gear.	Does backlash of output shaft exceed 2°?	Replace reduction gear.
		2. Crank section is loose.	Looseness of mounting bolt of the rod end bearing	Retighten
		3. Rod end bearing is defective in the crank section.	Wear, backlash and abnormal noise of bearing	Replace bearing.
		4. ETP bush mounted on the crank arm is defective.	Slipping of ETP bush and shaft	Replace ETP bush.
		5. Shear pin mounted on the swing arm is broken.	Breakage of pin	Replace pin.
		6. Spherical bearing on the swing arm is defective.	Wear, backlash and abnormal noise of bearing	Replace bearing.
		7. Hoses interfere during reciprocation.	Interference of hoses and so on	Correct the interference and change hose routing.
		8. Defective reciprocation inverter	Parameter setting, and frequency	Reset or replace inverter.
B	Belt does not tilt smoothly.	1. HV chain is loose.	Elongation of HV chain	Tighten HV chain with tensioner.
		2. Gears are worn in the reduction gear.	Does backlash of output shaft exceed 2°?	Replace reduction gear.
		3. Chain of pulse generator is loose.	Chain elongation	Tighten chain with tensioner.
		4. Proximity sensor for home position and out of position is defective.	Looseness of proximity sensor Amplifier lamp lighting	Replace sensor amplifier.

Continued on the next page.



	Phenomenon	Possible cause	Check content	Countermeasure
B	Belt does not tilt smoothly.	5. Defective tilt inverter	Parameter setting, and frequency.	Replace inverter.
C	Tracking is not smooth.	1. Gears are worn in the reduction gear.	Does backlash of output shaft exceed 2°?	Replace reduction gear.
		2. HV chain is loose.	Elongation of HV chain	Tighten HV chain with tensioner.
		3. Servo motor is defective.	Looseness of terminal and cable breakage	Replace motor cable.
		4. Pinion gear is broken.	Teeth state of pinion gear	Replace
		5. Rack is worn or foreign material is caught in the rack.	State of rack	Cleaning, and grease-up
		6. Backlash and wear on the universal joint	Backlash of bearing of universal joint	Replace universal joint.
		7. Backlash between tracking rail and block (linear bearing)	Wear and backlash of rail and block	Grease-up
		8. Pulse generator for tracking is defective.	Amplifier lamp lighting	Replace
		9. Cableveyor is deformed or broken.	State of cableveyor	Correct or replace.
D	Bell elevation is not smooth.	1. Gears are worn in the reduction gear.	Does backlash of output shaft exceed 2°?	Replace reduction gear.
		2. Elevation drive chain is loose.	Chain elongation	Tensioner adjustment
		3. Backlash and wear on the universal joint.	Backlash of bearing of universal joint	Replace universal joint.
		4. Gear is worn in the gear box.	Backlash of gear	Replace

Continued on the next page.

	Phenomenon	Possible cause	Check content	Countermeasure
D	Bell elevation is not smooth.	5. Elevation chain is excessively tight.	 <p>10 mm or less at the chain center at the upper limit of the elevator.</p>	Tensioner adjustment
		6. Elevation chain is elongated.	440 mm or less with 17 links	Replace chain.
		7. Oil shortage of the chain	 <p>Tangle of chain</p>	Replace chain.
		8. Backlash of the coupling	Looseness of bolts	Retighten
		9. Defective pillow block	Oil blotting or ball run-out	Replace pillow block.
		10. Defective sprocket in the elevation section	Wear and breakage of sprocket teeth	Replace
		11. Backlash between elevation rail and block (linear bearing)	Wear and backlash of rail and block	Grease-up
		12. Backlash of the spline shaft	Wear and engagement of spline shaft grooves	Replace
		13. Fastening bolts are loose.	Looseness or get-off	Retighten
		14. Defective pulse generator for elevation	Amplifier lamp lighting	Replace
		15. Defective inverter for elevation	Parameter setting and frequency	Reset or replace inverter.

Troubleshooting for Other Accessories

Phenomenon	Possible cause	Check content	Countermeasure
Paint is not discharged.	1. Defective trigger valve	ON and OFF of pilot air	Replace
	2. Air/paint hose is broken.	Routes of air/paint hoses	Replace
	3. Defective 2CV for paint	ON and OFF of pilot air	Replace
	4. Defective solenoid valve	Lamp lighting	Replace
	5. Defective electro-pneumatic converter	Operation signal	Adjust the span or replace electro-pneumatic converter.
	6. Improper paint circulation	Pump operation and ball valve open/close	Adjust
	7. Insufficient manual operation	Refer to the operation manual.	Retry the switch operation
Air motor does not operate.	1. Broken air hose	Disconnection of hose route	Reconnect or replace.
	2. Defective tachometer	Operation	Replace
	3. Defective optical fiber cable for rotation detection	Kink of fiber, and amplifier operation	Replace and adjust amplifier.
	4. Defective solenoid valve	Lamp lighting	Replace
	5. Defective air regulator	Specified pressure is delivered from the outlet of the air regulator or not.	Replace air regulator.
	6. Defective air operation valve	ON and OFF of air operation valve	Replace air operation valve.
	7. Defective air motor	Seizure of air motor	Replace air motor.

Continued on the next page.

Phenomenon	Possible cause	Check content	Countermeasure
Shaping air is not delivered.	1. Air hose breakage	Disconnection of air hose route	Connect or replace air hose.
	2. Defective air operation valve	ON and OFF of air operation valve	Replace air operation valve.
	3. Defective solenoid valve	Lamp lighting	Replace
	4. Defective air regulator	Specified pressure is delivered from the outlet of the air regulator or not.	
	5. Stained shaping ring or clogged hole	Shaping ring	Wash with thinner or blow-off dust with air.

