INSTRUMENT QUESTIONS

I. PNEUMATICS:

1. EXPLAIN HOW A FLAPPER AND NOZZLE WORKS?
2. SKETCH A TYPICAL AIR SUPPLY TO AN INSTRUMENT?
3. EXPLAIN HOW A PNEUMATIC RELAY WORKS?
4. WHY DO WE HAVE A VENT HOLE AT THE BOTTOM OF A REGULATOR?
5. IF SUPPLY AIR HEADER PRESSURE FALL FROM 100 PSI TO 50 PSI, WILL THE REGULATOR OUTPUT ALSO FALL?
6. HOW DOES A LOCK UP RELAY WORKS?
7. DRAW A SKETCH OF A PNEUMATIC CONTROLLER WITH P.& I. D CONTROL?

11. FLOW;

1. HOW TO CHECK ZERO A FLOW TRANSMITTER (ORIFICE)?
2. WHAT ARE THE TYPES OF ORIFICE PLATES?
3. WHY DO WE HAVE A SMALL HOLE, SOMETIMES ABOVE OR BELOW THE ORIFICE HOLE?
4. HOW TO TOP UP/ FILL LINES ON FILLED SYSTEM INSTALLATION?
5. ADVANTAGES/DISADVANTAGES OF ORIFICE PLATES, VENTURI TUBES ETC.
6. SIZING OF ORIFICE PLATES (ENGINEER, S.I.T ONLY)
7. SKETCH TYPICAL FLOW INSTALLATION.
8. WHY DO WE FIND A SQUARE ROOT EXTRACTOR ON FLOW LOOPS?
9. WHY ARE MAGNETIC TYPE FLOW METERS GENERALLY NOT USED IN REFINERIES?
10. RE RANGE A D.P TYPE FLOW METER (CALCULATION)

111. LEVEL:

1. HOW DO YOU CALIBRATE A LEVELTROL/DENSITY ADJUSTMENT?
2. HOW DO CALIBRATE AN INSTRUMENT USED ON INTERFACE SERVICE?
3. HOW DO CALIBRATE A LEVEL SWITCH (INCREASING AND DECREASING) SIGNAL?
4. ELEVATION AND SUPPRESSION KITS WHY WE USE?
5. TYPICAL OPEN AND CLOSED TANK LEVEL MEASURING SYSTEM?
6. CAPACITANCE LEVEL TYPE LEVEL MEASUREMENT, EXPLAIN.
7. TYPICAL LEVEL ALARM SETTINGS FOR HIGH (H), HIGH HIGH (HH), LOW (L), AND LOW LOW(LL)
8. ENRAF TYPE LEVEL GAUGES.
9. BUBBLE TUBE TYPE INSTALLATION
10. EFFECT OF DENSITY ON LEVEL MEASUREMENT?

1V. PRESSURE:

1. TYPE OF PRESSURE GAUGES .
2. ABSOLUTE / GAUGE PRESSURE / DIFFERENTIAL PRESSURE.
3. ZERO ADJUSTMENT ON A PRESSURE GAUGE.
4. MEASURING VACUUM. VACUUM SCALE EXPLAIN.
5. HOW DOES A BOURDON TUBE WORKS?
6. HOW DOES A D.P CELL WORKS?
7. HOW WOULD YOU CALIBRATE A HIGH RANGE PRESSURE TRANSMITTER (0~100 H.G)

V. TEMPERATURE:

1. 2 ,3 AND 4 WIRE R.T.D. CIRCUITS?
2. THERMOCOUPLE PRINCIPLE.
3. TYPES OF THERMOCOUPLES.
4. UPSCALE BURNOUT.

5. ABSOLUTE TEMPERATURE/ DEG.F TO DEG.C CONVERSION.
6. DIFFERENCE BETWEEN THERMOCOUPLE CABLE AND COMPENSATING CABLE.
7. FILLED SYSTEMS. SCALE READING FOR LIQUID , VAPOUR AND GAS.
8. CONNECTING OF THERMOCOUPLE LEADS TO COMPENSATING CABLE.
9. AMBIENT TEMP. COMPENSATION FOR THERMOCOUPLES.
10. AMBIENT TEMP. COMPENSATION FOR FILLED SYSTEMS.

VI.CONTROL VALVES:

1. TYPES OF CONTROL VALVES.
2. SKETCH IN DETAIL ALL PARTS OF A VALVE.
3. WHY DO WE USE A POSITIONER?
4. WHAT IS F.O / F.C / F.L (FAIL OPEN, FAIL CLOSED, FAIL LOCKED)?
5. WHAT IS A C.V OF A VALVE?
6. ADVANTAGES, DISADVANTAGES OF DIFFERENT TYPES OF VALVES.
7. SEAT TIGHTNESS (ENGINEERS, S.I.T.S, ONLY)
8. SIZING OF CONTROL VALVES (ENGINEERS, S.I.T. ONLY)
9. HOW TO REVERSE ACTION OF A VALVE?
10. REPLACEMENT OF VALVE PACKING.
11. HOW WOULD YOU DEAL WITH A JERKY OR STICKING OF A CONTROL VALVE?

VII. AUTOMATIC CONTROL SYSTEMS:

1. EXPLAIN P.&I.D ACTION.
2. WHERE DO WE NORMALLY USE D ACTION.
3. SKETCH CASCADE CONTROL LOOP. EXPLAIN OPERATION.
4. WHY WE USE CASCADE CONTROL?
5. EXPLAIN HOW DO YOU TUNE A CONTROL LOOP.
6. IN CASCADE CONTROL, WHICH IS MASTER, WHICH IS SLAVE?
7. WHAT IS ON-OFF CONTROL?
8. HOW TO COMMISSION A CASCADE LOOP?
9. HOW CAN INTEGRAL ACTION INTRODUCE PROBLEM?

VIII. SAFETY, HAZARDOUS AREAS:

1. EXPLAIN INTRINSIC SAFETY.
2. WHAT IS A ZENER BARRIER?
3. ZONE CLASSIFICATIONS.
4. USE OF TEST EQUIPMENT IN HAZARDOUS AREAS.
5. PURGING OF CABINETS WITH INERT GAS OR CLEAN AIR.
6. WHAT IS THE NORMAL ZONE CLASSIFICATION FOR A REFINERY.
7. USE OF WORK PERMITS(HOT AND COLD PERMITS).
8. MEANING OF EXPLOSION PROOF?

GENERAL QUESTIONS:

1. EXPLAIN THE PRINCIPLE OF OPERATION OF AN ELECTRONIC TRANSMITTER WITH BLOCK DIAGRAM.
2. WHAT IS A HOOK - UP DIAGRAM? WHAT ARE THE DIFFERENT TYPES OF TAPPING FOR AN ORIFICE PUT IN (A) GAS (B) LIQUID (C) STEAM SERVICE EXPLAIN.
3. WHAT ARE DIFFERENT TYPES OF FLOW MEASUREMENTS/
4. EXPLAIN A TYPICAL PROCESS (IN YOUR PLANT) ITS AND ASSOCIATED MEASUREMENT + CONTROL. (VIZ. TANK LEVEL, AIR COMPRESSOR, ETC.).
5. WHAT IS A SIMPLE P.I.D CONTROLLER? EXPLAIN THE ACTIONS OF P.I.D.
6. EXPLAIN THE DIFFERENCE BETWEEN ALIGNMENT AND TUNING OF THE CONTROLLER?
7. EXPLAIN TUNING OF THE CONTROLLER WITH JUSTIFICATION?
8. WHAT IS A CASCADE CONTROL SYSTEM? GIVE A TYPICAL EXAMPLE AND EXPLAIN?

9. DRAW A FLOW LOOP (CLOSED)WITH PROPER SYMBOLS? (PNEUMATIC AND ELECTRONIC).
10. LIST DIFFERENT TYPES OF CONTROL VALVES? NAME THE PARTS OF A TYPICAL VALVE YOU ARE FAMILIAR WITH.
11. HOW YOU REDUCE CAVITATION IN THE VALVE?
12. EXPLAIN THE APPLICATION OF SINGLE SEATED AND DOUBLE SEATED VALVES WITH ITS LIMITATIONS?
13. WHAT ARE THE DIFFERENT ACCESSORIES OF A CONTROL VALVE?
14. WHAT ARE THE MATERIALS USED FOR PLUG AND SEAT WHEN THE TEMPERATURE OF THE FLUID IS HIGH AT CORROSIVE ATMOSPHERE?
15. EXPLAIN FLOW CHARACTERISTIC OF A VALVE + C.V OF VALVE.
16. WHAT ARE THE DIFFERENCE BETWEEN R. T. D. + THERMOCOUPLE? LIST DIFFERENT TYPES OF THERMOCOUPLE AND THEIR RANGES.
17. EXPLAIN THE METHOD OF CALIBRATING A LEVEL TROL IN SITE WITH WATER?
18. WHAT IS A JUNCTION BOX? EXPLAIN THE FUNCTION OF IT.
19. INTRINSIC SAFETY - EXPLAIN.
20. DRAW A CIRCUIT OF FULL WAVE RECTIFIER AND DERIVE A DUAL POWER SUPPLY.
21. WHAT ARE THE LOGIC CIRCUITS? EXPLAIN AND, OR, NOT NOR, NAND CIRCUITS USING DIODES.
22. WHAT IS A MULTIPLEXER?
23. STATE THE DIFFERENCES BETWEEN RELAY LOGIC + PROGRAMMABLE LOGIC CONTROLLER?
24. EXPLAIN THE ACTION OF AIR TO OPEN AND AIR TO CLOSE ACTION OF A CONTROL VALVE? EXPLAIN WHY.
25. EXPLAIN WITH EXAMPLE SPLIT RANGE ACTION.
26. WHAT IS AN IMPULSE LINE? ITS LIMITATIONS.
27. CONNECT A THREE WAY SOLENOID VALVE TO A CONTROL VALVE AND EXPLAIN SHUTDOWN ACTION FOR A TYPICAL PROCESS YOU ARE FAMILIAR WITH.
28. LIST THE TEST INSTRUMENTS FOR CALIBRATING 0 - 1000 PSI ELECTRONIC TRANSMITTER AND EXPLAIN THE METHOD.
29. WHAT ARE UNITS OF PRESSURE , FLOW ,TEMPERATURE ,AND CONDUCTIVITY?
30. EXPLAIN A TYPICAL PROBLEM YOU HAVE FACED IN YOUR PLANT IN RECENT TIMES + HOW DID YOU TROUBLE SHOOT IT?

M.F. KENTZ QUESTIONS:

FROM : L.H. CRINNION, INST. SUPT., K.P.S.
SUBJECT : TYPICAL QUESTIONS ASKED BY K.N.P.C. FOR THE POSITION OF SENIOR FOREMAN AN ALSO TO SOME EXTENT FOREMAN.

1. DRAW A TYPICAL FLOW ,LEVEL, PRESSURE, TEMPERATURE CONTROL LOOP AND GIVE A FULL EXPLANATION.
2. NAME AS MANY PRIMARY MEASURING ELEMENTS AS YOU CAN FOR FLOW, LEVEL, PRESSURE, AND TEMPERATURE.
3. WHAT IS MEANT BY CLOSED LOOP AND OPEN LOOP CONTROL.
4. DESCRIBE THE SEQUENCE USED TO ISOLATE A D/P TRANSMITTER.
5. DESCRIBE CALIBRATION OF A D/P CELL TRANSMITTER.
6. HOW DO IDENTIFY FLOW DIRECTION THROUGH AN ORIFICE PLATE.
7. HOW DO TUNE A CONTROL LOOP.
8. DESCRIBE (IN GRAPH FORM AND VERBALLY) EACH OF THE 3 TERMS OF CONTROL P. , P +I , P + I +D .
9. DESCRIBE THE OPERATION OF I / P CONVERTER.
10. FUNCTIONS OF A VALVE POSITIONER.
11. SKETCH AND IDENTIFY MAJOR PARTS OF A TYPICAL CONTROL VALVE.
12. PROCEDURE OF HAVING A CONTROL VALVE ISOLATED AND REMOVED FROM THE PROCESS LINE (NOT FORGETTING OBTAINING WORK PERMIT)
13. WHAT TO LOOK FOR AND WHAT ACTION IN THE EVENT OF CONTROL VALVE STUCK IN …… POSITION.
14. HOW DO WE MEASURE LEVEL?
15. HOW DO WE COMMISSION A DP CELL USED FOR LEVEL MEASUREMENT IN A CLOSED VESSEL?

16. WHAT IS A THERMOCOUPLE ------ PRINCIPLE OF OPERATION----- HOT AND COLD AND JUNCTION--- EXPLAIN EXTENSION LEAD (COMPENSATION CABLE) – TYPE OF THERMOCOUPLE AND TYPICAL TEMP. RANGE.
17. WHAT IS A RTD? EXPLAIN DIFFERENCE 2 AND 3 WIRE SYSTEM. DRAW SKETCH A TYPICAL WHEATSTONE BRIDGE A SHOWING A 3 WIRE RTD.
18. WHAT IS FOX NET? EXPLAINATION OF SYSTEM AND TIE - INST. THROUGH U.E.M. , WHAT IS MEANT BY C.C.M.? WHAT IS THE TOTAL NUMBER OF INTERSPEC STATIONS CONNECTED TO AN INTERSPEC BUS? TIE IN OF INTERSPEC TO FOX NET.
19. WHAT IS A CASCADE CONTROL SYSTEM?
20. PROCEDURE OF COMMISSIONING A CASCADE CONTROL LOOP. SHOW TYPICAL SKETCH AND APPLICATION.

ATSCO INSTRUMENTATION QUESTIONS:

I. FLOW:

1. WHAT ARE THE PRIMARY ELEMENT USED FOR FLOW MEASUREMENTS?

   ORIFICE PLATE, VENTURI TUBE, FLOW NOZZLE, PITOT TUBE, AUNNUBAR.

2. WHAT ARE THE DIFFERENT TYPES OF ORIFICE AND ITS USES? WHERE IS A QUADRANT ORIFICE USED?

   CONCENTRIC - LIQUID, STEAM AND GAS SERVICE.
   ECCENTRIC - VISCOUS AND SLURRY FLOW.
   SEGMENTAL - SLURRY & COLLOIDAL FLOW.
   QUADRANT - USED FOR VISCOUS FLUIDS.