A-3  
Inspection Check Sheet

Preventative Maintenance Inspection Check Sheet

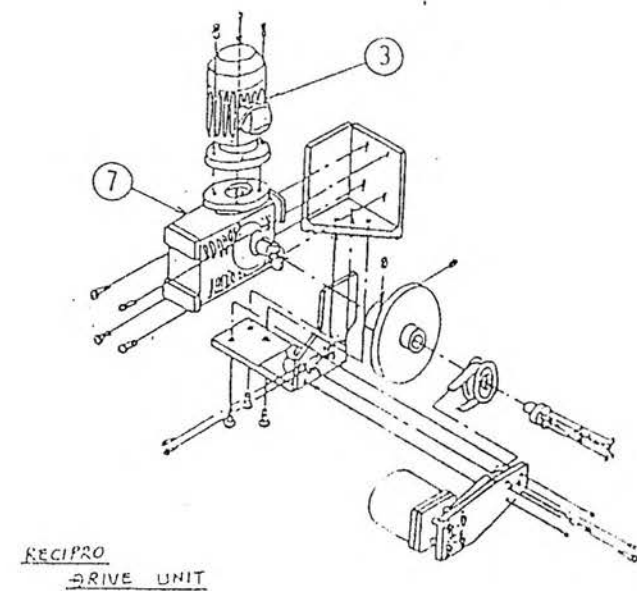
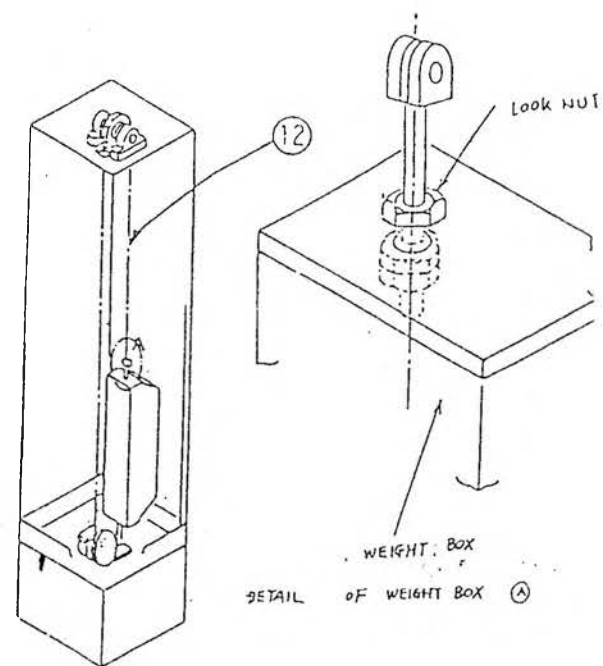
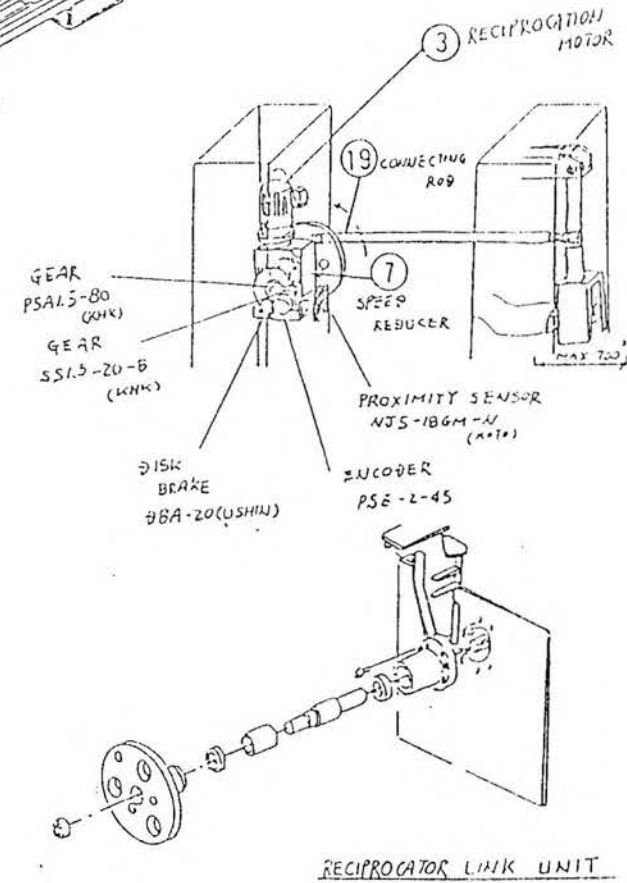
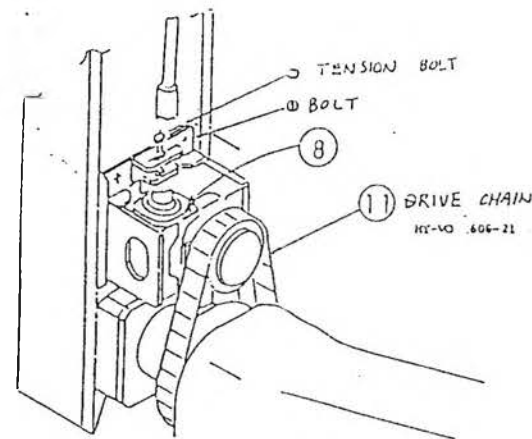
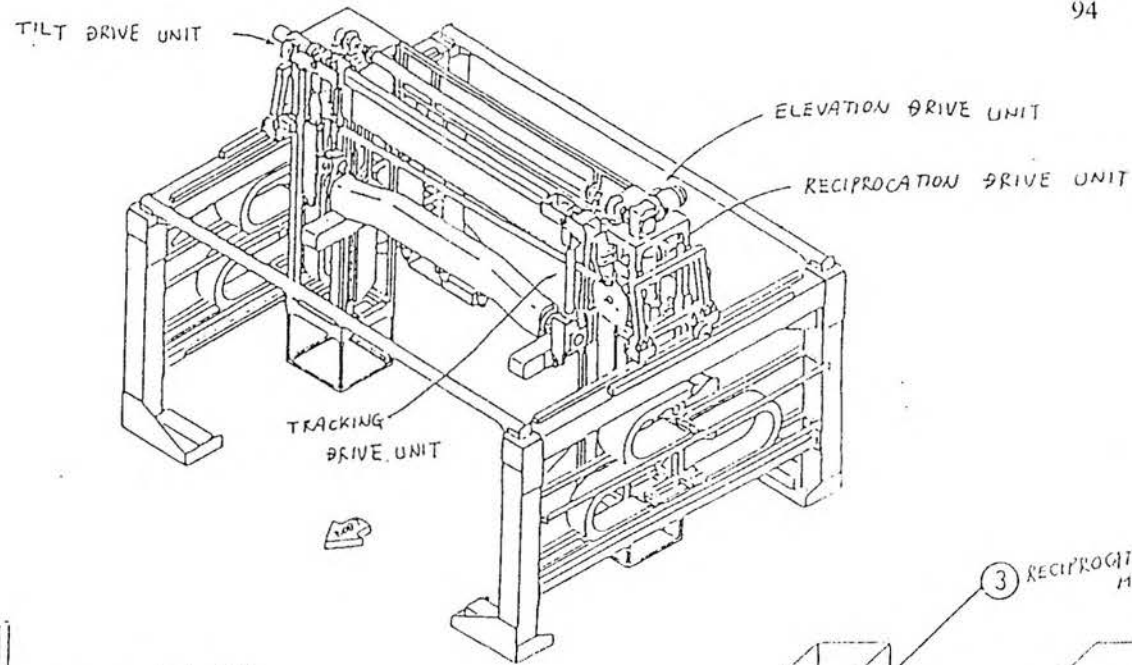
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Stage 3

Approval Seal	Write up

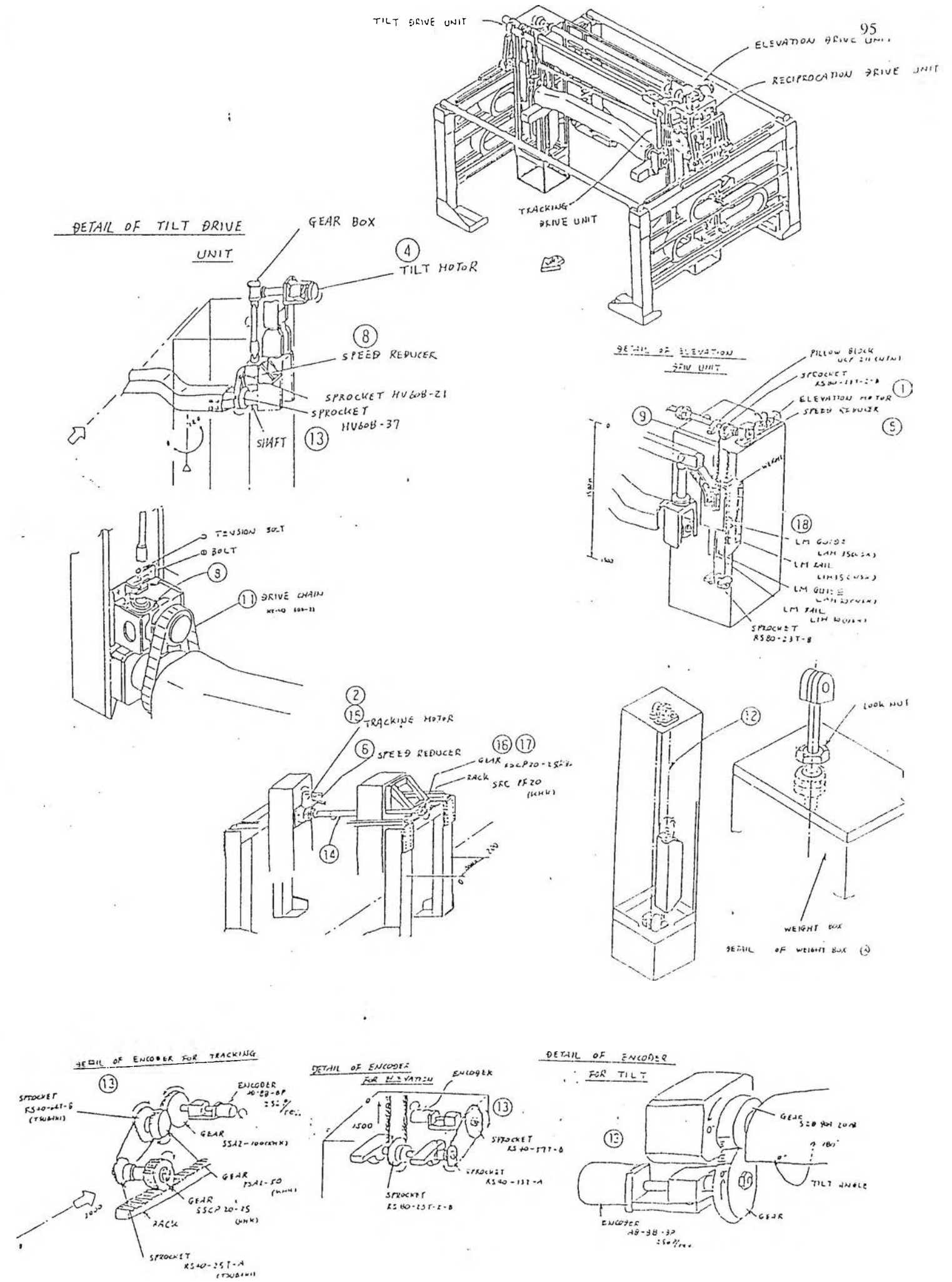
3 Bell (91) Roof Machine

C	Cleaning	T	Tightening	O	No abnormalities
A	Adjustment	X	Replacement	△	Maintenance pending
W	Repair	L	Lubrication		

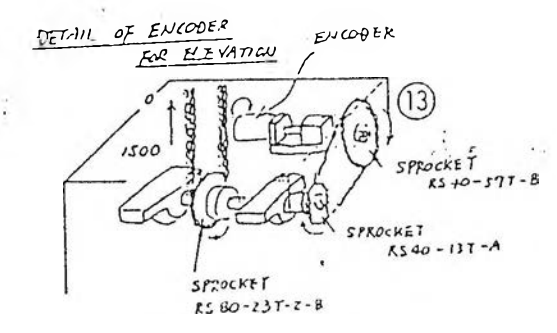
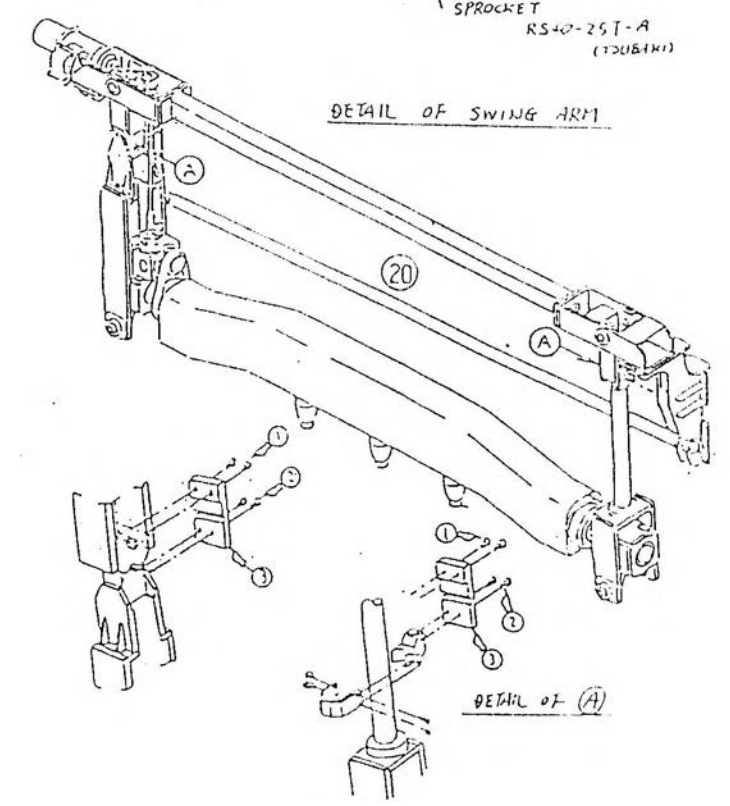
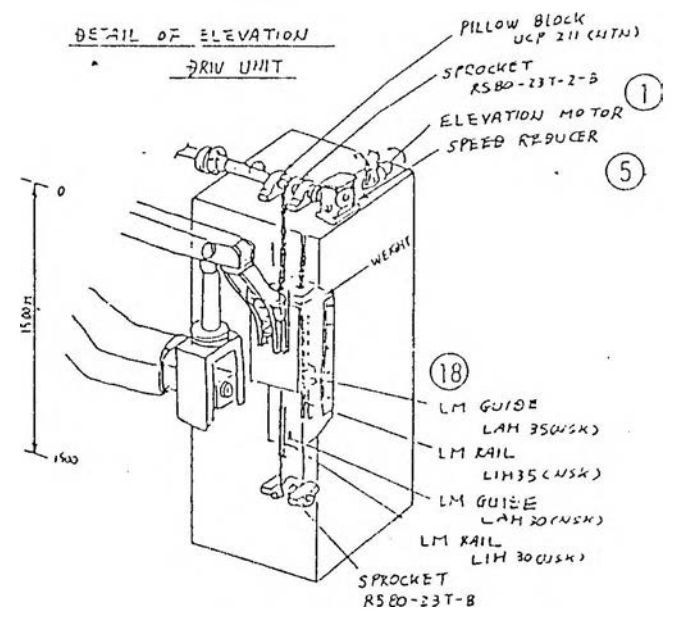
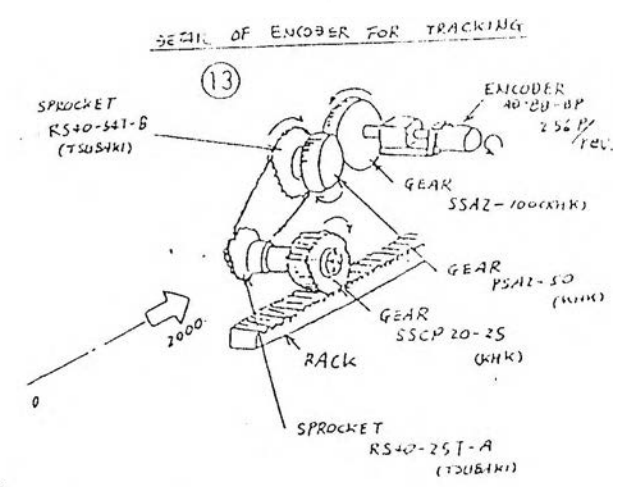
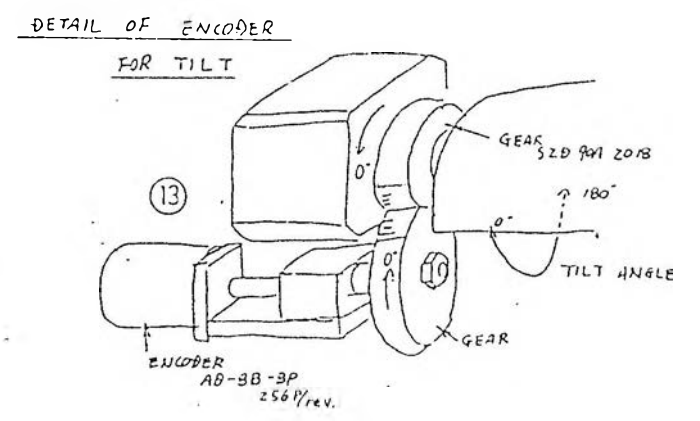
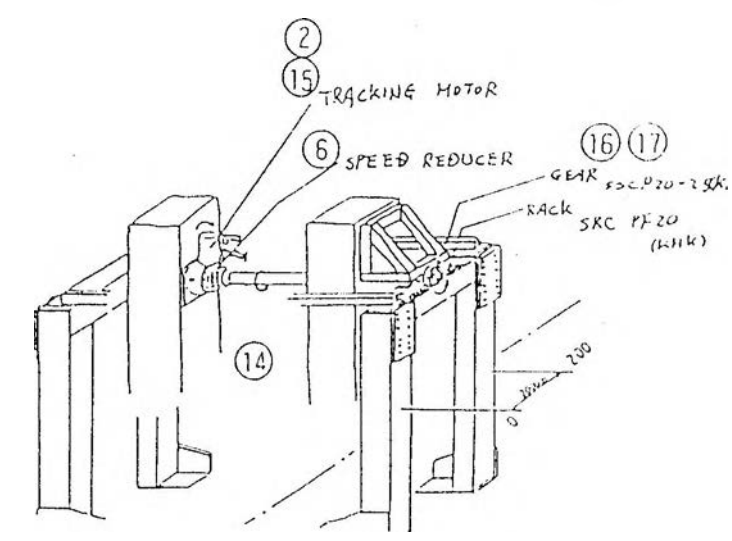
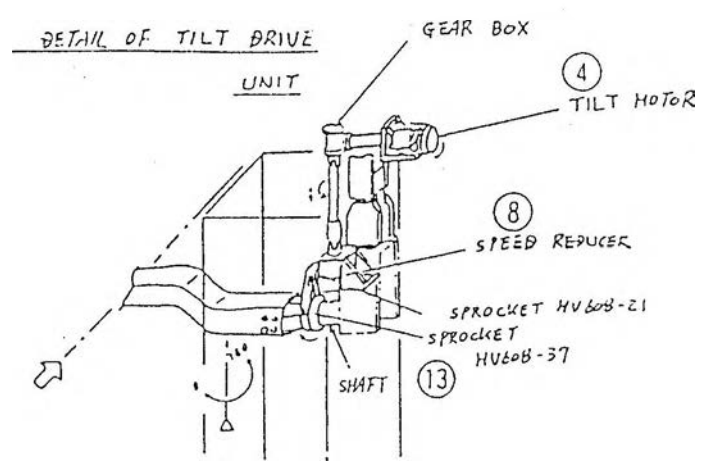
No.	Inspection Location	Inspection Description & Procedures	Evaluation Standard	Check	Comments
1	Elevation Motor	Check for excessive noise, excessive heat, severed cables. Evaluate by using stethoscope, thermometer, visual and tactile inspection.	Exterior temp. less than booth temp. + 15 C. No abnormal noises.		
2	Tracking Motor	Check for excessive noise, excessive heat, severed cables. Evaluate by using stethoscope, thermometer, visual and tactile inspection.	Exterior temp. less than booth temp. + 50 C. No abnormal noises.		
3	Reciprocator Motor	Check for excessive noise, excessive heat, severed cables. Evaluate by using stethoscope, thermometer, visual and tactile inspection.	Exterior temp. less than booth temp. + 15 C. No abnormal noises.		
4	Tilt Motor	Check for excessive noise, excessive heat, severed cables. Evaluate by using stethoscope, thermometer, visual and tactile inspection.	Exterior temp. less than booth temp. + 30 C. No abnormal noises.		
5	Elevation Speed Reducer	Check for excessive noise, excessive heat, and sufficient oil supply. Evaluate by using stethoscope, thermometer, visual and tactile inspection.	Exterior temp. less than booth temp. + 40 C. No abnormal noises. Oil within level indication.		
6	Tracking Speed Reducer	Check for excessive noise, excessive heat, and sufficient oil supply. Evaluate by using stethoscope, thermometer, visual and tactile inspection.	Exterior temp. less than booth temp. + 40 C. No abnormal noises. Oil within level indication.		
7	Reciprocator Speed Reducer	Check for excessive noise, excessive heat, and sufficient oil supply. Evaluate by using stethoscope, thermometer, visual and tactile inspection.	Exterior temp. less than booth temp. + 40 C. No abnormal noises. Oil within level indication.		