3. HOW DO YOU IDENTIFY AN ORIFICE PLATE IN THE PIPE LINE AND THE INLET OR HP?

   INDICATION OF AN ORIFICE PLATE IN A LINE IS IDENTIFIED BY THE TAB WHICH EXTENDS OUT OF THE LINE. HIGH PRESSURE SIDE IS IDENTIFIED BY INDENT ON TAB.

4. AN OPERATOR TELLS YOU THAT FLOW INDICATION IS MORE. HOW WOULD YOU START CHECKING IT?

   FIRST FLUSH THE TRANSMITTER (BOTH IMPULSE LINES). ADJUST ZERO BY EQUALISING IF NECESSARY. IF STILL THE INDICATION IS MORE THEN CHECK LP SIDE FOR CHOKE. IF THAT IS CLEAR THEN CHECK LEAKS ON THE LP SIDE. IF NO, CALIBRATE THE TRANSMITTER.

5. HOW WOULD YOU DO GLYCOL FILLING OR SEAL LIQUIDS IN SEAL POT?

   CLOSE THE PRIMARY ISOLATION VALVE. OPEN VENTS ON THE SEAL POTS. DRAIN THE USED GLYCOL IF PRESENT. CONNECT THE HAND PUMP ON THE LP SIDE. WHILE FILLING THE HP SIDE WITH GLYCOL, KEEP THE EQUALISING VALVE OPEN & LP SIDE CLOSED AND VICE VERSA.

6. HOW DO YOU CALCULATE NEW FACTOR FROM NEW RANGE, USING OLD FACTOR AND OLD RANGE?

$$\frac{\text{NEW FACTOR}}{\text{OLD FACTOR}} = \frac{\text{NEW RANGE}}{\text{OLD RANGE}}$$

7. WHY IS FLOW MEASURED IN SQUARE ROOT?

FLOW IS DIRECTLY PROPORTIONAL TO SQUARE ROOT OF DP. SINCE THIS FLOW VARIES DIRECTLY. THE FLOW CAN BE DETERMINED ONLY BY TAKING THE SQ. ROOT OF THE PEN.

8. WHERE IS INTEGRAL ORIFICE USED?

INTEGRAL ORIFICE IS USED TO MEASURE SMALL FLOW RATES.

9. WHAT IS A REYNOLDS NUMBER?

$$\frac{S\ V\ D}{U} \quad OR \quad \frac{3.54\ X\ Q\ N\ X\ P\ B}{U\ X\ D}$$

Q N = NOR. FLOW M3 / HR P B = DENSITY K G/ M3
U = VISCOSITY IN POISE D = I DIAMETER OF PIPE IN MM S = SP. GRAVITY

10. GIVEN Q1 = 200 M3/ HR , Q2 = 60 M3 / HR , DP1 = 2500 MM H2O. DP2 = ?
ALARM = 60 M3 / HR

Q1 / Q2 = K1 DP1 / K2 DP2 P2 = 225 MM

11. HOW DO YOU CONVERT PSI SIGNAL IN TO LINEAR?

PSI SIGNAL IN TO LINEAR = ((A-3) / 12) X 12 + 3

12. HOW DO YOU CALIBRATE A D / P TRANSMITTER IN LINE?

PROCUREMENT OF WORK PERMIT. CONTROLLER IN MANUAL MODE AND IF TRIP EXISTS, DISABLE THE SAME BY INFORMING THE OPERATOR. CLOSE THE MAIN ISOLATION VALVE (HP & LP), EQUALISE & DRAIN THE LIQUID IF ANY. ADJUST ZERO OF THE TRANSMITTER & REQUIRED SPAN BY APPLYING MAX. CAL. SPAN.

13. WHAT IS THE SEAL LIQUID FOR FILLING IMPULSE LINES ON CRUDE/ VISCOUS LIQUIDS?

GLYCOL.

14. HOW DO YOU CARRY OUT PIPING FOR D/P TRANSMITTER ON LIQUIDS, GAS & STEAM SERVICE?

FIG. 1

15. DRAW ANY FLOW CONTROL LOOP?

FIG. 2

16. I E C CODING AND CLASSIFICATIONS OF HAZARDOUS AREA

ZONE 0 AN EXPLOSIVE AIR MIXTURE IS PRESENT CONTINUOUSLY.
ZONE 1 AN EXPLOSIVE GAS MIXTURES IS LIKELY TO OCCUR.
ZONE 2 AN EXPLOSIVE GAS AIR MIXTURE IS LIKELY TO OCCUR , IF DOES OCCUR IT WILL ONLY EXIST FOR A SHORT TIME.

17. WHAT IS THE ROLE OF A RESTRICTOR IN THE SUPPLY LINE OF A TRANSMITTER?

TO AVOID DUST PARTICLE ENTERING.

18. ON WHICH SIDE OF THE FORCE BEAM IS THE FEEDBACK BELLOWS CONNECTED?

OPPOSITE TO THE FORCE BEAM MOVEMENT.

19. WHAT IS THE DIAMETER OF THE TRANSMITTER NOZZLE?

0.030" (0.8 MM)

20. WHY IS ma SIGNAL PREFERRED FOR SIGNAL TRANSMISSION?

NOISE REDUCTION AND NO CURRENT DROP FOR LONG TRANSMISSION LINE.

21. WHY DOES A TRANSMITTER O/ P SIGNAL START FROM 3 - 15 OR 4 - 20 M. A?

LINEAR AND CAN CHECK UP WHETHER ITS LIVE ZERO OR DEAD ZERO.

I. PRESSURE:

1. HOW WILL YOU CALIBRATE AN ABSOLUTE PRESSURE TRANSMITTER USING VACUUM MEASUREMENT RANGE 0 - 400 MM A B S. HG?

1. CONNECT THE AIR SUPPLY TO THE TRANSMITTER.
2. CONNECT TEST GAUGE OF 0 - 1.4 KG / CM 2 TO THE OUTPUT.
3. CONNECT VACUUM PUMP WITH TEE - OFF TO THE MANOMETER.
4. APPLY 760 MM HG VACUUM AND ADJUST ZERO.
5. APPLY 360 MM HG VACUUM AND ADJUST SPAN.

2. WHAT IS THE PRINCIPLE OF PRESSURE GAUGE?

MEASURING THE STRESS IN AN ELASTIC MEDIUM.

II. LEVEL:

1. WHAT ARE THE LIMITATION OF A LEVEL TROL?

MIN - 12" MAX - 72"

2. WHAT HAPPENS IF THE DISPLACER HAS FALLEN OR HAS A HOLE IN IT?

DISPLACER HAS FALLEN, OUTPUT WILL BE MAXIMUM.
HAS A HOLE IN IT, OUTPUT WILL BE MINIMUM.

III. CONTROL VALVE:

1. TYPES OF ACTION / TYPES OF ACTUATOR?

AIR TO CLOSE (DIRECT) AND AIR TO OPEN (REVERSE)

2. TYPES OF BODY DESIGN?

   GLOBE VALVE, SINGLE OR DOUBLE SEATED.
   ANGLE VALVE, BUTTERFLY VALVE, THREE WAY VALVE, PINCH VALVE, SAUNDERS VALVE AND BALL VALVE.

3. WHAT IS C_v OF A VALVE?

   NO. OF U.S GALLONS / MIN. OF H2O WHICH PASS THROUGH A FULLY OPEN VALVE AT A PRESSURE DROP OF 1 PSI AT 60 DEG. F .

4. WHAT TYPE OF BONNETS WOULD YOU USE FOR HIGH TEMPERATURE AND VERY LOW TEMPERATURE?

   HIGH TEMPERATURE BONNETS ARE PROVIDED WITH RADIATING FINS.
   LOW TEMPERATURE : EXTENDED BONNETS.

5. WHAT IS THE USE OF POSITIONER?

   1. QUICK ACTION AND POSITIONING OF CONTROL VALVE.
   2. VALVE HYSTERSIS. 3. VALVE USED ON VISCOUS LIQUIDS. 4. SPLIT RANGE. 5. LINE PRESSURE CHANGES ON VALVES. 6. VALVE BENCH SET NOT STANDARD 7. REVERSING VALVE OPERATION. 8. SPRING LESS ACTUATORS. 9. CHANGING VALVE CHARACTERISTICS.

6. WHEN CAN A BY- PASS NOT BE USED ON POSITIONER?

   1. SPLIT RANGE OPERATION.
   2. REVERSING ACTION POSITIONER.
   3. VALVE BENCH SET NOT STANTARD.

7. WHAT ARE THE DIFFERENT VALVE CHARACTERISTICS?

   LINEAR, EQUAL % , QUICK OPENING.

8. HOW WILL YOU CHANGE THE ACTION OF A CONTROL VALVE?

   IF THE CONTROL VALVE IS WITHOUT BOTTOM FLANGE THE ACTUATOR NEEDS TO BE CHANGED. IF THE BOTTOM FLANGE IS PROVIDED, DISCONNECT STEM, SEPARATE BODY FROM BONNET. REMOVE THE BOTTOM FLANGE AND PLUG FROM BODY . DETACH THE PLUG FROM THE STEM BY REMOVING THE PIN. FIX THE STEM AT THE OTHER END OF THE PLUG AND FOX THE PIN BACK. TURN THE BODY UPSIDE DOWN. CONNECT IT BACK TO THE BONNET AFTER INSERTING THE PLUG AND STEM. CONNECT BACK THE STEM AND COUPLE IT. FIX BACK THE BOTTOM FLANGE. CALIBRATE THE VALVE.

9. AN OPERATOR TELLS YOU THAT A CONTROL VALVE IS STUCK, HOW WILL YOU START CHECKING?

   PROCUREMENT OF WORK PERMIT, CONTROLLER IN MANUAL MODE, TRIP ENABLE NECESSARY TOOLS TO BE TAKEN, BYPASS OF A VALVE (TO BE DONE BY OPERATOR). APPLY AIR SIGNAL TO ACTUATOR, CHECK FOR STROKE. IF NUMBER DISENGAGE FROM SPLIT CLAMP AFTER TAKING NECESSARY PRECAUTION, SUPPLY TO ACTUATOR IF MOVING , PROBLEM IN BODY OF VALVE - REMOVE AFTER LINE IS DE PRESSURISING / DRAINED.

10. WHAT ARE E.S.D SYSTEM ON BOILER AND FURNACE?

    BOILER 1. FUEL PR. LOW
           2. ATOMISING STEAM PR. LOW

3. DRUM PR. HIGH
4. RETURN OIL PR. HIGH
5. FAN TRIP
6. FLAME FAILURE
7. DRUM LEVEL LOW

FURNACE

1. FUEL PRESSURE HIGH OR LOW
2. FEED FLOW LOW
3. FLAME FAILURE
4. FAN TRIP (ID & FD)

11. EXPLAIN RATIO CONTROL (FUEL TO AIR RATIO CONTROL OF FURNACE DIAGRAM)

FIG. 3

12. WHAT ARE INTRINSICALLY SAFE SYSTEM / CIRCUIT?

INTRINSIC SAFETY IS A TECHNIQUE FOR DESIGNING ELECTRICAL EQUIPMENT SAFE USE IN FLAMMABLE GAS OR VAPOUR AREA.
INTRINSICALLY SAFE CIRCUIT IS ONE IN WHICH ANY SPARK OR THERMAL EFFECT INDUCED EITHER NORMALLY OR UNDER SPECIFIED FAULT CONDITION IS IN CAPABLE OF USING ANY IGNITION IN AIR MIXTURE AT THE MOST EASILY IGNITED CONCENTRATION.

13. EXPLAIN DRAFT CONTROL.

WHEN BOTH FORCED DRAFT & INDUCED ARE USED TOGETHER AT SAME POINT IN THE SYSTEM THE PRESSURE WILL BE THE SAME AS THAT OF ATMOSPHERE. THEREFORE THE FURNACE PRESSURE MUST BE NEGATIVE TO PREVENT HOT GAS LEAKAGE. (0.1" H 2 O).

14. WHAT IS FEED BACK & FEED FORWARD CONTROL?

FEED BACK CONTROL INVOLVES THE DETECTION OF THE CONTROLLED VARIABLE & COUNTER ACTING OF CHANGES IN ITS VALUE RELATIVE TO SET POINT BY ADJUSTMENT OF THE MANIPULATED VARIABLE.
FEED FORE WARD CONTROL IS A SYSTEM IN WHICH CORRECTIVE ACTION IS BASED ON MEASUREMENT OF DISTURBANCE INPUTS INTO THE PROCESS.

15. EXPLAIN CASCADE CONTROL (TO PREVENT OUTSIDE DIST. FROM ENTERING THE PROCESS - FAST RECOVERY FROM LOAD CHANGES)

FIG. 4

CASCADE CONTROL MEANS TWO CONTROLLERS IN SERIES, ONE OF THEM IS A MASTER OR PRIMARY & THE SECOND IS THE SECONDARY OR SLAVE. THE SLAVE O/ P OF THE SLAVE CONTROLLER OPERATES THE FINAL CONTROL ELEMENT.

16. EXPLAIN PID CONTROL ON / OFF / DIFF. GAP. P = PROPORTIONAL CONTROL

P + CONTROL ONLY ATTEMPTS TO RETURN A MEASUREMENT TO THE SET POINT AFTER A LOAD UPSET HAS OCCURRED. HOWEVER IT IS IMPOSSIBLE FOR RETURN THE MEASUREMENT EXACTLY TO THE SET POINT.

P + RESET IT IS INTRODUCED TO ELIMINATE THE OFFSET & WILL INTEGRATE ANY DIFFERENCE BETWEEN MEASUREMENT & SET POINT & CAUSE THE CONTROLLERS OUTPUT TO CHANGE UNTIL THE DIFFERENCE BETWEEN THE MEASUREMENT & SET POINT IS ZERO. RESET WILL ACT AS LONG AS AN ERROR EXISTS.

P + I + D RATE ACTION HELPS THE CONTROLLER TO OVERCOME SYSTEM INERTIA & RESULT IN FASTER, MORE PRECISE CONTROL. DERIVATIVE ACTION OCCURS WHENEVER THE MEASUREMENT SIGNAL CHANGES. IT INJECTS MORE CORRECTIVE ACTIVE.

DIFF. GAP CONTROL IS SIMILAR TO ON - OFF CONTROL EXCEPT THAT A BAND OF GAP EXISTS AROUND THE CONTROL POINT.

17. EXPLAIN TUNING OF CONTROLLER; (A) CLOSED LOOP METHOD, (B) OPEN LOOP METHOD.

TUNING BASICALLY INVOLVES ADJUSTMENT OF P + I + D PARAMETERS TO ACHIEVE GOOD CONTROL. THE GAIN, TIME, CONSTANTS & DEAD TIMES AROUND THE LOOP WILL DICTATE THE SETTINGS OF VARIOUS PARAMETERS OF THE CONTROLLERS.
CLOSED LOOP METHOD : ULTIMATE GAIN METHOD.
OPEN LOOP METHOD : PROCESS REACTION CURVE.

18. ANALOGUE INTEGRATOR & ANALOGUE DIFFERENTIATOR.

FIG. 5 & 6

19. WHAT IS AN ANTI RESET WINDUP AND DE-SATURATORS?

ANTI RESET WINDUP - IF THE LIMIT ACTS THE FEEDBACK SECTION OF THE CONTROL AMPLIFIERS INTEGRAL CIRCUIT, THE CONTROLLERS OUTPUT WILL IMMEDIATELY BEGIN TO DRIVE IN THE OPPOSITE DIRECTION AS SOON AS THE PROCESS SIGNAL CROSSES THE SET POINT.

DE-SATURATORS - IN BATCH PROCESS LONG TRANSIENT RESPONSES ARE EXPECTED DURING WHICH A SUSTAINED DEVIATION IS PRESENT. THE CONTROLLER INTEGRAL ACTION CONTINUOUSLY DRIVES THE OUTPUT TO A MINIMUM OR MAXIMUM OF THE VALUE, HENCE OVERSHOT OCCURS TO AVOID THIS PHENOMENON DE-SATURATORS AND BIAS IS EMPLOYED, LIMITING THE POSITIVE FEED BACK SIGNAL TO MAINTAIN THE OUTPUT TO A VALUE TO WHICH THE UNIT IS SET. CONTROLLER ACTION CAN THUS RESUME IMMEDIATELY.

IV. TEMPERATURE:

1. TYPES OF THEMOCOUPLE?

1. IRON - CONSTANTAN (J) 210 - 800 DEG C.
2. CHROMEL - ALUMEL (K) 270 - 1000 DEG C.
3. CHROMEL - CONSTANTAN (E) 270 - 700 DEG C.

4. CU - CONSTANTAN (T) 270 - 400 DEG C.
5. PT - PT + RHODIUM(10%) (S) 50 - 1700 DEG C.
6. PT - PT + RHODIUM (13%) (R) 50 - 1500 DEG C.

2. RTD - TYPES?

1. RESISTANCE TEMPERATURE DETECTOR
2. PLATINUM
3. NICKEL
4. COPPER

3. WHAT DOES PT 100 MEAN?

PT - 100 MEANS 100 OHMS AT 0 DEG C.
RANGE : -220 TO 1050 DEG C.

4. DRAW 2 WIRE AND 3 WIRE RTD SYSTEM?

TWO WIRE THREE WIRE
FIG. 8 & 9

5. WHAT IS BURNOUT FEATURE IN A RECORDER AND SKIN T/C?

BURNOUT PROVIDES THE WARNING FEATURE OF DRIVING INDICATOR TO END OF SCALE IF THE INPUT CIRCUIT IS OPEN.
BURNOUT FEATURE UPSCALE - 20 MA
DOWN SCALE - 4 MA

6. WHY IS THERMOWELL USED?

THERMOWELL IS USED TO AVOID DIRECT EXPOSURE TO THE PROCESS, TO PROTECT FROM CORROSION, EROSION, ABRASION & HIGH PRESSURE PROCESS AND TO PROTECT FROM PHYSICAL DAMAGE DURING HANDLING & NORMAL OPERATION.

7. WHAT IS THREE ELEMENT CONTROL FEED WATER CONTROL SYSTEM?

FEED WATER CONTROL DRUM LEVEL CONTROL STEAM CONTROL

FIG. 7

$P3 = R(P2 - P1 - K) + P4 + K0$

WHERE, R = GAIN
K = ADJ. SUPPRESSION
K0 = ADJ. BIAS

BENTLY NEVADA VIBRATION MONITORING SYSTEM

INTRODUCTION :

STUDY OF MACHINES BEHAVIOUR IS IMPORTANT BOTH FOR MALFUNCTION DIAGNOSIS AND PREDICTIVE MAINTENANCE . MACHINES BEHAVIOUR IS EVIDENCED BY RADIAL AND AXIAL MOTIONS OF THE SHAFT . THE NATURE AND, ESPECIALLY , THE AMPLITUDE OF THESE SHAFT PROCESSIONS , REFERRED TO AS SHAFT ORBITS ARE SYMPTOMATIC OF WHAT IS GOING WRONG WITH THE MACHINE . IF THE MACHINE IS PERFECTLY ALIGNED AND BALANCED , AND IF ALL COMPONENTS OF THE MACHINE ARE IN PERFECT OPERATING ORDER , NO SEVERE SHAFT MOTION INDICATES SOMETHING IS OUT OF ORDER IN THE ROTATING MACHINE . EDDY CURRENT PROXIMITY MEASURING METHOD IS WIDELY USED FOR MACHINE PROTECTION AND MALFUNCTION DIAGNOSIS.

PROXIMITY MONITORING:

BENTLY MACHINE PROTECTION SYSTEM PROVIDES INSTRUMENTS TO MONITOR AND RECORD THE FOLLOWING PARAMETERS :

ROTOR DYNAMIC MOTION (RELATIVE VIBRATION)
ROTOR POSITION (AXIAL AND RADIAL)
ROTOR ECCENTRICITY
ROTOR TO SHELL DIFFERENTIAL EXPANSION
ROTOR SPEED
SHELL VIBRATION

BENTLY MACHINE PROTECTION ESSENTIALLY CONSIST OF

I) NON CONTACTING TYPE EDDY CURRENT PROBE
II) PROXIMITOR
III) MONITOR
IV) POWER SUPPLY UNIT

DEFINITION OF TERMS:

PROBE : A PROXIMITY MEASUREMENT DEVICE THAT RADIATES AN RF FIELD INTO A GIVEN AREA TO ALLOW NON CONTACTING MEASUREMENTS OF STATIC AND VARYING GAPS . TYPICAL PROBE DIAMETERS ARE 0.190 ‘’ AND 0.300 ‘’

PROXIMITOR : A TRANSDUCER AND RF GENERATING DEVICE THAT ARRIVES THE PROBE AND CONVERTS THE PROBE GAP INFORMATION INTO A PROPORTIONALLY LINEAR D.C OUTPUT VOLTAGE.

50 OHM INTEGRAL CABLE : A COAXIAL CABLE OF SPECIFIC / THAT IS AN INTEGRAL PART OF THE PROBE . THE CABLE IS THE INPUT / OUTPUT CONNECTION FOR THE PROBE .

95 OHM EXTN. CABLE : A COAXIAL CABLE OF SPECIFIC LENGTH / THAT INTERCONNECTS THE PROBE WITH 50 OHMS INTEGRAL CABLE AND CONNECTOR TO THE PROXIMITOR.

PROBE CALIBRATION CURVE : A PLOTTED CURVE OF A PROBE GAP IN MILS VERSUS PROXIMITOR OUTPUT IN D.C VOLTAGE , THAT REPRESENTS THE OPERATING CHARACTERISTICS OF THE PROBE , EXTENSION CABLE AND PROXIMITOR.

INITIAL GAP VOLTAGE : THE POINT ON THE PROBE CALIBRATION CURVE THAT CORRESPONDS TO THE APPROXIMATE CENTRE OF THE LINEAR OPERATING RANGE.

OBSERVED SURFACE : THE CONDUCTING SURFACE FROM WHICH THE PROBE IS GAPPED. THIS SURFACE IS ALSO THE SURFACE BEING MONITORED FOR GAP CHANGES BY THE PROBE .

MONITOR : IT IS THE INDICATING DEVICE WHICH CONVERTS THE PROXIMITOR OUTPUT TO A METER READOUT OF VIBRATION OF VIBRATION OR THRUST POSITION .

FUNCTIONAL DESCRIPTION :

FUNCTIONAL OPERATION CAN BE DIVIDED IN TO TWO DISTINCT CATEGORIES GAP MEASUREMENT (INITIAL GAP SETTING AND THRUST OR ECCENTRICITY MEASUREMENTS) AND VIBRATION MEASUREMENT (VARYING GAP MEASUREMENT).

GAP MEASUREMENT :

THE PROXIMITOR IS POWERED BY - 18 VOLTS FROM THE MONITORING DEVICE. THE PROXIMITOR CONVERTS THE - 18 VOLTS INTO AN RF SIGNAL THAT IS APPLIED TO THE PROBE THROUGH THE 95 OHMS COAXIAL EXTENSION CABLE . THE RF SIGNAL FREQUENCY IS ABOUT 2 ½ MHZ. THE PROBE COIL RADIATES THE RF SIGNAL INTO THE SURROUNDING AREA AS A MAGNETIC FIELD. IF THERE IS NO CONDUCTIVE MATERIAL WITHIN A SPECIFIED DISTANCE TO INTERCEPT THE MAGNETIC FIELD , THERE IS NO POWER LOSS IN THE RF SIGNAL . WITH NO POWER LOSS IN THE RF SIGNAL , THE OUTPUT SIGNAL AT THE PTROXIMITOR OUTPUT TERMINAL IS MAXIMUM (APPROXIMATELY - 14 VOLTS).

WHEN A CONDUCTIVE MATERIAL APPROACHES THE PROBE TIP, EDDY CURRENTS ARE GENERATED ON THE SURFACE OF THE MATERIAL, RESULTING IN A POWER LOSS IN THE RF SIGNAL . AS A POWER LOSS IS DEVELOPED IN THE RF SIGNAL, THE OUT PUT SIGNAL VOLTAGE AT THE PROXIMITOR OUTPUT TERMINAL IS REDUCED PROPORTIONATELY. AS THE OBSERVED CONDUCTIVE SURFACE COMES CLOSER TO THE PROBE TIP, MORE POWER IS ABSORBED BY THE EDDY CURRENTS ON THE SURFACE OF THE MATERIAL . WHEN THE PROBE IS VERY CLOSE TO THE CONDUCTIVE MATERIAL SURFACE , NEARLY ALL OF THE POWER RADIATED BY THE PROBE IN ABSORBED BY THE PROBE IN ABSORBED BY THE MATERIAL. THIS IS REFLECTED AS A MAXIMUM POWER LOSS OF RF SIGNAL , RESULTING IN A MINIMUM D.C OUTPUT SIGNAL AT THE PROXIMITOR OUTPUT TERMINAL . THE PROXIMITOR MEASURES THE MAGNITUDE OF THE RF SIGNAL , AND PROVIDES A D.C NEGATIVE D.C OUTPUT SIGNAL PROPORTIONAL TO THE PEAKS OF THE RF SIGNAL . THRUST MEASUREMENTS (AXIAL DISPLACEMENT) AND A ECCENTRICITY MEASUREMENTS AT A SLOW RATES OF CHANGE IN THE GAP (**SEE FIG. 1**).

VIBRATION MEASUREMENT:

IF THE OBSERVED SURFACE IS ROTATING AND RAPIDLY CHANGING THE GAP DISTANCE , THE RF SIGNAL AMPLITUDE IS NOT A CONSTANT AMPLITUDE , BUT VARIES IN DIRECT PROPORTION , TO THE PEAK TO PEAK MOVEMENT OF THE OBSERVED AS SHOWN IN **FIG. 2**

THIS PEAK TO PEAK MOVEMENT OF THE OBSERVED SURFACE CAUSES THE RF SIGNAL TO BE AMPLITUDE MODULATED . THE PROXIMITOR DETECTS THE MODULATED RF SIGNAL AS AN AC SIGNAL

VARYING AROUND A CONSTANT AVERAGE D.C VOLTAGE (INITIAL PROBE GAP SETTING) AS SHOWN IN **FIG. 3.**

HARDWARE DESCRIPTION :

PROBE :

THE ESSENTIAL PART OF THE PROBE IS A SMALL PANCAKE COIL PLACED ON THE TIP. THE COIL IS CONSTRUCTED OF SILVER WIRE AND IS ENCASED IN A CERAMIC CASE WITH A FIBRE GLASS PROTECTIVE FACE . THE RANGE OF ANY EDDY CURRENT PROBE IS DETERMINED BY THE COIL DIAMETER . THE LARGER THE COIL DIAMETER , THE LONGER THE OPERATING RANGE OF THE PROBE . FOR EXAMPLE , THE BENTLY PROBE WITH A TIP DIAMETER OF 190 MILS. HAS A TOTAL USABLE RANGE OF APPROXIMATELY 50 MILS . THE PROBE WITH A TIP DIAMETER OF 300 MILS HAS AN OPERATING RANGE OF APPROXIMATELY 80 MILS . DEPENDING UPON THE DESIGN REQUIREMENTS OF THE MACHINE TO BE MONITORED THE PROBE CAN TAKE ON MANY PHYSICAL CONFIGURATIONS . THE SILVER COIL AND CERAMIC TIP CAN BE CONTAINED IN ANY NUMBER OF DIFFERENT STAINLESS STEEL BODY DESIGNS. THESE DIFFERENT HOUSINGS WILL NOT AFFECT THE ELECTRICAL CHARACTERISTICS OF THE PROBE. EACH PROBE IS EQUIPPED WITH AN INTEGRAL COAXIAL CABLE AND CONNECTOR.

THE PROBE OPERATES ON INDUCTIVE PROXIMITY PRINCIPLE; THEREFORE THE PROBE DOES NOT CONTACT THE OBSERVED SURFACE AND IS NOT AFFECTED BY NON- CONDUCTING MATERIALS SUCH AS AIR, OIL, GAS, PLASTICS ETC., IN THE GAP BETWEEN THE PROBE TIP AND OBSERVED SURFACE.