No.	Inspection Location	Inspection Description & Procedures	Evaluation Standard	Check	Comments
8	Tilt Speed Reducer	Check for excessive noise, excessive heat, and sufficient oil supply. Evaluate by using stethoscope, thermometer, visual and tactile inspection.	Exterior temp. less than booth temp. + 40 C. No abnormal noises. Oil within level indication.		
9	Elevation Drive Chain	Check for sufficient amount of grease, for adequate tension, that stretch is less than specification value, and for any uneven wear. Evaluation by visual inspection, calipers and scale.	Absence of rust. Tension less than 4 % of spanner length. Stretch less than 2% of specification length.		
10					
11	Tilt Drive Chain	Check for sufficient amount of grease, for adequate tension, that stretch is less than specification value, and for any uneven wear. Evaluation by visual inspection, calipers and scale.	Absence of rust. Tension less than % of spanner length.		
12	Elevation Chain (R,L)	Check for sufficient amount of grease, for adequate tension, that stretch is less than specification value, and for any uneven wear. Evaluation by visual inspection, calipers and scale.	Absence of rust. Tension less than 4 % of spanner length. Stretch less than 2% of specification length.		
13	Drive Chain for Sensors (for Cam, Pulse Wheel)	Check for sufficient amount of grease, for adequate tension, that stretch is less than specification value, and for any uneven wear. Evaluation by visual inspection, calipers and scale.	Absence of rust. Tension less than 4 % of spanner length. Stretch less than 2% of specification length.		
14	Elevation Connecting Shaft and Universal Joint (incl. bearings)	Check for sufficient amount of grease, for any grease being spattered, for any fallen keys, and that bolts are tight. Evaluation by visual inspection and torque wrench.	No spattering of sealing grease. Absence of rust. Torque 5 to 8 kg m (M14, M16)		
15	Tracking Drive Shaft and Universal Joint (Incl. bearings)	Check for sufficient amount of grease, for any grease being spattered, for any fallen keys, and that bolts are tight. Evaluation by visual inspection and torque wrench.	No spattering of sealing grease. Absence of rust. Torque 5 to 8 kg m (M14, M16)		



No.	Inspection Location	Inspection Description & Procedures	Evaluation Standard	Check	Comments
16	Tracking Drive Gear and Rack Gear	Check for sufficient amount of grease, for any uneven wear, and that bolts are tight. Evaluation by visual inspection and torque wrench.	Absence of rust. Chain links not worn. Torque 1 to 2 kg m (M8, M10)		
17	Tracking Guide Rail and Bearing	Check for sufficient amount of grease, for any uneven wear, that bolts are tight, and for any scratches. Evaluation by visual inspection torque wrench.	Absence of rust. Chain links not worn. No scratches. Torque 1 to 2 kg m (M8, M10)		
18	Elevation Guide Rail and Bearings	Check for sufficient amount of grease, for any uneven wear, that bolts are tight, and for any scratches. Evaluation by visual inspection torque wrench.	Absence of rust. Chain links not worn. No scratches. Torque 1 to 2 kg m (M8, M10)		
19	Reciprocator Link Mechanism (Incl. bearings)	Check for sufficient amount of grease, for any uneven wear, that bolts are tight, and for any scratches. Evaluation by visual inspection torque wrench.	Absence of rust. Chain links not worn. No scratches. Torque 1 to 2 kg m (M8, M10)		
20	Swing Arm and Holder	Check for sufficient amount of grease, for any uneven wear, that bolts are tight, and for any scratches. Evaluation by visual inspection torque wrench.	Absence of rust. Chain links not worn. No scratches. Torque 1 to 2 kg m (M8, M10)		
21	Bell Mounting and Bell Pitch	Check for adequate tension, for any leaks for the air cylinder, for any fallen debris inside the cover, that bolts are tight, and for valve leaks. Evaluation by visual and tactile inspection and torque wrench.	No scratches or wear to belt. No air or paint leaks. No signs of wear. Torque 0.4 to 0.8 kg m (M5, M6)		
22	Cable Tray and Enclosure	Check for any damage, that all components are properly mounted, for any obstructions or interferences, and for any looseness. Evaluation by visual inspection and torque wrench.	No wear or scratches. Torque 1 to 2 kg m (M8, M10)		
23	Hoses and Couplings	Check for any cuts or bends, for any leaks, holes, and scratches. Evaluation by visual and tactile inspection and spanner.	No wear or scratches. No air or paint leaks. No contact with movable parts.		
24	Motor Current	Elevation (Measure with amp probe.) Reciprocator (Measure with amp probe) Tracking (Measure with amp probe) Tilt (Measure with amp probe.)	Less than A Less than A Less than A Less than A		
25	Bell RPM and Voltage	R Bell (by tachometer, voltmeter) C Bell (by tachometer, voltmeter) L Bell (by tachometer, voltmeter)	rpm KV rpm KV rpm KV		
26	PC Back Up	Will back up new data.			





A-4  
Paint System

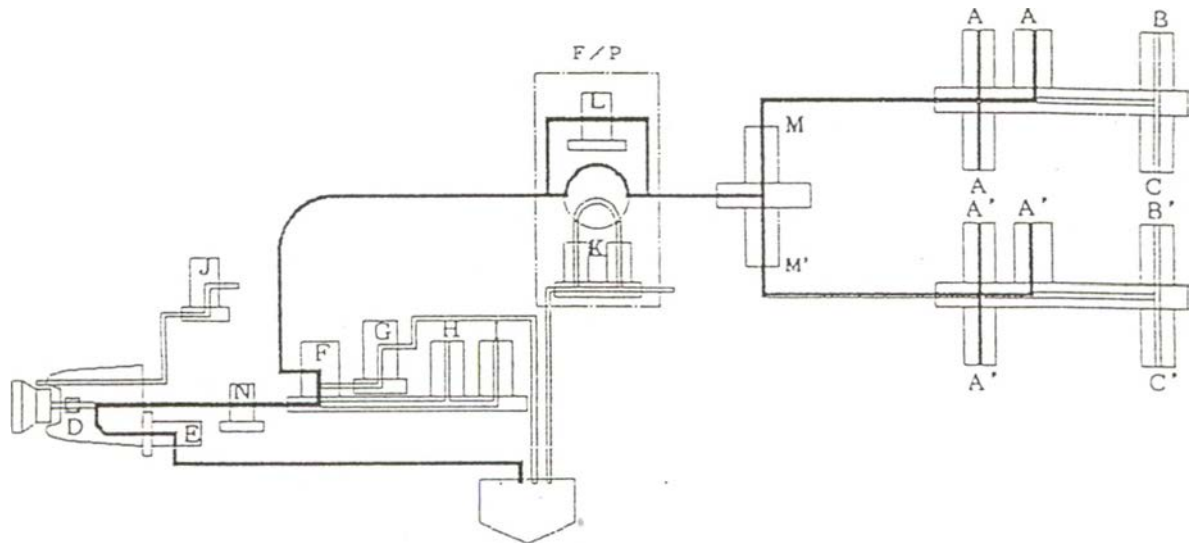
### 3-6 Explanation of various valves (No.3ST BELL)

This spray machine is controlled with the following types of valves.

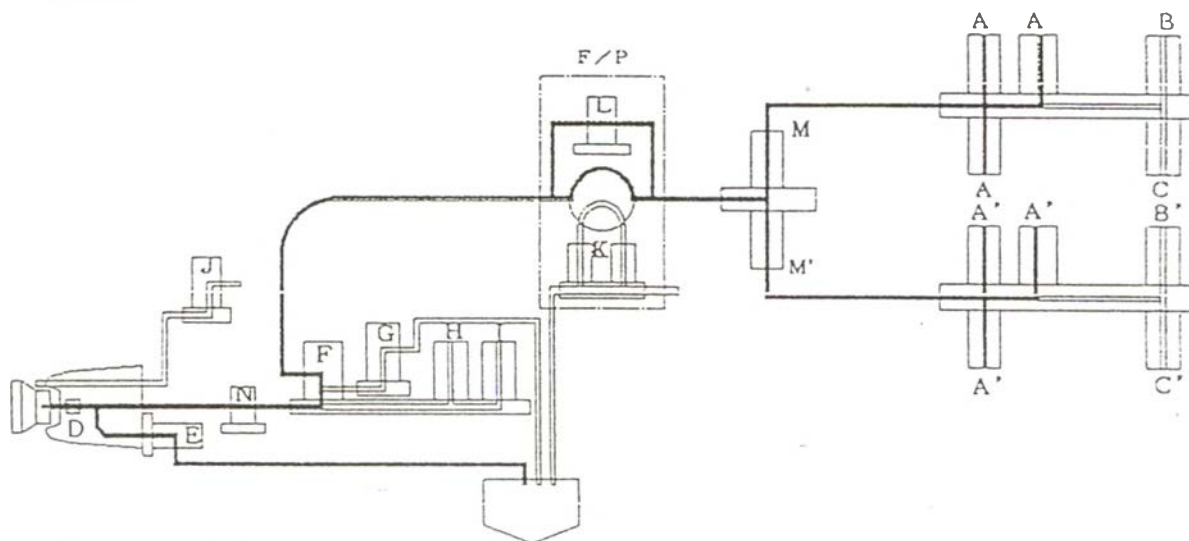
- |                        |       |  |
|------------------------|-------|--|
| (A) CCV                | ..... | Each paint is connected, and selected with this valve.   |
| (B) PURGE AIR 1, 2     | ..... | This is the valve for the air used when washing the DUMP side.   |
| (C) PURGE THINNER 1, 2 | ..... | This is the valve for the thinner used when washing the DUMP side.   |
| (D) NEEDLE             | ..... | This valve turns ON when paint or thinner is discharged to the BELL CUP side. This is interlocked with the AIR MOTOR rotation. |
| (E) HEAD DUMP          | ..... | This valve turns ON during PRESPRAY and HEAD DUMP WASHING.   |
| (F) TRIGGER            | ..... | This valve turns the paint ON and OFF.   |
| (G) DUMP               | ..... | This valve turns ON during PRESPRAY and DUMP WASHING.  |
| (H) SOFT AIR           | ..... | This is the valve for the air used during HEAD DUMP WASHING.   |
| (I) SOFT THINNER       | ..... | This is the valve for the thinner used during HEAD DUMP WASHING.   |
| (J) BACK FACE THINNER  | ...   | This is the valve for the thinner used during washing of the back of the BELL CUP.   |
| (K) SHAFT PURGE        | ..... | This is the valve that washes the gear shaft used in the F/P.  |
| (L) BYPASS VALVE       | ..... | This is the F/P bypass route for the paint used during PRESPRAY and the air and thinner used during washing.                   |
| (M) CENTER VALVE 1, 2  | ..... | This valve selects the SOLID or CLEAR color system of the paint.   |
| (N) METALLING          | ..... | This is the valve only installed on the ROOF M/C, and is used for paint CAM CUT.   |

### 3-7 Configuration of various valves (No. 3ST BELL)

#### HEAD DUMP PRESPRAY



#### NEEDLE PRESPRAY



- |         |               |          |                   |
|---------|---------------|----------|-------------------|
| (A) ... | CCV           | (I) .... | SOFT THINNER      |
| (B) ... | PURGE AIR     | (J) .... | BACK FACE THINNER |
| (C) ... | PURGE THINNER | (K) ...  | SHAFT PURGE       |
| (D) ... | NEEDLE        | (L) ...  | BYPASS VALVE      |
| (E) ... | HEAD DUMP     | (M) ...  | CENTER VALVE 1, 2 |
| (F) ... | TRIGGER       | (N) ...  | METALLING         |
| (G) ... | DUMP          |          |                   |
| (H) ... | SOFT AIR      |          |                   |

### 3-8 PAINT TIME CHART (No.3ST BELL)

This paint system detects the body's relative position by counting the conveyor pulses and paints.

The body can be painted by setting the paint conditions in "POINTS" 1 to 17 (SIDE) and 1 to 30 (ROOF). These points can be set per model so painting that meets the body shape is possible.

The meaning of each point is explained below.

#### (1) MACHINE START

The machine start counter begins to count when the body carrier turns the machine start LS ON. When the preset machine start value is reached, the data regarding the model and color to be handled is read in, and the paint point detector count begins. If the machine is still painting when the machine start is executed, the machine start will be ignored.

#### (2) PRESPRAY

When the machine is started, paint will be supplied to the bell tip when washing is completed (after washing is completed if during washing). This movement is called "PRESPRAY" in this machine.

#### (3) POINT 1 (WASHING CHECK)

If the machine is washing or in the PRESPRAY check at this point, "WASHING FAULT" will occur.

A STOP COMMAND will be issued to the conveyor at this time, and washing or PRESPRAY will continue.

To restart, press "RESET" - "CONVEYOR RESET" after PRESPRAY is completed.

#### (4) POINT 2

The HIGH VOLTAGE, SHAPING AIR, RECIPRO motor and CCV are turned ON with this point.

#### (5) POINT 3 to 14 (SIDE), POINT 3 to 27 (ROOF)

The CCV turns ON between these points, and the FLOW RATE and SHAPING AIR stages can be changed.

#### (6) POINT 15 (SIDE), 28 (ROOF)

The CCV, RECIPRO motor are turned OFF with this point and brakes are applied to the AIR MOTOR, and lowers to the washing rotation.

#### (7) POINT 16 (SIDE), 29 (ROOF)

The HIGH VOLTAGE, SHAPING AIR are turned OFF with this point, and washing starts.

#### (8) POINT 17 (SIDE), 30 (ROOF)

The counter and work area are cleared with this point as the counter reset.

### 3-9 WASHING TIME CHART (No.3ST BELL)

By carrying out washing automatically, the color can be changed between bodies in this paint system.

Basically, the washing movement is controlled completely with timers, and can be carried out with a combination of the four washing cycles shown below.

#### (1) DUMP WASHING

This washing cycle washes in the order of "MANIFOLD" → "CENTER VALVE" → "F/P" → "TRIGGER" → "DUMP".

Washing is carried out by closing the TRIGGER, opening the CENTER VALVE and DUMP, and alternately turning the PURGE AIR and PURGE THINNER valves ON and OFF.

#### (2) HEAD DUMP WASHING

This washing cycle washes the HEAD DUMP.

Washing is carried out by opening the HEAD DUMP, closing the needle and alternately turning the SOFT AIR and SOFT THINNER valves ON and OFF.

#### (3) NEEDLE WASHING

This washing cycle washes in the order of "HEAD DUMP" → "NEEDLE" → "BELL".

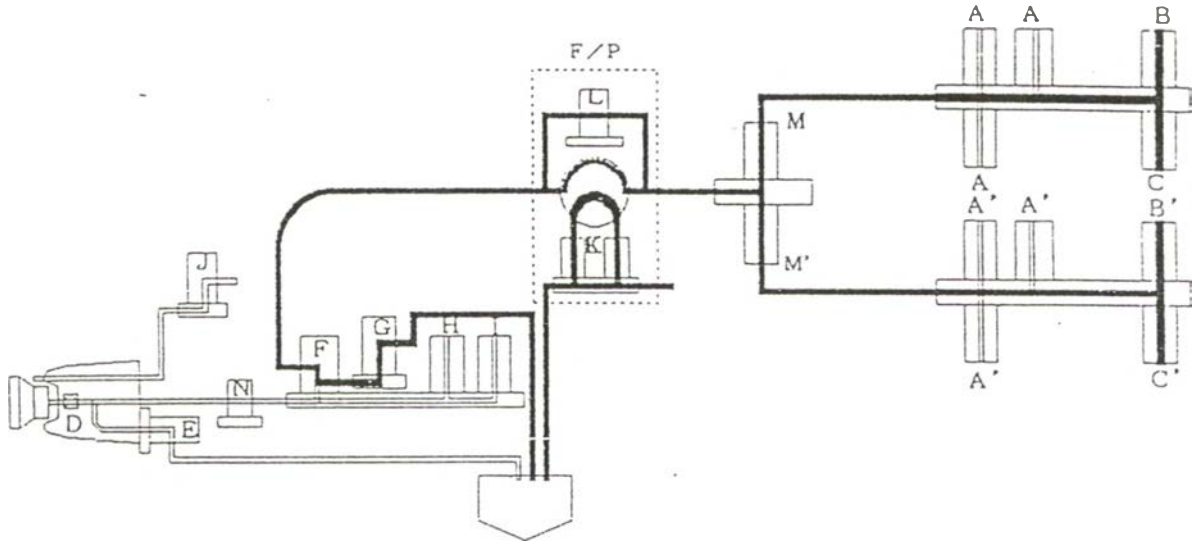
Washing is carried out with the HEAD DUMP and NEEDLE opened, and by alternately turning the SOFT AIR and SOFT THINNER valves ON and OFF.