THE SELECTION OF PROBES FOR SPECIFIC APPLICATIONS DEPENDS ON THE FOLLOWING REQUIREMENTS:

1. MEASURING RANGE
2. PHYSICAL SHAPE OF PROBE
3. PROBE ENVIRONMENT
4. DISTANCE FROM THE PROBE TO THE PROXIMITOR

PROXIMITOR:

THE PROXIMITOR IS THE AMPLIFYING UNIT THAT CONDITIONS THE ELECTRICAL ENERGY SUPPLIED TO THE PROBE AND ADJUST OR LINEARIZES THE RETURN SIGNAL TO A STANDARD OF 200 MV/MIL. THE OUTPUT OF THE PROXIMITOR IS A VOLTAGE VARYING DIRECTLY AS THE DISTANCE BETWEEN THE PROBE AND THE OBSERVED SURFACE VARIES. THIS OUTPUT VOLTAGE MAY BE USED TO DRIVE NUMEROUS DEVICES SUCH AS OSCILLOSCOPE, DIGITAL VOLTMETER, CHART RECORDERS, TAPE RECORDERS OR MONITORS.

EXTENSION CABLE:

THE PURPOSE OF THE EXTENSION CABLE IS TO ALLOW SUFFICIENT PHYSICAL SEPARATION BETWEEN THE PROBE AND PROXIMITOR TO MOUNT THE PROXIMITORS IN A PROTECTED LOCATION.

BECAUSE THE 50 OHM COAXIAL CABLE USED FOR PROBE LEADS HAS APPROXIMATELY TWICE THE CAPACITANCE OF THE 95 OHM COAX USED FOR EXTENSION CABLES, THE PROBE LEAD MUST BE SUBTRACTED FROM THE FIXED LENGTH AT THE RATE OF TWO FEET. FOR EVERY FOOT OF ACTUAL 50 OHM PROBE LEAD.

EXAMPLE: A BNC 3120 PROXIMITOR DRIVING A BNC 300-00-00-08-18-12 PROBE WILL REQUIRE 17 FEET OF EXTENSION CABLE. (18 INCH PROBE LEAD - 1.5 FEET TIMES
2 = 3, 3 FEET SUBTRACTED FROM 20 FEET = 17 FEET EXTENSION CABLE REQUIRED)

VIBRATION MONITORS:

ALL VIBRATION MONITORS INDICATE THE MAXIMUM PEAK TO PEAK (DOUBLE AMPLITUDE) MOTION OF THE OBSERVED SHAFT. ALL VIBRATION MONITORS HAVE TWO TRIP LEVELS, ALERT AND

DANGER, ADJUSTABLE OVER THE FULL SCALE OF THE METER. WHEN THE TRIP AT LEVELS ARE EXCEEDED A RELAY IS ACTIVATED AND BOTH NORMALLY OPEN AND NORMALLY CLOSED CONTACTS ARE PROVIDED. THESE CONTACTS MAY BE USED TO TRIGGER ANY VARIETY OF EXTERNAL DEVICES. WHEN THE TRIP LEVELS EXCEEDED, YELLOW AND RED WARNING LIGHTS CORRESPONDING TO THE ALERT AND DANGER LEVELS COME ON. THE TRIP LEVEL MAY BE CHECKED AT ANY TIME BY DEPRESSING THE APPROPRIATE BUTTON ON THE FRONT OF THE MONITOR. THE METER WILL THEN INDICATE THE CORRESPONDING TRIP SETTING. ALL VIBRATION MONITORS HAVE A 0 - 10 V DC RECORDER OUTPUT IN PROPORTION OF THE FULL SCALE OF THE METER.

POSITION MONITORS:

ALL POSITION MONITORS , TRUST, ECCENTRICITY , ETC. ,HAVE A ZERO CENTRED METER AND INDICATE THE AVERAGE POSITION OF THE SHAFT RELATIVE TO THE INITIAL GAP SETTING (ZERO) . THE NORMAL OR PLUS DIRECTION ON A POSITION METER IS ALWAYS TOWARDS THE PROBE , UNLESS OTHERWISE SPECIFIED. POSITION MONITORS HAVE FOUR TRIP LEVELS ADJUSTABLE OVER THE FULL SCALE OF THE METER , I . E , ALERT AND DANGER NORMAL DIRECTION AND ALERT AND DANGER COUNTER DIRECTION . WHEN THE TRIP LEVELS ARE EXCEED, WARNING LIGHTS AND RELAYS ARE ACTIVATED . BOTH NO AND NC CONTACTS PROVIDED AND MAY BE USED TO ACTIVATE EXTERNAL ALARMS , AND OR IF DESIRED , TO INITIATE SHUTDOWN OF THE MACHINE . FROM 0 TO 120 RPM THE METER AND CIRCUITRY WILL TRACK THE ACTUAL CHANGING POSITION OF THE SHAFT . ABOVE 120 RPM IT INDICATES THE AVERAGE POSITION OF THE SHAFT .

VIBRATION MONITORS - FUNCTIONAL DESCRIPTION:

A CIRCUIT FLOW DIAGRAM OF THE 7200 RV MONITOR SYSTEM IS CONTAINED IN FIG . 6.2 . THE MONITOR PORTION OF THE DIAGRAM IS DIVIDED INTO THREE CIRCUIT BLOCKS.

I) SIGNAL CONDITIONING
II) OK , ALERT AND DANGER
III) VOLTAGE REGULATOR

I. SIGNAL CONDITIONING:

THE INPUT SIGNAL IS CONNECTED TO A BUFFER , AN AMPLIFIER AND PEAK TO PEAK DETECTOR , AND AN OK VOLTAGE COMPARATOR . THE OUT PUT OF THE BUFFER IS CONNECTED TO THE FRONT PANEL BINDING POST (PROX) AND THE FRONT PANEL GAP TOGGLE SWITCH . THE PROXIMITOR OUTPUT SIGNAL CAN BE OBSERVED BY CONNECTING DIAGNOSTIC INSTRUMENTS TO THE BINDING POST . BY PRESSING THE GAP SWITCH , THE AVERAGE VALUE OF THE BUFFERED PROXIMITOR SIGNAL IS DISPLAYED ON THE FRONT PANEL METER AS GAP VOLTS.

THE OUTPUT OF THE DETECTOR IS A 0 TO 40 VOLT D.C SIGNAL PROPORTIONAL TO THE PEAK TO PEAK VALUE OF THE INPUT VIBRATION SIGNAL . THE DETECTOR OUTPUT IS CONNECTED TO THE ALERT AND DANGER COMPARATORS , TO THE CENTRE TERMINAL OF THE GAP SWITCH . THE GAP SWITCH IS SPRING LOADED SO THAT THE METER NORMALLY INDICATES PEAK TO PEAK VIBRATIONS.

II. OK , ALERT AND DANGER:

THE PROXIMITOR INPUT IS APPLIED TO SEPARATE LIMIT DETECTORS IN THE OK VOLTAGE COMPARATOR . THE HIGH AND LOW DETECTORS ARE BIASED TO MONITOR A VOLTAGE RANGE OF - 2. 0 TO - 11.0 VOLTS FOR 3000 SERIES PROXIMITORS OR - 4.0 11.5 VOLTS FOR 7000 SERIES PROXIMITORS , OR - 3. 0 TO 17. 0 VOLTS FOR 7200 SERIES PROXIMITORS .

WHEN THE INPUTS ARE WITH IN THIS RANGE , A SIGNAL IS SENT TO THE OK INDICATOR KEEPING IT ILLUMINATED , AND THE NORMALLY ENERGISED CIRCUIT OF THE COMMON OK RELAY , KEEPING IT ENERGISED . AN OUT OF RANGE CONDITION EXTINGUISHES THE INDICATOR AND DE ENERGISES THE RELAY UNTIL THE SITUATION IS CORRECTED .

III. VOLTAGE REGULATOR :

UNREGULATED VOLTAGE (+ V , - V , -VR) ARE RECEIVED FROM THE COMMON POWER SUPPLY . THE MONITOR CONTAINS REGULATORS FOR +5, +15 , -13 AND EITHER -18 , OR - 24 VOLTS , DEPENDING UPON THE MONITOR OPTION , THAT SUPPLY ALL INTERNAL CIRCUITS AND THE DRIVE VOLTAGE FOR THE PROXIMITOR .

THRUST MONITOR - FUNCTIONAL DESCRIPTION :

A CIRCUIT FLOW DIAGRAM OF THE MONITOR IS CONTAINED IN FIG . THE PROXIMITOR OUTPUT (1) IS COUPLED TO THE MONITOR , WHERE THE SIGNAL IS PROCESSED BY A BUFFER (2) WHICH ALLOWS FOR OBSERVATION WITH DIAGNOSTIC EQUIPMENT ; A METER SEALER (3) WHICH PRODUCES THE PROPER METER DRIVE WHEN READING GAP VOLTS ; AN OK CIRCUIT (4) WHICH PROVIDES A VISUAL INDICATION OF PROPER PROBE PROXIMITOR / FIELD WIRING OPERATION ; AND AN AMPLIFIER (5) WHICH SCALES THE SIGNAL AND PROVIDES FOR METER ZEROING .

WHEN PROXIMITOR SIGNAL IS WITHIN THE PRESCRIBED OK LIMITS THE OK INDICATOR (II) WILL BE ILLUMINATED AND THE COMMON OK RELAY (10) WILL BE ENERGISED . THE AMPLIFIER (5) PROVIDES METER DRIVE WHEN THRUST POSITION IS DISPLAYED , RECORDER DRIVE VOLTAGE (12), AND THE ALERT / DANGER ALARM CIRCUIT INPUT .

THE ALERT (6) AND DANGER (7) ALARM CIRCUITS COMPARE THE AMPLIFIER OUTPUT TO ALARM SET POINTS . WHEN A SET POINT IS EXCEED THE RESPECTIVE ALARM INDICATOR (13) OR (14) ILLUMINATES AND AN ACTIVATION SIGNAL IS SENT TO THE ASSIGNED ALARM RELAY (8) OR (9) LOCATED OUTSIDE THE MONITOR.

POWER SUPPLY SYSTEM:

POWER UNITS ARE AVAILABLE SUITABLE FOR 115 V AC & 110 V DC POWER SUPPLIES . 115 V AC INPUT POWER SUPPLY SYSTEM GIVES OUTPUT VOLTAGES OF -18 V DC AND -20 V DC . THE -18 VOLTS OPERATES THE MEASURING AND MONITORING CIRCUITS OF THE SYSTEM , WHILE THE - 20 VOLTS IS USED TO ACTIVATE THE RELAYS AND INDICATOR LIGHTS.

110 V DC INPUT POWER SUPPLY SYSTEM :

THE POWER SUPPLY CONTAINS :

A) DC TO DC CONVERTER , FILTER CAPACITORS AND FUSES FOR UN REGULATED DC VOLTAGES .

B) A REMOVABLE CIRCUIT BOARD FOR RESET , LAMP TEST AND KEY POWER .

C) AN OPTIONAL REMOVABLE CIRCUIT BOARD FOR POWER - UP - INHIBIT .

D) A REMOVABLE FRONT PANEL WITH LED INDICATORS , SWITCHES AND CONNECTORS .

POWER SUPPLY SYSTEM - FUNCTIONAL DESCRIPTION :

A CIRCUIT FLOW DIAGRAM OF THE POWER SUPPLY IS SHOWN IN FIG .

DC -TO - DC CONVERTER OPERATION:

THE OPERATION OF THE DC - TO - DC CONVERTER CONSISTS OF FEEDING THE DC LINE INPUT TO A TRANSISTERISED HIGH POWER OSCILLATOR THAT CHOPS THE DC INPUT INTO AC CURRENT OF APPROXIMATELY 1500 TO 2200 HERTZ FREQUENCY .THIS AC CURRENT SUPPLIES A TRANSFORMER THAT PROVIDES THREE SECONDARY VOLTAGES . THE THREE SECONDARY AC VOLTAGES ARE FULL WAVE RECTIFIED AND FILTERED RESULTING IN THREE UNREGULATED PLUS AND MINUS DC OUTPUTS.

THE THREE UNREGULATED VOLTAGES ARE

A) (+ V) +18 TO + 29 VOLTS
B) (- V) - 28 TO - 45 VOLTS
C) (- VR) - 16 TO - 29 VOLTS

TWO OF THE VOLTAGES (+ V 1 - V) ARE REGULATED IN THE MONITORS , THE THIRD VOLTAGE (- VR) REMAINS UNREGULATED AND IS USED FOR RELAYS AND INDICATORS . SIGNAL COMMON IS THE RETURN FOR ANALOGUE SIGNALS AND THE + V, AND - V VOLTAGES . LAMP / RELAY COMMON IS THE RETURN FOR ALL SYSTEM RELAYS AND INDICATORS.

POWER - UP - INHIBIT:

THE POWER - UP - INHIBIT OPTION IS ORDINARILY USED WITH NORMALLY DE-ENERGISED ALARM RELAYS TO PROVIDE PROTECTION FROM FALSE ALARMS DUE TO POWER OUTAGES. THE OPTION AUTOMATICALLY DISABLES THE MONITOR ALARM CIRCUITS AND SIGNALS A NOT - OK CONDITION, WHEN ANY UNREGULATED POWER SUPPLY DROPS BELOW NORMAL OPERATING LEVEL. THE ALARM CIRCUITS, OK RELAY AND OK INDICATORS ARE DISABLED UNTIL 30 TO 45 SECONDS AFTER THE VOLTAGES HAVE RETURNED TO NORMAL AND THEN AUTOMATICALLY RESTORED TO FULL OPERATION .

INSTALLATION / PROBE MOUNTING:

STANDARD PROBES FOR RELATIVE SHAFT MOTION MEASUREMENTS MAY BE MOUNTED AT ANY LOCATION OR IN THE MACHINE WITH THE END OF THE PROBE FACING THE MACHINE SHAFT . WHEN OBSERVING A VIBRATION POINT THE MACHINE SHAFT SURFACE SHOULD BE OR BEARING TYPE FINISH IN OR TO MINIMISE RUN OUT NOISE.

THE PROBES OBSERVE GAP DISTANCE FROM THE PROBE FACE TO THE RUNNING SHAFT . THEREFORE IT IS NECESSARY FOR ACCURATE MEASUREMENT OF VIBRATION , THAT THE HOLDING STRUCTURES OF THE PROBES DO NOT VIBRATE AT AMPLITUDES OR FREQUENCIES OF INTEREST FOR THE MEASUREMENT TO BE MADE . IF A BEAM CANNOT BE MOUNTED IN A SOLID LOCATION ON THE MACHINE , SUCH AS THE BEARING HOUSING , AND IT IS NECESSARY TO EMPLOY SOME SORT OF BEAM STRUCTURE , BE CERTAIN THE BEAM ITSELF CANNOT VIBRATE APPRECIABLY IN A PLANE THAT WILL CHANGE THE GAP DISTANCE . THE RESONANT FREQUENCY OF ANY SUCH MOUNTING STRUCTURE SHOULD BE FIELD CHECKED BY TAPPING LIGHTLY AND OBSERVING THE PROXIMITOR OUTPUT ON AN OSCILLOSCOPE .