#### (4) BELL CUP WASHING

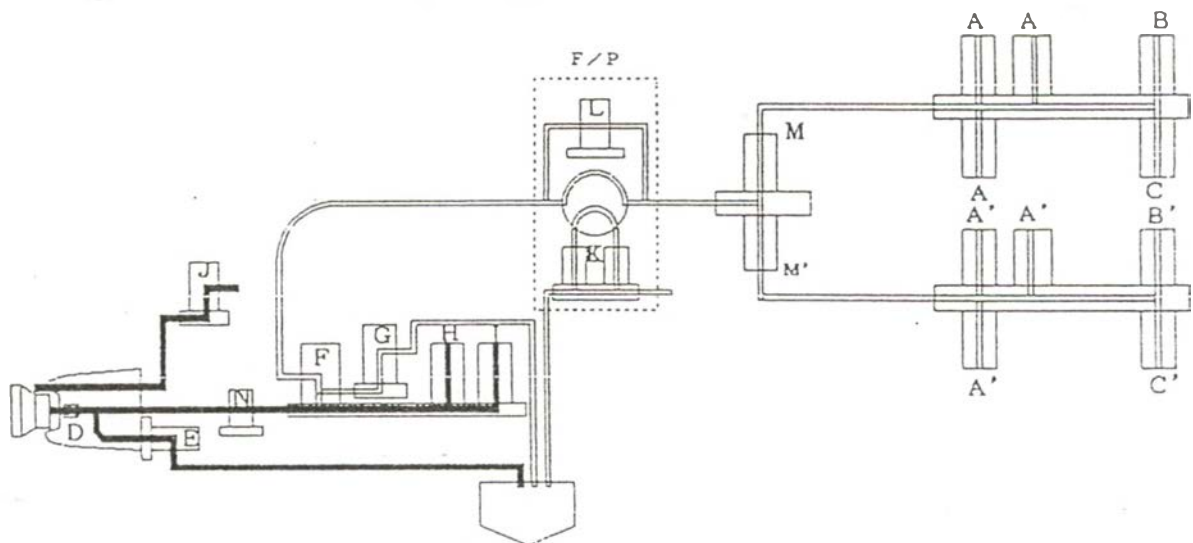
This washing cycle washes the back of the BELL CUP with BACK FACE THINNER.

### 3-10 Configuration of various valves (No.3ST BELL)

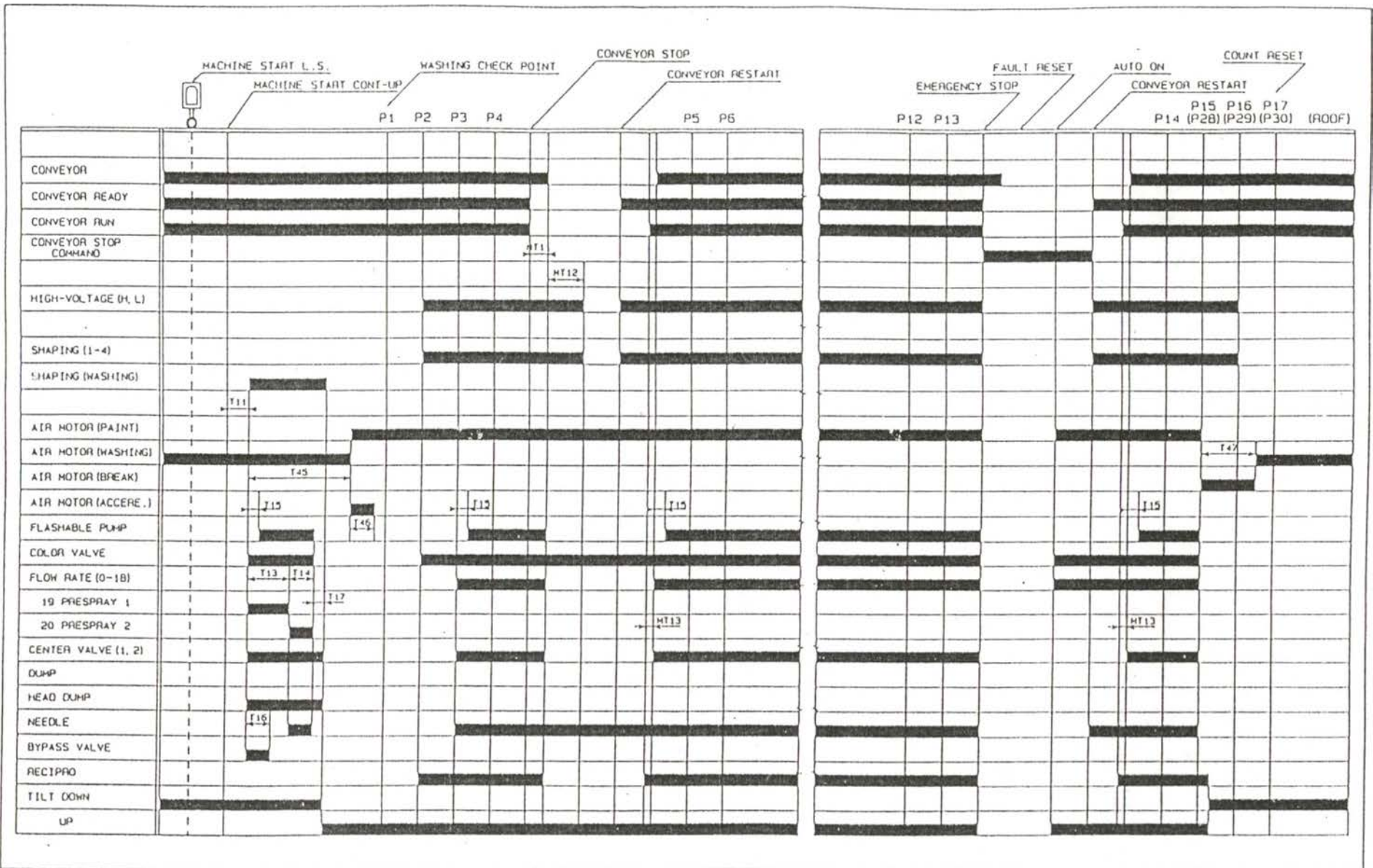
#### DUMP WASHING



#### HEAD DUMP & NEEDLE WASHING

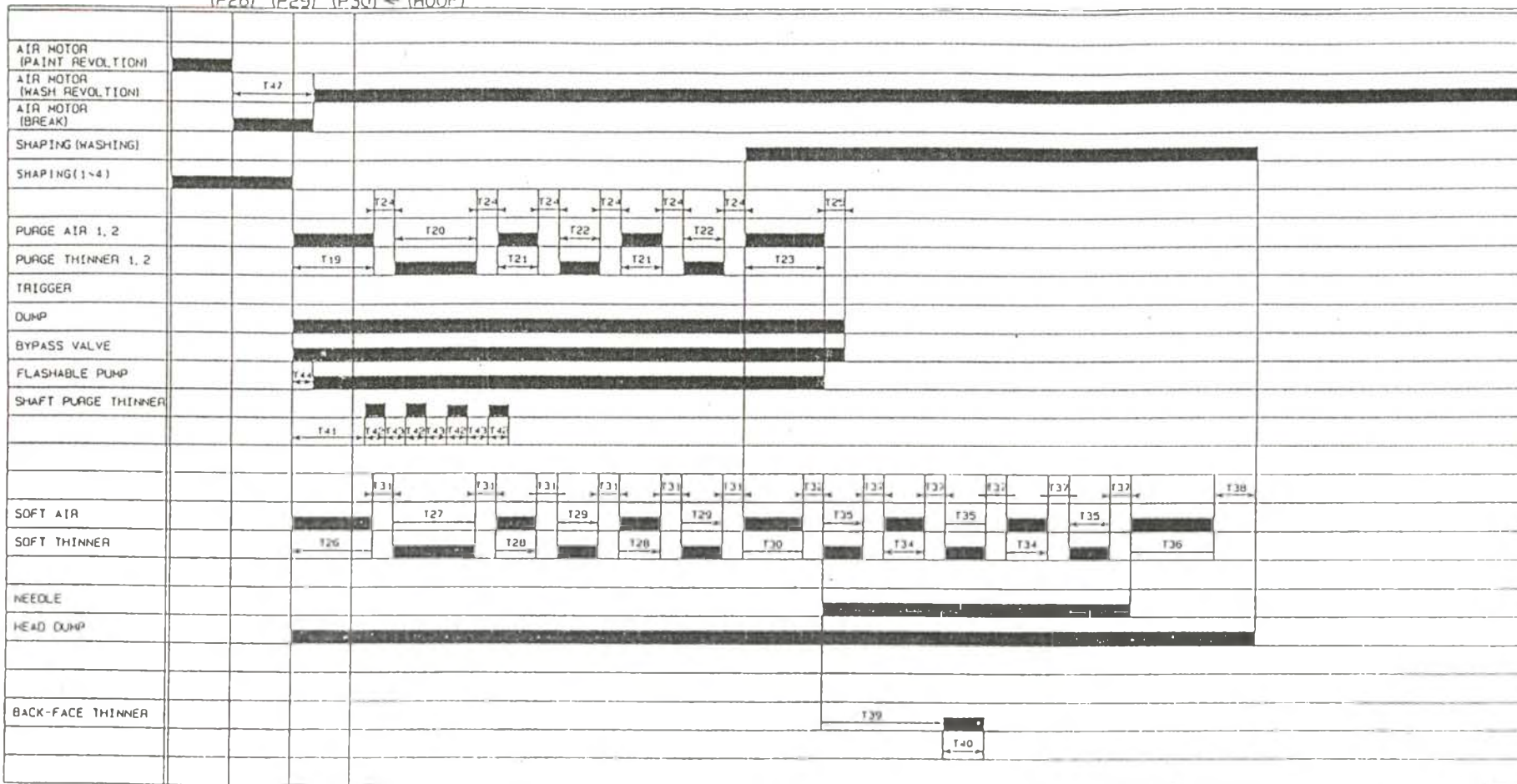


- |         |               |          |                   |
|---------|---------------|----------|-------------------|
| (A) ... | CCV           | (I) .... | SOFT THINNER      |
| (B) ... | PURGE AIR     | (J) .... | BACK FACE THINNER |
| (C) ... | PURGE THINNER | (K) ...  | SHAFT PURGE       |
| (D) ... | NEEDLE        | (L) ...  | BYPASS VALVE      |
| (E) ... | HEAD DUMP     | (M) ...  | CENTER VALVE 1, 2 |
| (F) ... | TRIGGER       | (N) ...  | METALLING         |
| (G) ... | DUMP          |          |                   |
| (H) ... | SOFT AIR      |          |                   |



No.	COMMENT	No.	COMMENT	No.	COMMENT	No.	COMMENT	No.	COMMENT	M/C	TITLE
MT11	CONVEYOR SLIP	T13	PRESRAY HEAD DUMP	T17	PRESRAY HEAD DUMP DELAY						TOP COAT, No. 3 STAGE PAINT TIME CHART
MT12	CONVEYOR H/V SP DELAY	T14	PRESRAY NEEDLE	T45	AIR MOTOR ACCELERATION TIMING						
MT13	CONVEYOR STOP PAINT DELAY	T15	FLASHABLE PUMP DELAY	T46	AIR MOTOR ACCELERATION						B E L L
T11	PRESRAY START DELAY	T16	PRESRAY BYPASS	T47	AIR MOTOR BREAK						
No.	COMMENT	No.	COMMENT	No.	COMMENT	No.	COMMENT	No.	COMMENT		

WASHING START  
 P15 P16 P17 ← SIDE  
 (P28) (P29) (P30) ← (ROOF)



T19	BOX WASHING FIRST AIR	T24	BOX WASHING CHANGE TIMING	T29	HEAD DUMP WASHING SOFT THINNER	T35	NEEDLE WASHING SOFT THINNER	T40	CUP BACK FACE THINNER
T20	BOX WASHING FIRST THINNER	T25	BOX WASHING DELAY TIMING	T30	HEAD DUMP WASHING FINAL SOFT THINNER	T36	NEEDLE WASHING FINAL AIR	T41	SHAFT PURGE START TIMING
T21	BOX WASHING PURGE AIR	T26	HEAD DUMP WASHING FIRST SOFT AIR	T31	HEAD DUMP WASHING CHANGE TIMING	T37	NEEDLE WASHING CHANGE TIMING	T42	SHAFT PURGE THINNER
T22	BOX WASHING PURGE THINNER	T27	HEAD DUMP WASHING FIRST SOFT THINNER	T32	NEEDLE WASHING INTERVAL	T38	NEEDLE WASHING DELAY TIMING	T43	SHAFT PURGE INTERVAL
T23	BOX WASHING FINAL AIR	T28	HEAD DUMP WASHING SOFT AIR	T34	NEEDLE WASHING SOFT AIR	T39	CUP WASHING START TIMING	T44	WASHING FLASHABLE PUMP DELAY
No.	COMMENT	No.	COMMENT	No.	COMMENT	No.	COMMENT	T47	AIR MOTOR BREAK

TILTLE

M/C

TOP COAT No. 3 STAGE  
 WASH TIME CHART

B E L L



APPENDIX B : Machine Failure and Repair Record

<b>Machine Failure and Repair Record</b>			
<b>Machine Code</b>	<b>Date of Failure</b>	<b>Cause of Failure</b>	<b>Corrective Action</b>
T-Bell4-015			
	10/1/94	valve soft air leaks	change the vavle
	1/2/94	valve purge air malfunctions	change the vavle
	16/2/94	valve soft air malfunctions	change the vavle
	11/5/94	valve purge air leaks	change the vavle
	2/6/94	valve soft air malfunctions	change the vavle
	1/8/94	valve purge air leaks	change the vavle
	23/8/94	valve soft air malfunctions	change the vavle
	20/10/94	valve purge air malfunctions	change the vavle
	21/12/94	valve soft air leaks	change the vavle
	28/2/95	valve soft air leaks	change the vavle
	22/3/95	valve purge air leaks	change the vavle
	24/4/95	valve soft air malfunctions	change the vavle
	9/5/95	valve purge air leaks	change the vavle
	29/5/95	valve purge air malfunctions	change the vavle
	30/5/95	valve soft air malfunctions	change the vavle

<b>Machine Failure and Repair Record</b>			
<b>Machine Code</b>	<b>Date of Failure</b>	<b>Cause of Failure</b>	<b>Corrective Action</b>
T-Bell4-015			
	13/7/95	valve purge air leaks	change the vavle
	20/7/95	valve soft air malfunctions	change the vavle
	21/8/95	valve soft air leaks	change the vavle
	13/9/95	valve purge air malfunctions	change the vavle
	25/10/95	valve soft air leaks	change the vavle
	9/1/96	valve purge air leaks	change the vavle
	25/1/96	valve soft air malfunctions	change the vavle
	14/2/96	valve purge air leaks	change the vavle
	22/4/96	valve soft air malfunctions	change the vavle
	17/6/96	valve purge air malfunctions	change the vavle
	17/7/96	valve soft air leaks	change the vavle
	12/9/96	valve purge air leaks	change the vavle
	30/9/96	valve soft air malfunctions	change the vavle

## APPENDIX C : Equipment Stop Daily Report

# EQUIPMENT TOP DAILY REPORT

DATE .....  
SHIFT "B"

TIME		M/C NAME	EQUIPMENT	LINE	BY	CAUSE	ปัญหา	สาเหตุ และการวิเคราะห์	ซ่อม / แก้ไข และการป้องกัน	ผู้ปฏิบัติการ
FORM	TO		STOP(MIN)	STOP(MIN)						
8.00	8.12.	B#4.	12.	11.9.	M/T	7.	BELL ROOF ท่อ L B#4 มีขี้ปูน ขาดต่อเนื้องจาก ก: A (ท่อตันเข้า). (หินเหล็ก ทรายใส่ผ่านหน้า)	สาเหตุ (ไม่ทราบทาง ก: A) ไปด้วย แก้ไข	ท่อน (ทาง ก: "A")	"A"
10.20	10.28.	B#4.	8.10 CONV. 10.11	7.6.	P/D	7.	PRESSURE THINNER VAL M/C DROP ลงเหลือบประมาณ 2 kg ทน P/D B#4. ทราย CONV	สาเหตุ - ทน P/D MIX 70% เปิด VALVE THINNER หัวของ JUNIOR MIXING B#4 ทำการล้างหัว. ทำให้ PRESSURE ตก. วิเคราะห์ - RUMP THINNER รั่ว. - หัว SUPPLY, RETURN รั่ว ทน.	ท่อน - แจ้งทาง P/D ให้ปิด VALVE หลัง 10 PRESSURE O.k.	"B"
<p>(1) เปลี่ยนชื่อ FORM ให้สั้น ตัวเขียน ยกเลิก FORM เดิม * FORM ใหม่ ป้องกันข้อผิดพลาด</p>										
11.10	11.10.	B#4.	6.	5-7.	M/T	3.	BELL ROOF ท่อ L ST3 มีขี้ปูนตามเส้นท่อ. 1) PRESSURE (อุดตันชั่วคราว)	สาเหตุ - ปิด BY PASS VALVE เสีย. เปลี่ยนชั่วคราว และ	ท่อน - เปลี่ยนชุด BY PASS VALVE ตามเดิม หัว → O.k. เปลี่ยนชุดและเปิด PLAN 607 BY PASS ออกของ CHE	"B"

- ประเภทของสาเหตุ
1. บกพร่องจากการบำรุงรักษา
  2. บกพร่องจากการซ่อม/หัดแปลง
  3. ปัญหาเครื่องจักร
  4. การเสื่อมสภาพที่ไม่สามารถตรวจพบได้
  5. การออกแบบที่ไม่เหมาะสม
  6. การใช้งานไม่ถูกต้อง
  7. สาเหตุอื่นๆ

SUMMARY DAILY RECOARD					
EQUIPMENT STOP(MIN)			LINE STOP(MIN)		
M/T	9		M/T	9	
P/D			P/D		
O/T			O/T		
BIG POBLEM >10 MIN BY M/T			ITEM		
PRODUCTION TIME			MIN		
OVERTIME (O.T) BY M/T			MIN		

M/E	CF/EM	CHEK	ISSUE
[Signature]	[Signature]	[Signature]	SUNASAK

# EQUIPMENT TOP DAILY REPORT

DATE: .....  
SHIFT: B. ....