THRUST POSITION PROBES SHOULD ALWAYS BE MOUNTED WITHIN 12” OF THE TRUST BEARING TO MINIMISE THE EFFECT OF THERMAL GROWTH ON THE GAP CHANGE . WHEN INSTALLING A PROBE THAT HAS A LEAD ATTACHED CARE MUST BE TAKEN TO ROTATE THE CABLE WITH THE PROBE , WHEN THREADING THE PROBE INTO THE MOUNT . DO NOT ALLOW HIGH TWIST LOADS TO OCCUR AT THE PROBE CABLE JOINT AS CABLE DAMAGE OR A BROKEN CONNECTION MAY RESULT . THE PROBE MUST BE SOLIDLY LOCKED INTO ITS MOUNT BY A LOCK NUT , CLAMP , OR OTHER VIBRATION SECURE DEVICE . THE MOUNTING HOLE SHOULD BE CLEAR OF OBSTRUCTIONS . THE PROBE SHOULD BE MOUNTED AGAINST THE OBSERVED SURFACE WITH FINGER TIGHT ONLY , WHEN THE OBSERVED SURFACE IS MOVING , IT SHOULD NOT RUB THE PROBE .

INITIAL GAP IS DETERMINED WITH THE HELP OF THE PROBE CALIBRATION GRAPH . THE INITIAL GRAPH SHOULD BE SET WITH IN +/-5 MILS OF THE RECOMMENDED GAP. IN OPEN INSTALLATIONS , THE GAP CAN BE SET BY A FEELER GAUGE OR PLASTIC SHIM . THE GAP MAY ALSO BE SET BY OBSERVING THE PROXIMITOR OUTPUT AND ADJUSTING THE PROBE - GAP UNTIL THE PROXIMITOR VOLTAGE OUTPUT FOR THE RECOMMENDED GAP AS INDICATED BY THE PROBE CALIBRATION GRAPH.

IN BLIND HOLES , BE CERTAIN THAT THE PROBE IS OBSERVING THE SHAFT BY MOVING THE PROBE TO INCREASE AND DECREASE THE GAP WHILE OBSERVING THE OUTPUT VOLTAGE . IN THE COMPLETE INSTALLATION THERE SHOULD BE NO METAL WITHIN 0.150 INCHES OF THE PROBE FACE EXCEPT THE OBSERVED SURFACE . COUNTER BORING , CHAMBERING , OR OTHER RELIEVING MAY BE NECESSARY TO ACHIEVE THIS CLEARANCE.

SOLID OR FLEXIBLE CONDUCT SHOULD BE EMPLOYED TO MECHANICALLY PROTECT THE PROBE CABLE FROM DAMAGES .

PROXIMITOR MOUNTING :

THE PROXIMITORS DESIGNED TO OPERATE WITH A SPECIFIC LENGTH OF 95 OHM COAXIAL CABLE . THE PROPER LENGTH IS NOTED IN THE LAST TWO DIGITS OF THE PROXIMITOR MODEL NUMBER , I.E , THE 3106 REQUIRES 6 FEET , THE 3109 REQUIRES NINE FEET , THE 3115 REQUIRES 15 FEET , ETC. HOWEVER FOR MECHANICAL REASONS , A SMALLER 50 OHMS CABLE IS USED FOR PIG - TAIL LEADS ON STANDARD PROBES . WHEN A 95 OHM EXTENSION CABLE IS USED IN CONJUNCTION WITH A 50 OHM PROBE LEAD , AN ADJUSTMENT IN TOTAL LENGTH MUST BE MADE IN ACCORDANCE WITH FOLLOWING ; ONE FOOT OF 50 OHM LEAD IS THE EQUIVALENT OF TWO FEET OF 95 OHM LEAD. FOR INSTANCE , WITH A 3115 PROXIMITOR AND 2 ½ FEET OF 50 OHM PROBE LEAD , USE A 10 FOOT 95 OHM EXTENSION CABLE . PHYSICAL LENGTH EQUALS 12 ½ FEET ELECTRICAL LENGTH EQUALS 2 X 2 ½ FEET PLUS 10 FEET FOR 15 FEET TOTAL.

PROXIMITORS ARE CALIBRATED TO 4140 STEEL . ALL 1000 AND 4000 SERIES STEELS HAVE VIRTUALLY IDENTICAL RESPONSE . IF THE OBSERVED MATERIAL IS SPECIAL , THE GRAPH SHOULD BE RUN AGAINST THE SPECIAL MATERIAL , THE PROXIMITOR SHOULD BE RE CALIBRATED . THE OUT PUT OF THE PROXIMITOR IS A VOLTAGE THAT VARIES FROM 0 TO - 15 VOLT DC AT APPROXIMATELY 2500 OHM IMPEDANCE . THE VOLTAGE OUTPUT VARIES DIRECTLY AS THE DISTANCE BETWEEN THE PROBE AND THE OBSERVED SURFACE VARIES . THE PROXIMITOR WILL FOLLOW ANY MOTION FROM 0 TO 4000 CPS , CONSTANT OR VARIABLE . PROXIMITY PROBES SHOULD NOT BE USED OVER CHROME PLATED SHAFTS . VARIATION IN THICKNESS AND METALLURGICAL COMPOSITION OF THE PLATING WILL RESULT IN HIGH ELECTRICAL RUN OUT , CAUSING ERRATIC AND IM PREDICTABLE METER READINGS .

CONE EFFECT :

EDDY CURRENT PROBES DO NOT MEASURE SURFACE AREA EQUAL TO THE DIAMETER OF THE PROBE . THERE EXISTS CONE EFFECT AS THE PROBE ACTUALLY RADIATES LATERALLY , IN ADDITION TO STRAIGHT A HEAD . THIS APPROXIMATE 45 DEGREE DIVERGENCE FROM THE TIP.

OBSERVED AREA = PROBE TIP + 2 X PROBE GAP

EXAMPLE : PROBE WITH DIAMETER 300 MILS ,

GAP = 30 MILS ,

SO OBSERVED AREA = 300 X 2 X 50 = 400 MIL (DIA.)
FIG. 4

TEMPERATURE EFFECT

THE CHANGE N THE PROBE TEMPERATURE WILL AFFECT THE RANGE LIMITS OF THE PROBE BUT NOT SO MUCH . BUT THE DYNAMIC READINGS ARE NOT AFFECTED .

VAREC LEVEL GAUGE - MODEL 6500 (ROSEMOUNT)

PRINCIPLE OF OPERATION:

THE FIGURE 6500 GAUGE IS DESIGNED TO ACCURATELY MEASURES LIQUID LEVELS BY MAINTAINING A BALANCE OF PHYSICAL FORCES ACTING ON THE GAUGE. THE GAUGE WILL MAINTAIN A FORCE BALANCE OR NULL CONDITION WHEN THE LIQUID LEVEL IS STATIONARY . THIS PRINCIPLE IS ILLUSTRATED ON THE FOLLOWING FIGURE .

WHEN THE DISPLACER ENTERS THE LIQUID SURFACE , THE LIQUID EXERTS AN UPWARD BUOYANT FORCE OPPOSING THE DISPLACER WEIGHT . THE WEIGHT OF THE DISPLACER IS GREATER THAN THE BUOYANT FORCE ACTING ON THE DISPLACER . THE NET DOWNWARD FORCE (DIFFERENCE BETWEEN DISPLACER WEIGHT AND BUOYANT FORCE) IS BALANCED BY A SPRING INCORPORATED IN THE GAUGE TO

MAINTAIN THE DISPLACER AT THE LIQUID SURFACE . WITHOUT THIS BALANCING FORCE , THE DISPLACER WOULD SLOWLY GO TO THE BOTTOM OF THE TANK .

A VERY SMALL CHANGE IN LIQUID LEVEL WILL UPSET THE BALANCE MAINTAINED BY THE SPRING .THE SERVO MOTOR WILL TURN ON AND ROTATE THE MEASURING DRUM TO ALLOW THE DISPLACER TO FOLLOW THE LIQUID SURFACE .

A POSITIVE MECHANICAL DRIVE SETS THE MECHANICAL COUNTER FOR LOCAL LEVEL INDICATION AND SIMULTANEOUSLY POSITIONS THE ENCODER PORTION OF THE TRANSMITTER . THE ENCODER OUTPUT IS CONNECTED TO THE TRANSMITTER ELECTRONICS WHERE IT IS CONVERTED TO A PULSE CODE FORMAT AND TRANSMITTED TO A REMOTE INDICATING DEVICE.

THEORY OF OPERATION:

GENERAL:

THE FIGURE 6500 GAUGE OPERATES MECHANICALLY BY THE FORCE BALANCE PRINCIPLE . WHEN THE LIQUID LEVEL IN THE TANK IS STATIONARY , ALL OPPOSING FORCES ARE EQUAL.

A BALANCE SPRING IS ATTACHED AT ONE END TO A DETECTION PLATE AND AT THE OTHER END TO THE HELICAL GEAR . THE DETECTION PLATE IS BOLTED TO THE SHAFT WHICH IS MAGNETICALLY COUPLED TO THE MEASURING DRUM . THE HELICAL GEAR IS POSITIONED BY THE SERVO MOTOR VIA A WORM GEAR .

THE END OF THE DETECTION PLATE IS POSITIONED IN THE SLOT OF THE SLOT INITIATOR . THE SLOT INITIATOR IS SUPPLIED WITH 10 V DC FROM THE MOTION CONTROL BOARD . THE VOLTAGE IS TRANSFERRED TO THE SLOT INITIATOR VIA CARBON RINGS AND A CONTACT BLOCK TO ALLOW FOR ROTATION . THE DETECTION PLATE BREAKS THE MAGNETIC LINES OF FORCE PRODUCED BY THE SLOT INITIATOR (HALL EFFECT). THE CURRENT PRODUCED BY THE SLOT INITIATOR WILL VARY BETWEEN 1 AND 7 MA , DEPENDING ON WHERE THE DETECTION PLATE IS LOCATED IN THE SLOT . THIS CHANGE IN CURRENT IS DETECTED AS A VOLTAGE CHANGE ACROSS A SERIES RESISTOR ON THE MOTION CONTROL BOARD INPUT CIRCUITRY . THIS VOLTAGE IS COMPARED TO TWO REFERENCE VOLTAGES . THE UP REFERENCE IS 4. 9 V DC AND THE DOWN REFERENCE IS 1.8 V DC . IN A BALANCED CONDITION, THE VOLTAGE DETECTED WILL BE BETWEEN 4. 9 V DC AND 1. 8 V DC , AND NEITHER AN UP NOR A DOWN SIGNAL IS PRODUCED .

WHEN THE LIQUID LEVEL IN THE TANK DROPS , THE DISPLACER WILL DROPS SLIGHTLY , TURNING THE SHAFT IN A CLOCKWISE DIRECTION . THE DETECTION PLATE MOVES AGAINST THE SPRING THIS INITIAL ROTATION IS LIMITED BY A PIN ON THE HELICAL GEAR WHICH EXTENDS THROUGH AN ELONGATED HOLE ON THE DETECTION PLATE . THE DETECTION PLATE IS NOW BLOCKING THE MAXIMUM LINES OF FORCE PRODUCED IN THE SLOT INITIATOR AND HAS DROPPED THE VOLTAGE TO THE MOTION CONTROL CIRCUIT TO 1.8 V DC OR LESS .

THE SERVO MOTOR WILL START , AND ROTATE THE HELICAL GEAR IN A CLOCKWISE DIRECTION . THIS ALLOWS THE SHAFT TO TURN AND THE DISPLACER TO SLOWLY DROP UNTIL THE LIQUID LEVEL STOPS DROPPING , WHILE CONTINUOUSLY MAINTAINING TENSION ON THE WIRE .

WHEN THE LIQUID STOPS DROPPING , THE FORCE AGAINST THE BALANCE SPRING DECREASES AND THE DETECTION PLATE MOVES OUT AND THE VOLTAGE INCREASES TO ABOVE 1.8 V DC .

WHEN THE LIQUID LEVEL INCREASES , THE SAME PRINCIPLES APPLY . THE SPRING TENSION IS THEN GREATER THAN THE DOWNWARD FORCE OF THE DISPLACER . THE DEFLECTION PLATE MOVES AWAY FROM THE SLOT INITIATOR AND A VOLTAGE OF 4.9 V DC OR GREATER IS PRODUCED WHICH DRIVES THE SERVO MOTOR TO MAINTAIN TENSION ON THE WIRE AS THE DISPLACER MOVES UP .

THE BALANCE SPRING TENSION EQUALS THE SURFACE TENSION OF THE DISPLACER ON THE LIQUIDS SURFACE WHEN THE LEVEL IS STATIONARY .

AS THE SERVO MOTOR MOVES TO MAINTAIN TENSION ON THE MEASURING WIRE , THE LEVEL INFORMATION IS TRANSFERRED TO OTHER SECTIONS OF THE GAUGE VIA A DRIVE BELT. THE DRIVE BELT

IS TOOTHED TO MAINTAIN A POSITIVE DRIVE TO THE MECHANICAL COUNTER, THE OPTICAL ENCODER ,AND THE CAM SWITCHES.

THE MECHANICAL COUNTER PROVIDES AN ACCURATE , LOCAL READOUT AND IS MOUNTED WITHIN THE GAUGE HOUSING . IT CAN BE VIEWED THROUGH A SIGHT GLASS .

THE OPTICAL ENCODER PRODUCES A HIGHLY ACCURATE DIGITAL ELECTRONIC SIGNAL WHICH IS TRANSMITTED TO A REMOTE LOCATION FOR LEVEL INDICATION .

DRUM ASSEMBLY:

THE DRUM ASSEMBLY TRANSFERS LIQUID LEVEL INFORMATION TO THE SERVO ASSEMBLY . THE DRUM ASSEMBLY DETECTS A SLIGHT CHANGE IN LEVEL WHICH CAUSES A ROTATION OF THE SHAFT IN THE SERVO COMPARTMENT . THIS INITIAL MOVEMENT IS INDEPENDENT OF THE SERVO CONTROL , AND IS LIMITED BY A MECHANICAL STOP ON THE SERVO ASSEMBLY . AFTER INITIAL MOVEMENT IS DETECTED , THE SERVO MOTOR WILL TURN ON AND THE DRUM ASSEMBLY WILL ROTATE , ALLOWING THE DISPLACER TO MOVE WITH THE LIQUID SURFACE BY DISPENSING MEASURING WIRE IN THE PROPER DIRECTION .

DISPLACER:

THE STANDARD DISPLACER IS OF A CYLINDRICAL / CONICAL SHAPE WITH A DIAMETER OF 145 MM . ITS WEIGHT , INCLUDING APPROPRIATE HARDWARE , IS 280 GRAMS +/- 1.5 GRAM . THROUGH THE USE OF THIS DISPLACER , THE GAUGE WILL DETECT A LIQUID LEVEL VARIATION OF A MAXIMUM OF 0.5 MM SPECIFIC GRAVITY VARIATIONS FROM 0.75 TO 1 KG/ DM3 WILL INDUCE A MAXIMUM ERROR OF 0.45 MM THE 145 MM DISPLACER IS ALSO AVAILABLE . DISPLACERS OF VARIOUS SIZES AND MATERIALS CAN BE MADE TO MEET SPECIAL APPLICATION ON REQUEST .

MEASURING WIRE :

THE MEASURING WIRE IS SOLID 316 STAINLESS STEEL WITH A DIAMETER OF 0.25 MM AND HAS MINIMUM THERMAL EXPANSION . THE WIRE IS STORED AND DISPENSED FROM THE MEASURING DRUM , MOVING BACK AND FORTH ALONG THE LONGITUDINAL AXIS OF THE DRUM AS THE DISPLACER MOVES UP AND DOWN WITH THE LIQUID LEVEL.

MEASURING DRUM AND MAGNETIC COUPLING:

THE MEASURING DRUM HAS A PRECISION MACHINED HELICAL GROVE WHICH HOLDS UP TO 36 M OF MEASURING WIRE . THE STANDARD MATERIAL OF CONSTRUCTION IS STAINLESS STEEL ON ALUMINIUM . DRUMS MADE OF 316 STAINLESS STEEL OR MOULDED GRAPHITE ARE AVAILABLE AS AN OPTION .

THE DRUM IS MOUNTED ON A STAINLESS STEEL SHAFT WITH STAINLESS STEEL BALL BEARING S OR WITH TEFLON / CARBON BEARINGS . THE ELECTRICAL RESISTANCE OF THE BEARING IS LOWER THAN 1.4 X 10 TO POWER OF MINUS FOUR OHM / CM , IN ORDER TO AVOID STATIC LOADS DUE TO FRICTION FROM THE WIRE ON THE DRUM . THE DRUM ALSO SUPPORTS THE PRIMARY MAGNET OF THE MAGNETIC COUPLING . A NON MAGNETIC STAINLESS STEEL SCREEN SEPARATES THE PRIMARY FROM THE SECONDARY MAGNET. THE DRUM , SHAFT AND MAGNETIC COUPLING ARE BALANCED .

THE DRUM ROTATES DUE TO THE MOVEMENT OF THE LIQUID SURFACE AND DISPENSES MEASURING WIRE TO MAINTAIN THE DISPLACER IN A BUOYANT CONDITION IN THE LIQUID . THIS ROTATION IS PROPORTIONAL TO THE ACTUAL LIQUID LEVEL AND IS DETECTED AND USED TO SET THE MECHANICAL COUNTER AND ENCODER .

SERVO ASSEMBLY:

THE SERVO ASSEMBLY MAINTAINS THE FORCE BALANCE CONDITION OF THE GAUGE WHEN THE LIQUID LEVEL IS STATIONARY AND QUICKLY DETECTS A CHANGE IN LEVEL TRANSFERRED BY THE DRUM ASSEMBLY . IT ALSO TRANSFERS LEVEL MEASUREMENT , WHICH IS PROPORTIONAL TO THE MEASURING DRUM ROTATION, VIA A MECHANICAL LINK TO THE LOCAL COUNTER AND THE ELECTRONIC ENCODER.

SERVO MOTOR :

THE SERVO MOTOR IS A TWO WAY MOTOR WITH REDUCTION GEARS . A 24 V AC 50 OR 60 HZ POWER SUPPLY DRIVES THE MONITOR IN BOTH DIRECTIONS .

THE MOTION CONTROL BOARD SWITCHES THE SERVO MOTOR ON AND OFF IN EITHER DIRECTION . AN ADJUSTABLE TIME DELAY IS INCORPORATED TO PREVENT EXCESSIVE FAST SWITCHING OF THE MOTOR . THE TIME DELAY IS ADJUSTABLE BETWEEN 2 AND 15 SECONDS AND FACTORY SET AT 6 SECONDS NOMINAL .

SLOT INITIATOR :

THE SLOT INITIATOR PRODUCES MAGNETIC LINES OF FORCE ON ONE SIDE OF AN AIR GAP . THE MAGNETIC FORCE GENERATES A CURRENT ON THE OPPOSITE SIDE OF THE AIR GAP . A DETECTION PLATE , BOLTED TO THE MEASURING SHAFT , MOVES WITHIN THE AIR GAP OF THE SLOT INITIATOR , BLOCKING THE MAGNETIC FORCE PROPORTIONAL TO ITS POSITION WITHIN THE AIR GAP . THIS MOVEMENT OF THE DETECTION PLATE PRODUCES THE VARIABLE CONTROL CURRENT FOR THE SERVO MOTOR .

BALANCE SPRING :

THE BALANCE SPRING MAINTAINS A FORCE BALANCE ON THE GAUGE BY COMPENSATING FOR THE DIFFERENCE OF THE UPWARD BUOYANT FORCE OF THE MEASURED LIQUID AND THE DOWNWARD FORCE OF THE DISPLACER .

ONE END OF THE SPRING IS ATTACHED TO THE DETECTION PLATE , THE OTHER END TO THE HELICAL GEAR . BECAUSE OF THIS , THE SPRING WILL CONTINUOUSLY TRY TO MAINTAIN A BALANCE , WHEN THE LEVEL IS CHANGING AND THE SERVO MOTOR IS RUNNING . THE SERVO MOTOR WILL MOVE THE HELICAL GEAR TO BRING THE SLOT INITIATOR BACK TO THE DETECTION PLATE AND A BALANCE CONDITION .

PROCESS INSTRUMENTATION - SPIC TRAINING CENTRE

UNIT - I:

1. EXPLAIN :-
A) MEASUREMENT B) PROCESS C) MEASURING MEANS D) PROCESS VARIABLE
E) MEASURED VARIABLE

2. EXPLAIN THE STATIC CHARACTERISTICS OF AN INSTRUMENT .

3. A) EXPLAIN THE DYNAMIC CHARACTERISTICS OF AN INSTRUMENT .
B) WHAT ARE THE MAIN PROCESS CHARACTERISTICS THAT CAUSES PROCESS LAG ?

4. MENTION DIFFERENT MEASURING MEANS FOR PROCESS VARIABLES LIKE PRESSURE, FLOW, LEVEL, AND TEMPERATURE.

1. EXPLAIN THE FOLLOWING TERMS
A) STATIC ERROR
B) REPRODUCIBILITY
C) ACCURACY
D) DYNAMIC ERROR
E) DEAD ZERO

6. MENTION ANY THREE IMPORTANT MAIN PROCESS CHARACTERISTICS AND EXPLAIN THEM BRIEFLY .

1. A) EXPLAIN THREE DIFFERENT TYPES OF RESPONSE CURVES
B) DEFINE:
I) PROCESS RESISTANCE II) PROCESS LAG III) PROCESS CAPACITANCE IV) DEAD TIME

8. WRITE DOWN THE ELEMENTS OF AN INSTRUMENT .

1. A) GIVE REASONS FOR NECESSITY OF LEVEL MEASUREMENT .
B) NAME AND DISCUSS SOME DIRECT LEVEL INDICATORS.

10. EXPLAIN THE OPERATION OF ANY TWO DIRECT LIQUID LEVEL INDICATORS .

2. A) STATE ARCHIMEDIE'S PRINCIPLE .
B) EXPLAIN THE OPERATION OF FLOAT TYPE LEVEL MEASUREMENT .

12. A) EXPLAIN THE OPERATION OF BUBBLER TYPE LEVEL MEASUREMENT.
B) EXPLAIN THE OPERATION OF BALL FLOAT TYPE LEVEL MEASUREMENT .

13. EXPLAIN HOW WILL YOU USE A DIFFERENTIAL PRESSURE TRANSMITTER FOR LEVEL MEASUREMENT .

3. A) EXPLAIN THE METHOD OF STATIC PRESSURE TYPE LEVEL MEASUREMENT .
B) EXPLAIN AIR PURGE SYSTEM LEVEL MEASUREMENT .

15. EXPLAIN HOW THE INTERFACE LEVEL OF TWO IMMISICIBLE LIQUIDS IN A TANK IS MEASURED .

4. A) WHY LEVEL MEASUREMENT IS NEEDED IN PROCESS INDUSTRIES .
B) EXPLAIN METHOD OF MEASURING SOLID LEVEL .

17. EXPLAIN ANY TWO METHODS OF OPEN TANK LEVEL MEASUREMENT .

5. A) EXPLAIN THE LEVEL MEASUREMENT BY USING ARCHIMEDIE'S PRINCIPLE .
B) WRITE A SHORT NOTES WITH AN EXAMPLE ON
I) PROCESS
II) MEASUREMENT MEANS

19. A) WRITE A BRIEF NOTES ON I) AIR PURGE SYSTEM LEVEL MEASUREMENT
II) STATIC PRESSURE TYPE LEVEL MEASUREMENT

B) DEFINE ARCHIMEDIE'S PRINCIPLE .

20. EXPLAIN WITH SKETCHES
I) ELEVATION MODEL LEVEL MEASUREMENT
II) SUPPRESSION LEVEL MEASUREMENT

21. BRIEFLY EXPLAIN ANY TWO LEVEL MEASUREMENT FOR AN OPEN TANK .

1. A) EXPLAIN IN TWO WAYS THAT HOW WILL YOU USE A GIVEN D.P TRANSMITTER FOR LEVEL MEASUREMENT.

B) EXPLAIN HOW WILL YOU MEASURE LEVEL WITH THE GIVEN PRESSURE GAUGE .

23. WRITE THE SHORT NOTES ON THE FOLLOWING
I) PROCESS VARIABLE
II) MEASURED VARIABLE
III) PROCESS CAPACITANCE
IV) PROCESS RESISTANCE

24. WHAT ARE ALL THE VARIOUS MEASURING MEANS FOR PROCESS VARIABLE .

2. EXPLAIN HOW WILL YOU USE A DIFFERENTIAL PRESSURE TRANSMITTER FOR LEVEL MEASUREMENT .

UNIT - II:

1. A) WHAT ARE THE UNITS OF TEMPERATURE ?
B) EXPLAIN THE WORKING PRINCIPLE OF A BIMETALLIC THERMOMETER .

2. A) EXPLAIN A FUNDAMENTAL UNITS OF TEMPERATURE ?
B) EXPLAIN THE WORKING PRINCIPLE OF A MERCURY THERMOMETER ?

3. A) INDICATE THE TEMPERATURE RANGE IN WHICH BIMETALLIC THERMOMETERS ARE USED. MENTION THE ADVANTAGE OF BIMETALLIC THERMOMETER .
B) WHY PLATINUM RESISTANCE THERMOMETER IS PREFERRED IN INDUSTRY ? SHOW THE CONSTRUCTION OF A PLATINUM RESISTANCE THERMOMETER .

4. A) EXPLAIN THE WORKING OF A BIMETALLIC THERMOMETER .
B) SKETCH AND EXPLAIN THE CHARACTERISTICS OF FOUR THERMOCOUPLE .

5. A) EXPLAIN WHY PLATINUM RESISTANCE THERMOMETER IS WIDELY USED IN INDUSTRIES .
B) COMPARE THE LIQUID - FILLED , VAPOUR - FILLED AND GAS FILLED THERMOMETERS FROM THE POINT OF ACCURACY, RANGE, SPAN, LINEARITY, AND APPLICATION .

6. A) EXPLAIN LIQUID FILLED SYSTEM FOR MEASURING TEMPERATURE .
B) EXPLAIN THE WORKING OF A THERMOCOUPLE .

7. A) INDICATE THE APPLICATION OF THERMOCOUPLE IN PETROCHEMICAL INDUSTRY .

B) EXPLAIN THE WORKING PRINCIPLE OF A THERMOCOUPLE .

8. A) INDICATE THE INDUSTRIAL APPLICATION OF A RESISTANCE THERMOMETER.
   B) WRITE DOWN THE MERITS AND DEMERITS OF VAPOUR , LIQUID AND GAS FILLED TEMPERATURE GAUGES .

9. A) HOW ARE THE THERMOCOUPLES USEFUL FOR THE PROCESS INDUSTRY .
   B) WRITE DOWN THE ERRORS ENCOUNTERED WHILE MAKING TEMPERATURE MEASUREMENT .

10. A) EXPLAIN THE DIFFERENT SOURCES OF STATIC ERROR ENCOUNTERED IN THE INDUSTRIAL PRESSURE THERMOMETER AND COMPENSATION METHOD USED FOR THE SAME.
    B) STATE THE ADVANTAGES AND LIMITATIONS OF FILLED SYSTEM THERMOMETERS .

11. A) NAME THE MOST COMMONLY USED THERMOCOUPLE AND USEFUL TEMPERATURE RANGE OF MEASUREMENT .
    B) STATE VARIOUS CHARACTERISTICS OF THERMOCOUPLES .

12. A) SKETCH AND EXPLAIN VARIOUS INDUSTRIAL RESISTANCE THERMOMETER BULBS.
    B) EXPLAIN THE WORKING PRINCIPLE OF THERMOCOUPLE .

13. A) INDICATE THE TEMPERATURE RANGE IN WHICH THERMOCOUPLES ARE USED .
    B) SKETCH AND EXPLAIN THE CONSTRUCTION OF THERMOCOUPLE .