TIME		M/C NAME	EQUIPMENT	LINE	BY	CAUSE	ปัญหา	สาเหตุ และการวิเคราะห์	ซ่อม / แก้ไข และการป้องกัน	ผู้ปฏิบัติงาน
FORM	TO		STOP(MIN)	STOP(MIN)						
							๗๖ จากหน้าทวน (2) พดรค.FNG เคยทำซ้ำบ่อย เลขที่ไฟใต้ SOLT0 พดรค. SUCLEAN	สาเหตุ - ชด BY THRS VALUE เสีย. - VALUE SOFT ATR เสีย. - VALUE SOFT TANNER เสีย. - VALUE BURGE ARR "1" เสีย. - CHECK VALUE SOFT ATR. ตั้งขึ้น 7.0 ต่อวัน.	ผลิต 1. 1.1 ทำตามเปลี่ยน ตามกบ 1.1.1 ทำตามหลักตามต้น ต้น. 1.1.2 ทำตาม ๗๖ → O.K.	" B "
๕.๐๐	๒๑.๐๐			๗ B S	M/T	-	No 7.0 ต่อวัน	เปลี่ยน FORM ใหม่ ๗๖ เลือก FORM ๗๖		

- ประเภทของรายการ**
1. บกหรือจากการบำรุงรักษา
  2. บกหรือจากการซ่อม/หัดแปลง
  3. ปัญหาเครื่อง
  4. การเตือนสภาพที่ไม่สามารถควบคุมได้
  5. การออกนอกพื้นที่ไม่เหมาะสม
  6. การใช้งานไม่ถูกต้อง
  7. สาเหตุอื่นๆ

SUMMARY DAILY RECOARD					
EQUIPMENT STOP(MIN)			LINE STOP(MIN)		
M/T			M/T		
P/D			P/D		
O/T			O/T		
BIG POBLEM >10 MIN BY M/T			ITEM		
PRODUCTION TIME			MIN		
OVERTIME (O.T) BY M/T			MIN		

MCR	CF/PM	CHECK	ISSUE
[Signature]	[Signature]	[Signature]	SCM ๗๖/๒๑

## APPENDIX D : Median Rank Table





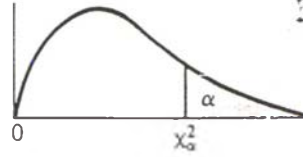






## APPENDIX E : Critical Values of Chi-square Table

TABLE 5 Critical values of chi-square



d.f.	$\chi^2_{0.995}$	$\chi^2_{0.990}$	$\chi^2_{0.975}$	$\chi^2_{0.950}$	$\chi^2_{0.900}$
1	0.0000393	0.0001571	0.0009821	0.0039321	0.0157908
2	0.0100251	0.0201007	0.0506356	0.102587	0.210720
3	0.0717212	0.114832	0.215795	0.351846	0.584375
4	0.206990	0.297110	0.484419	0.710721	1.063623
5	0.411740	0.554300	0.831211	1.145476	1.61031
6	0.675727	0.872085	1.237347	1.63539	2.20413
7	0.989265	1.239043	1.68987	2.16735	2.83311
8	1.344419	1.646482	2.17973	2.73264	3.48954
9	1.734926	2.087912	2.70039	3.32511	4.16816
10	2.15585	2.55821	3.24697	3.94030	4.86518
11	2.60321	3.05347	3.81575	4.57481	5.57779
12	3.07382	3.57056	4.40379	5.22603	6.30380
13	3.56503	4.10691	5.00874	5.89186	7.04150
14	4.07468	4.66043	5.62872	6.57063	7.78953
15	4.60094	5.22935	6.26214	7.26094	8.54675
16	5.14224	5.81221	6.90766	7.96164	9.31223
17	5.69724	6.40776	7.56418	8.67176	10.0852
18	6.26481	7.01491	8.23075	9.39046	10.8649
19	6.84398	7.63273	8.90655	10.1170	11.6509
20	7.43386	8.26040	9.59083	10.8508	12.4426
21	8.03366	8.89720	10.28293	11.5913	13.2396
22	8.64272	9.54249	10.9823	12.3380	14.0415
23	9.26042	10.19567	11.6885	13.0905	14.8479
24	9.88623	10.8564	12.4011	13.8484	15.6587
25	10.5197	11.5240	13.1197	14.6114	16.4734
26	11.1603	12.1981	13.8439	15.3791	17.2919
27	11.8076	12.8786	14.5733	16.1513	18.1138
28	12.4613	13.5643	15.3079	16.9279	18.9392
29	13.1211	14.2565	16.0471	17.7083	19.7677
30	13.7867	14.9535	16.7908	18.4926	20.5992
40	20.7065	22.1643	24.4331	26.5093	29.0505
50	27.9907	29.7067	32.3574	34.7642	37.6886
60	35.5346	37.4848	40.4817	43.1879	46.4589
70	43.2752	45.4418	48.7576	51.7393	55.3290
80	51.1720	53.5400	57.1532	60.3915	64.2778
90	59.1963	61.7541	65.6466	69.1260	73.2912
100	67.3276	70.0648	74.2219	77.9295	82.3581

TABLE 5 (Concluded)

$\chi^2_{0.100}$	$\chi^2_{0.050}$	$\chi^2_{0.025}$	$\chi^2_{0.010}$	$\chi^2_{0.005}$	d.f.
2.70554	3.84146	5.02389	6.63490	7.87944	1
4.60517	5.99147	7.37776	9.21034	10.5966	2
6.25139	7.81473	9.34840	11.3449	12.8381	3
7.77944	9.48773	11.1433	13.2767	14.8602	4
9.23635	11.0705	12.8325	15.0863	16.7496	5
10.6446	12.5916	14.4494	16.8119	18.5476	6
12.0170	14.0671	16.0128	18.4753	20.2777	7
13.3616	15.5073	17.5346	20.0902	21.9550	8
14.6837	16.9190	19.0228	21.6660	23.5893	9
15.9871	18.3070	20.4831	23.2093	25.1882	10
17.2750	19.6751	21.9200	24.7250	26.7569	11
18.5494	21.0261	23.3367	26.2170	28.2995	12
19.8119	22.3621	24.7356	27.6883	29.8194	13
21.0642	23.6848	26.1190	29.1413	31.3193	14
22.3072	24.9958	27.4884	30.5779	32.8013	15
23.5418	26.2962	28.8454	31.9999	34.2672	16
24.7690	27.5871	30.1910	33.4087	35.7185	17
25.9894	28.8693	31.5264	34.8053	37.1564	18
27.2036	30.1435	32.8523	36.1908	38.5822	19
28.4120	31.4104	34.1696	37.5662	39.9968	20
29.6151	32.6705	35.4789	38.9321	41.4010	21
30.8133	33.9244	36.7807	40.2894	42.7956	22
32.0069	35.1725	38.0757	41.6384	44.1813	23
33.1963	36.4151	39.3641	42.9798	45.5585	24
34.3816	37.6525	40.6465	44.3141	46.9278	25
35.5631	38.8852	41.9232	45.6417	48.2899	26
36.7412	40.1133	43.1944	46.9630	49.6449	27
37.9159	41.3372	44.4607	48.2782	50.9933	28
39.0875	42.5569	45.7222	49.5879	52.3356	29
40.2560	43.7729	46.9792	50.8922	53.6720	30
51.8050	55.7585	59.3417	63.6907	66.7659	40
63.1671	67.5048	71.4202	76.1539	79.4900	50
74.3970	79.0819	83.2976	88.3794	91.9517	60
85.5271	90.5312	95.0231	100.425	104.215	70
96.5782	101.879	106.629	112.329	116.321	80
107.565	113.145	118.136	124.116	128.299	90
118.498	124.342	129.561	135.807	140.169	100

From "Tables of the Percentage Points of the  $\chi^2$ -Distribution." *Biometrika Tables for Statisticians*, Vol. 1, 3rd ed. (1966). Reproduced by permission of the Biometrika Trustees.

## VITAE

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