14. A) EXPLAIN ABOUT THERMOCOUPLE LEAD WIRE .
    B) WHY PLATINUM RESISTANCE THERMOMETER IS WIDELY USED IN INDUSTRY ?

15. A) SKETCH AND EXPLAIN THE PRINCIPLE OF MILLIVOLTMETER .
    B) WHAT ARE CHARACTERISTICS OF THERMOCOUPLE LEAD WIRE INSULATION ?

16. A) WHAT IS MEANT BY COLD JUNCTION COMPENSATION OF A THERMOCOUPLE WIRE ?
    B) WHAT IS THE ACCURACY LEVEL INDUSTRIAL THERMOMETER ?

17. STATE THE LAW S OF THERMOELECTRIC CIRCUITS ? EXPLAIN PELTIER & THOMSON EFFECT OF THERMOCOUPLES ? STATE & EXPLAIN THE DESIRABLE PROPERTIES OF THERMOCOUPLES.

1. EXPLAIN THE PRINCIPLE OF VOLUMETRIC AND PRESSURE THERMOMETERS .

2. A) WHAT IS THOMSON EFFECT OF A THERMOCOUPLE ?
   B) EXPLAIN THE WORKING PRINCIPLE OF A BIMETALLIC THERMOMETER .

20. A) WHY THERMOCOUPLE WIRE NEED TO BE INSULATED? STATE DIFFERENT TYPES OF INSULATING MATERIALS USED .
    B) EXPLAIN THE WORKING PRINCIPLE OF A MERCURY THERMOMETER .

21. A) EXPLAIN THE COLD JUNCTION COMPENSATION OF A THERMOCOUPLE .
    B) WRITE DOWN THE MERITS & DEMERITS OF FILLED SYSTEM THERMOMETER .

22. A) SKETCH & EXPLAIN THE CONSTRUCTION OF THERMOWELL ?
    B) WHAT ARE THE PROPERTIES CONSIDERED IN THE SELECTION OF THERMOWELL ?

23. A) EXPLAIN THE EFFECT OF WELL ON THE THERMOCOUPLE RESPONSE .
    B) EXPLAIN THE WORKING PRINCIPLE OF THERMOCOUPLE .

24. WRITE SHORT NOTES ON
    A) INDUSTRIAL RESISTANCE - THERMOMETER BULBS .
    B) THERMOWELL AND PROTECTING TUBES .

C) MILLIVOLTMETER .

25. WRITE SHORT NOTES ON
    A) THERMOELECTRICITY .
    B) STATIC ACCURACY OF THERMOMETER .

UNIT - III:

1. A) EXPLAIN THE LAMINAR AND TURBULENT FLOW .
   B) WHAT ARE THE VARIABLE HEAD MARKS USED IN CLOSED AND OPEN CHANNELS .

2. A) EXPLAIN HOW THE OPEN CHANNEL FLOW MEASUREMENT IS MADE .
   B) DRAW A VENTURI TUBE AND EXPLAIN ITS FUNCTION .

3. A) EXPLAIN THE WORKING PRINCIPLE OF A PISTON TYPE AREA FLOW METER .
   B) INDICATE THE APPLICATIONS OF ORIFICE PLATES , WEIRS AND ORIFICE TAPS IN PETROCHEMICAL INDUSTRY .

4. A) EXPLAIN THE WORKING PRINCIPLE OF ROTATING DISC FLOW METER .
   B) EXPLAIN THE WORKING PRINCIPLE OF AN AXIAL TYPE MASS FLOW METER .

5. A) EXPLAIN THE WORKING PRINCIPLE OF A ROTAMETER INDICATE ITS INDUSTRIAL APPLICATIONS .
   B) HOW WILL YOU MEASURE FLOWS IN OPEN CHANNELS ?

6. A) INDICATE THE APPLICATIONS OF FLOW NOZZLES IN PETROCHEMICAL INDUSTRY .
   B) EXPLAIN THE WORKING PRINCIPLE OF MAGNETIC FLOW METER .

7. A) EXPLAIN HOW FLOW MEASUREMENT IS MADE IN OPEN CHANNEL USING WEIRS AND PARSHALL FLUME .
   B) DISCUSS THE PIPING REQUIREMENT IN A METER INSTALLATION WITH ORIFICE METER .

8. A) EXPLAIN THE PRINCIPLE OF OPERATION OF POSITIVE DISPLACEMENT FLOW METER .
   B) DISCUS THE PERFORMANCE CHARACTERISTICS OF ROTAMETER .

9. A) EXPLAIN THE USE & PRINCIPLE OF VENTURI TUBES .
   B) SKETCH ANY ONE POSITIVE DISPLACEMENT FLOW METER AND EXPLAIN ITS WORKING .

10. A) WHAT IS STRAIGHTENING VANES IN HEAD FLOW METER .
    B) EXPLAIN THE WORKING PRINCIPLE OF A PITOT TUBE ?

11. A) DISCUS THE RELATIVE ADVANTAGE AND LIMITATION OF VARIOUS TAP CONNECTION FOR ORIFICE .
    B) DRAW A VENTURI TUBE AND EXPLAIN ITS FUNCTION .

12. A) WHAT ARE THE VARIABLE HEAD METERS USED IN CLOSED AND OPEN CHANNEL ?
    B) EXPLAIN THE WORKING PRINCIPLE OF MASS FLOW METER .

13. A) EXPLAIN THE WORKING PRINCIPLE OF NUTATING DISC POSITIVE DISPLACEMENT FLOW METERS ?
    B) WHAT IS WEIR ? EXPLAIN THE DIFFERENT TYPES OF WEIR USED FOR FLOW MEASUREMENT .

14. A) EXPLAIN THE WORKING PRINCIPLE OF ANY ONE OF A VELOCITY METER .
    B) DISCUSS THE PIPING REQUIREMENT IN A METER INSTALLATION WITH ORIFICE PLATE .

15. A) DISCUSS THE PERFORMANCE CHARACTERISTICS OF VARIABLE AREA FLOW METER .
    B) EXPLAIN HOW THE OPEN CHANNEL FLOW MEASUREMENT IS MADE .

16. A) DISCUSS THE TAPPING REQUIREMENT FOR ORIFICE METER .
    B) DISCUSS THE PERFORMANCE CHARACTERISTICS OF HEAD FLOW METER .

17. A) WHAT ARE THE DIFFERENT TYPES OF ORIFICE PLATE USED ?
    B) EXPLAIN THE WORKING PRINCIPLE OF PISTON TYPE AREA FLOW METER .

18. A) WHAT ARE TYPES OF FLOAT USED IN ROTAMETER ?
    B) INDICATE THE APPLICATIONS OF ORIFICE PLATE, WEIRS AND ORIFICE TAPS IN PETROCHEMICAL INDUSTRY .

19. A) SKETCH ANY ONE OF QUANTITY METER AND EXPLAIN ITS WORKING .
    B) WHAT IS THE ADVANTAGE OF PITOT TUBE .

20. A) SKETCH & EXPLAIN THE WORKING PRINCIPLE OF LOBED IMPELLER METER .
    B) WHAT ARE THE FACTORS TO BE CONSIDERED IN SELECTING PIPING ARRANGEMENT FOR HEAD FLOW METER .

21. A) SKETCH AND EXPLAIN THE PRINCIPLE OF NOTATING DISC METER .
    B) WHAT IS THE ADVANTAGES OF VENA- CONTRACTA TAPS FOR ORIFICE PLATE .

22. A) STATE BERNOULLI'S EQUATION ?
    B) DRAW A VENTURI TUBE & ITS FUNCTION .

23. WRITE SHORT NOTES ON
    A) V. NOTCH WEIR .
    B) ROTAM - VANE METER .

24. WRITE SHORT NOTES ON
    A) BELLOWS METER .
    B) FLOW COEFFICIENT.

25. WRITE SHORT NOTES ON
    A) FLOW OF INCOMPRESSIBLE FLUID IN PIPES .
    B) HYDRAULIC FLUMES MEASUREMENT FOR OPEN CHANNEL FLUID .

UNIT - IV:

1. A) EXPLAIN THE USE OF MANOMETER.
   B) EXPLAIN ANY ONE METHOD OF MEASURING HIGH VACCUM.

2. A) EXPLAIN HOW A VERY LOW ABSOLUTE PRESSURE IS MEASURED USING MCLEOD GAUGE.
   B) EXPLAIN THE OPERATION OF BELL TYPE PRESSURE GAUGE.

3. A) DISCUSS THE APPLICATION AND MATERIALS OF CONSTRUCTION OF C, SPIRAL AND HELICAL TYPE BOURDON SPRING GAUGE.
   B) DERIVE THE TRANSFER FUNCTION OF CAPACITANCE PRESSURE TRANSDUCER AND DISCUSS THE FREQUENCY RESPONSE OF IT.

4. A) DRAW A NEAT SKETCH AND EXPLAIN THE WORKING PRINCIPLE OF A BOURDON SPRING

GAUGE USED FOR A PRESSURE MEASUREMENT.
B) EXPLAIN HOW THE VACCUM MEASUREMENTS ARE MADE.

5. A) EXPLAIN THE TERMS .
   I) ABSOLUTE PRESSURE.
   II) ATMOSPHERIC PRESSURE.
   III) VACCUM PRESSURE.
   B) EXPLAIN THE WORKING PRINCIPLE OF LIQUID COLUMN GAUGE.

6. A) EXPLAIN THE WORKING PRINCIPLE OF KUNDSON GAUGE.
   B) HOW ARE THE MAGNETIC, MECHANICAL AND CAPACITANCE TRANDUCERS ARE USEFUL FOR PETROCHEMICAL INDUSTRY? WRITE DOWN THEIR RELATIVE MERITS AND DEMERITS.

7. A) WHAT ARE THE PRESSURE TRANSDUCERS?
   B) EXPLAIN THE WORKING OF A CAPACITANCE PRESSURE TRANSDUCER.

8. A) HOW ARE THE HIGH VACCUM MEASUREMENTS MADE?
   B) WRITE DOWN THE APPLICATIONS OF MECHANICAL, MAGNETIC AND CAPACITANCE PRESSURE TRANSDUCERS IN PETROCHEMICAL INDUSTRY.

9. A) DISCUSS ABOUT STATIC ERROR IN PRESSURE GAUGE?
   B) EXPLAIN THE OPERATION DIAPHRAGM SEAL PRESSURE GAUGE?

10. A) DISCUSS ABOUT RESPONSE OF MECHANICAL PRESSURE GAUGE?
    B) EXPLAIN THE WORKING PRINCIPLE OF LIQUID COLUMN GAUGE.

11. A) EXPLAIN WITH ONE TYPE OF GAUGE HOW ABSOLUTE PRESSURE IS MEASURED?
    B) WHAT ARE PRESSURE TRANSDUCERS?

12. A) WHAT ARE THE DIFFERENT TYPES OF GAUGES USED TO MEASURE ABSOLUTE PRESSURE?
    B) DISCUSS THE APPLICATION AND MATERIALS OF CONSTRUCTION OF C SPIRAL AND HELICAL TYPES OF BOURDON SPRING GAUGE.

13. A) CONVERT THE FOLLOWING MEASUREMENTS TO ABSOLUTE PRESSURE IN KG PER SQ. CM ABSOLUTE.
    I) 2880 PSIA.
    II) 200 ATM. ABSOLUTE.
    III) 20 INCHES OF HG VACCUM AT 32 DEG. F AND A BAROMETER OF 790 MM HG.
    B) EXPLAIN HOW A VERY LOW ABSOLUTE PRESSURE IS MEASURED USING MCLEOD GAUGE.

14. A) WRITE A BRIEF DESCRIPTION OF THE OPERATION OF DIAPHRAGM SEAL PRESSURE GAUGES.
    B) EXPLAIN THE WORKING OF A CAPACITANCE PRESSURE TRANSDUCERS.

15. WRITE SHORT NOTES ON
    I) UNDER RANGE & OVER RANGE PROTECTION OF PRESSURE ELEMENTS.
    II) LIQUID COLUMN PRESSURE GAUGES.
    III) PRESSURE TRANSDUCERS.

16. A) COMPARE BOURDON, BELLOWS, MERCURY MANOMETER, MCLEOD & KUNDSEN IN TERM OF VACUUM GAUGE PROPERTIES.
    B) STATE DIFFERENT TYPES OF PRESSURE SPRINGS AND ITS APPLICATION.

17. A) STATE THE USEFUL RANGES OF DIFFERENT VACCUM MEASURING GAUGE.
    B) DISCUSS ANY ONE OF INDICATING ELEMENT OF PRESSURE GAUGE?

18. A) STATE THE USEFUL RANGES OF DIFFERENT ABSOLUTE PRESSURE MEASURING GAUGES.
    B) EXPLAIN THE WORKING PRINCIPLE OF PIRANI GAUGE.

19. EXPLAIN THE UNITS / TERMS
    I) TORR, MICRONS.
    II) RESPONSE OF MECHANICAL PRESSURE GAUGES.
    III) BAROMETRIC PRESSURE.

20. A) WHAT ARE THE DIFFERENT TYPES OF GAUGES USED FOR MEASURING VACCUM? STATE THE PRINCIPLE OF OPERATION & ITS USEFUL RANGE OF MEASUREMENT.
    B) EXPLAIN THE WORKING OF A CAPACITANCE PRESSURE TRANSDUCER.

21. A) DRAW A NEAT SKETCH AND EXPLAIN THE WORKING PRINCIPLE OF BOURDON GAUGE FOR A PRESSURE MEASUREMENT.
    B) DISCUSS ITS APPLICATION AND MATERIALS OF CONSTRUCTION.

22. WRITE SHORT NOTES ON
    I) MCLEOD GAUGE .
    II) BOURDON SPRING ELEMENTS.
    III) SEALS PRESSURE MEASURING ELEMENTS.

23. WRITE SHORT NOTES ON
    I) LIQUID COLUMN PRESSURE GAUGES.
    II) STATIC ERROR IN METALLIC PRESSURE ELEMENTS.
    III) VACCUM GAUGES.

24. WRITE SHORT NOTES ON
    I) MANOMETERS.
    II) BOURDON GAUGE.
    III) KUNSDON GAUGE.

25. WRTE SHORT NOTES ON
    I) APPLICATION OF DIFFERENT TYPES OF BOURDON SPRING ELEMENTS.
    II) USEFUL RANGE OF DIFFERENT ABSOLUTE PRESSURE MEASURING GAUGES.
    III) UNDER RANGE AND OVER RANGE PROTECTION OF PRESSURE GAUGES.

UNIT - V:

1. EXPLAIN HOW WILL YOU ANALYSE A GIVEN SUBSTANCE BY USING EXTERNAL ENERGY SOURCES.

2. EXPLAIN THE FOLLOWING
    A) INTERACTION OF A SUBSTANCE WITH THERMAL ENERGY.
    B) INTERACTION OF A SUBSTANCE WITH ELECTROMAGNETIC ENERGY.
    C) INTERACTION OF A SUBSTANCE WITH CHEMICALS.

3. A) EXPLAIN THE TERM MASS SPECTROSCOPY.
    B) BRIEF THE OPERATION OF MASS SPECTROMETER WITH NEAT SKETCH.

4. A) HOW WILL YOU DETECT THE PRESENCE OF ORGANIC AND INORGANIC COMPOUNDS IN A SUBSTANCE.
    B) WRITE THE DEW POINT OF MEASURING HUMIDITY.

5. A) EXPLAIN PARAMAGNETISM.
    B) EXPLAIN O2 ANALYSER BY USING THIS EFFECT WITH SKETCH.

6. A) DEFINE
   I) PH.
   II) PH SCALE.
   B) EXPLAIN METHOD OF PH MEASUREMENT.

7. BRIEF THE TERM CHROMATOGRAPHY.
   EXPLAIN ONE OF CHROMATOGRAPHY APPLICATION.

8. A) DESCRIBE ANY ONE METHOD OF COMBUSTIBLE GAS ANALYSIS.
   B) DEFINE
   I) THERMAL CONDUCTIVITY
   II) CHROMATOGRAPHY
   III) PARAMAGNETISM
   IV) PH

9. A) BRIEF WHY COMBUSTIBLE GAS ANALYSIS METHOD IS NEEDED.
   B) WITH SKETCH EXPLAIN THE OPERATION OF COMBUSTIBLE GAS ANALYSER.

10. A) MENTION THE REASONS WHY PH MEASUREMENT IS NECESSARY IN INDUSTRIES.
    B) EXPLAIN WITH DIAGRAM AUTOMATIC PH CONTROL.

11. MENTION VARIOUS UNITS OF MASS SPECTROMETER AND EXPLAIN THE OPERATION.

1. A) BRIEF THE OPERATION OF PSYCHROMETER.
   B) DEFINE:
   I) HUMIDITY
   II) RELATIVE HUMIDITY
   III) KINEMATIC VISCOSITY
   IV) DENSITY

13. A) DEFINE
   I) VISCOSITY
   II) ABSOLUTE VISCOSITY
   III) KINEMATIC VISCOSITY
   IV) DENSITY
   B) GIVE REASONS FOR PH MEASUREMENT IN INDUSTRIES.

14. A) DISCUSS
   I) OPEN LOOP CONTROL
   II) CLOSED LOOP CONTROL
   B) DISCUSS MERITS AND DEMERITS OF OPEN AND CLOSED LOOP CONTROL.

15. WITH SKETCH SHOW THE VARIOUS ELEMENTS OF AN AUTOMATIC CONTROL AND DESCRIBE THE FUNCTION OF EACH ELEMENT.

1. BRIEF THE NECESSARY OF AUTOMATIC CONTROL IN AN PETROCHEMICAL INDUSTRY AND DRAW A CONTROL LOOP.

2. DEFINE AND EXPLAIN
   A) ON - OFF CONTROL

B) PROPORTIONAL CONTROL
C) PI CONTROL
D) PID CONTROL

18. DEFINE AND EXPLAIN
A) PROPORTIONAL BAND
B) GAIN
C) REPEATS PER MINUTE

19. EXPLAIN THE OPERATION OF TEMPERATURE CONTROL USING PID CONTROL

1. A) EXPLAIN THE TERM OFF - SET.
B) HOW WILL YOU ELIMINATE OFF - SET IN A CONTROL SYSTEM.
C) EXPLAIN WITH THE SUITABLE EXAMPLES

21. EXPLAIN DIFFERENT TYPES OF CONTROLS.

1. EXPLAIN HOW WILL YOU DESIRE THE VALUES OF PID FOR A NEW LOOP.
A) BRIEF THE OPERATION OF PSYCHROMETER.
B) WRITE THE DEW POINT METHOD OF MEASURING HUMIDITY.

24. EXPLAIN BRIEFLY HOW PH IS CONTROLLED IN A DISODIUM PHOSPHATE INDUSTRY, WITH NEAT SKETCH.

1. A) DISCUSS MERITS OF AUTOMATIC CONTROL.
B) DRAW CLOSED CONTROL LOOP FOR FLOW CONTROL.
C) EXPLAIN THE METHOD OF TUNING A CONTROL LOOP.

ATSCO QUESTIONS

1. WHAT IS A PLC? WHAT ARE ITS DISTINCT ADVANTAGES OVER CONVENTIONAL CIRCUITS.

A PLC STANDS FOR PROGRAMMABLE LOGIC CONTROLLER. ALL TYPE OF LOGIC FUNCTIONS CAN BE PERFORMED BY IT. SUCH AS SEQUENTIAL START UP OF SYSTEMS, FAIL SAFE RUNNING PLANT AND SEQUENTIAL SHUTDOWNS. THE CONVENTIONAL CIRCUITS USING RELAY DIGITISED GATES AND DIFFICULT TO CHANGE OR BYPASS AND BULKY. WHILE PLC IS SMALLER AND CHANGES CAN BE MADE BY PROGRAMMING WITHOUT CHANGING HARDWARE, MEANT FOR INDUSTRIAL ATMOSPHERE, CAN BE INSTALLED IN PLANT CONVENIENT, NO MOVING OR MECHANICAL PARTS SO, CHANCES OF FAILURE IS MINIMISED.

2. WHAT ARE DIFFERENT TYPES OF I/O IN TYPICAL PLC SYSTEM USED FOR SAFETY SHUTDOWN SYSTEM IN OIL INDUSTRIES.

INPUTS
1. RELAY AND SWITCHES CONTACTS. WITHOUT VOLTAGE (DRY CONTACT)
2. RELAY AND SWITCHES CONTACTS WITH 120 V AC OR 24 V DC.
3. LOGIC LEVELS FROM TRANSISTORISED CIRCUITS CAN ALSO BE INPUTS.

OUTPUTS
1. LOW VOLTAGE CONTACT FOR OTHER INTERLOCK FUNCTION
2. HEAVY RATED CONTACTS FOR SOV OR OTHER DEVICES

3. THYRISTER OUTPUTS.

3. GIVE MOST COMMONLY USED ENGINEERING UNITS FOR FOLLOWING IN MKS AND FPS SYSTEMS.

PARAMETERS	**MKS**	**FPS**
TEMPERATURE	DEG .C, DEG .K	DEG .F, DEG. R
GAS FLOW	MMSCF, ST. M3/D	SCFM, SCFH, M3/HR
OIL FLOW	BBL/D, METRIC TONS/D	GPM, LPM, LB/HR
TANK LEVEL	METER, CM, M3	FT, INCH, FT3
HEAT	CALORIE, K . CALORIE	B.T.U
DENSITY	GM/CM3, KG/M3	POUND/IN3
PRESSURE	KG/CM2, BAR, KP	PSI, IN. OF H2O, MM H2O, IN.OF HG.
VIBRATION	G/SEC, GM/SEC, CM/SEC	MILS, THOU.

4. GIVE NAMES OF TWO MOST COMMONLY USED FLAME DETECTORS USED FOR GAS FIRED HEATERS AND BRIEFLY DESCRIBE THE WORKING.

   A UV FLAME DETECTOR – UV RAYS SENSITIVE MATERIAL COATED ON THE TUBE ELECTRODE. WHEN IT SENSE RAYS IT STARTS CONDUCTING ELECTRONS ARE SENSED BY AMPLIFIER AND CIRCUIT IS OPERATED.

   FLAME ROD – ITS MADE OF HEAT SENSITIVE MATERIAL WHICH CHANGE IS SMALL AMOUNT OF CURRENT FLOW WHEN IT IS HEATED. THIS CURRENT AMPLIFY AND OPERATE THE CIRCUIT.

5. WHAT SHOULD BE THE SETTING OF A PRESSURE SWITCH, IF IT IS REQUIRED TO TRIP A PUMP AT 30 % OF THE FULL SCALE FLOW. (SWITCH IS CONNECTED TO OUTPUT OF A 3 - 15 PSI DP CELL)

   12 X (30%) SQUARED + MIN.(3) = 12 X 0.09 + 3 = 4.08 PSI.

6. WHAT WILL BE THE OUT PUT OF A SQUARE ROOT EXTRACTOR , IF IT IS INPUT 8 MA IN A STANDARD 2 WIRE TRANSMITTER SYSTEM?

   12 MA.

7. WHAT IS THE EFFECT OF TEMPERATURE AND PRESSURE ON GAS FLOW MEASUREMENT BY ORIFICE /DP CELL COMBINATION?

   MASS FLOW = VOLUME FLOW X (PRESSURE/ TEMPERATURE).

8. GIVE DEFINITION OF PROPORTIONAL BAND, INTEGRAL ACTION AND DERIVATIVE ACTION TIME.

   P.B - AMOUNT OF % ERROR REQUIRED TO CHANGE OUTPUT BY 100%.

   I.A.T- IT IS THE TIME TAKEN BY INTEGRATION TO CHANGE OUTPUT BY SAME COMMAND AS PROPORTIONAL BAND.

D.A.T - IT IS THE TIME WHICH WOULD HAVE BEEN REQUIRED TO OPEN AND CLOSE THE VALVE, BEFORE THE ERROR OCCURS.

9. WHAT IS THE DISADVANTAGES OF PROPORTIONAL ONLY CONTROL AND HOW WILL RESET ACTION OVERCOMES IT?

   PROPORTIONAL ONLY CONTROL HAS OFFSET WHENEVER CHANGES OCCUR. THE OFFSET VARIES WITH THE AMOUNT OF PROCESS DEVIATION.

   RESET ACTION INTEGRATES THIS ERROR AND KEEPS CHANGING THE OUTPUTS TILL THE OFFSET IS REDUCED TO ZERO.

10. WHAT ARE THE MOST IMPORTANT PARTS OF A GAS TURBINE?

    A) STARTOR
    B) AIR COMPRESSOR AND BLEED VALVES
    C) COMBUSTION CHAMBERS - AIR INLET FOR GAS CONTROL VALVES, FLAME DETECTION AND TEMPERATURE CONTROL.
    D) HP TURBINE - SPEED CONTROL GUIDE VANES, NOZZLE CONTROL.
    E) LP TURBINE OR POWER TURBINE - SPEED CONTROL, TEMP TRIPPING

11. WRITE DOWN THE STEPS IN STARTING UP OF A GAS TURBINE SEQUENTIALLY.

    A) LUBE OIL SYSTEMS ARE O.K..
    B) STARTOR ON
    C) REACH CERTAIN SPEED. PCD O.K.
    D) IGNITION ON. FLAME DETECTOR
    E) REACH CERTAIN SPEED
    F) ACCELERATE TO A HIGHER SPEED. MAIN BURNERS ARE ON. ACCELERATION CONTROL
    G) MAIN LUBE OIL SYSTEM ENHANCES. AND SPEED CONTROL O.K.
    H) SPEED CONTROL ACTIVATES
    I) AUXILLARY LUBE OIL SYSTEM OFF

12. WHAT IS A CDP OR PCD OR P2 PRESSURE AS REFERRED TO GAS TURBINE? WHAT IS ITS IMPORTANTCE.

IT IS A COMPRESSOR DISCHARGE PRESSURE AND IT IS IMPORTANT FOR MONITORING/CONTROL OF THE FOLLOWING:

    A) COMPRESSOR SURGE - TO OPERATE BLOW OFF VALVES.
    B) CONTROL OF SPEED - DURING START UP AND TIMING RATE OF CHANGE IN SPEED

13. WHAT PARAMETERS LIMIT THE TURBINE SPEED CONTROL?

    A) TEMP
    B) COMPRESSOR DISCHARGE PRESSURE
    C) LOAD

14. HOW IS THE SURGE IS AVOIDED IN A GAS TURBINE AIR COMPRESSOR?

    BY THE CONTROL OF ‘BLOW OFF’ VALVES.

15. WHAT IS SURGE IN COMPRESSORS? HOW IT IS PREVENTED?

IF THERE IS NOT ENOUGH CHARGE GAS TO COMPRESS (SPEED BEING CHANGED) THEN THE COMPRESSORS DISCHARGE PRESSURE RISES WHICH IN TURN NEEDS MORE

FLOW OF GAS. THIS WILL END UP IN AVALANCHE WHICH IS CALLED ‘SURGE’ IN COMPRESSORS.

16. DEFINE THE FOLLOWING TERMS USED IN DIGITAL SYSTEMS.

A) CPU - CENTRAL PROCESSION UNIT. THE HEART OF COMPUTER
B) ALU - ARITHMETIC LOGIC UNIT. PERFORMS ALL MATHEMATICAL FUNCTIONS.
C) EPROM - ERASABLE PROGRAMMABLE READ ONLY MEMORY
D) RAM - RANDOM ACCESS MEMORY
E) FLOPPY DISK - FLEXIBLE MAGNETIC DISK FOR DATA/ PROGRAM STORAGE
F) MODEM - MODULATOR / DEMODULATOR FOR COMMUNICATION OVER LONG DISTANCE
G) RS 232 - MOST COMMONLY USED SERIAL INTERFACE FOR PERIPHERALS.
H) HIWAY - MAIN CABLE FOR COLLECTION AND DISTRIBUTION OF DATA AT HIGH FREQ TO ALL THE DCS SUBSYSTEMS.
I) WATCH DOG TIMER -TIMER TO KEEP OVER MICROPROCESSOR CYCLE OPERATION.
J) PARITY DIGITAL SIGNALS ARE CODED TO HAVE A DEFINE PATTERN (EVEN/ODD/OTHER) FAILING WHICH.
K) A/D CONVERTER -ANALOGUE TO DIGITAL CONVERTER . 1 TO 5V. 0 TO 12 BITS OF DIGITAL SIGNAL BY A/D CONVERTER.