EXPERIENCE FROM UNUSUAL OCCURRENCES IN HWP (TUTICORIN)

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Starting from the construction and erection, an industry often faces a number of unintended and uninvited incidents which are hurdles to the progress. Even during the operation of the plants, these events occur and some of them unusual in nature. Analysing these unusual occurrences scientifically, the industry can gain valuable experience to prevent recurrence of the same thereby saving valuable property and life and achieving higher productivity. An attempt has been made here to give a detailed study of a few cases of unusual occurrences in HWP, Tuticorin.

CASE-I -

Rupture of ammonia cracker tubes :-

Ammonia Cracker in HWP (Tuticorin) is a rectangular furnace lined with light refractory bricks. 70 Nos. of inconel tubes filled with iron catalyst are kept vertically inside the same. (Ref. Fig.1). Vapour ammonia at a temp. of 550 deg. C and 130 atm. pressure normally pass through the catalyst bed and get dissociated as per the following reaction:-

$$2NH_3 \quad N_2 + 3H_2; \; dH = 11.04 \text{ KCal/mole}$$

Heat is supplied by the combustion of naphtha through the radiant burners mounted on furnace walls.

Prior to the occurrence, the cracker was operating with 92% of its design feed rate and all parameters were indicating normal. Suddenly a rise in catalyst temerature and furnace pressure was noticed and it was not getting maintained by the control systems. Field operator checked for the abnormality and reported a small fire at the bottom of the furnace. Within a few seconds a loud sound was heard and the bottom of the furnace was engulfed in fire. The operator managed to escape without injury. The shift-in-charge who rushed to the spot, tripped the plant from the field on seeing the fire. Snuffing steam to the furnace was opened simultaneous to the fire- fighting operation and fire was put out.

On inspection it was found that tube no. 1 and 2 were ruptured at the bottom. Whole plant was under long shut-down for further inspection, testing and repair works. Considerable production and property loss was realised. Non destructive Tests (NDT) showed that the rupture was due to creep failure. Inspectors were of the opinion that such failures can happen due to the following reasons:-

i) There would have been a flaw in the bottom of tube No.2 at the manufacturing stage itself which failed gradually in

service. The pin hole thus developed caused more opening, damaging itself and the adjacent tubes.

ii) There might be a low feed flow to the tube No.2 due to partial blocking in the catalyst resulting in higher temperature which was not noticed as no temperature measurement provision existed for this particular tube, causing failure at the weakest point. Besides being towards one end of the furnace, the tube was subjected to higher radiant heat, adding to the temperature shoot up.

iii) One of the burners in the affected zone might have developed a long flame, touching the tube and causing the failure.

Though such incidents are a common feature in a fertilizer industry, the following additional monitoring arrangements have been made for the early detection and minimising the chance of such failure:-

a) A new reduced limit on operating temperatures of tube skin, catalyst bed and flue gas is imposed.

b) Each catalyst tube has been fitted with temperature monitoring at the tube outlet pipe (hair pin) and monitored continuously from control room.

c) Additional temperature monitoring provision for the tube wall skin temp. has been made.

d) Operation manual was reviewed and updated incorporating the new stipulations.

e) Online NOX monitoring instrument has been installed for flue-gas to detect tube leak.

f) Systematic NDTs like 1) Ultrasonic - flaw detection,Hardness measurement, thickness measurement (2) dye penetrant test, (3) Ovality test (4) Replica test are being carried out in every ATA.

g) Besides vigorous visual inspection of the cracker in every shift by the field operators as well as shift engineers is enforced.

h) Additional fire protection arrangement has been made for the cracker. Two fixed fire monitors have been installed on both sides of the cracker. An electrical isolation switch has been provided near to the unit to cut off the power supply in case of any emergency.

The above incident occurred at 25% of design service life of the tubes. With all the monitoring provision incorporated, the cracker is completing 85% of its service life and no such incident has repeated so far.

CASE-II

Water entry in cable junction box through Nitrogen line

During a short shut-down of the plant, the general shift boiler operator drained the boiler and arranged a temporary nitrogen purging (as shown in the Fig-2) to prevent corrosion. The next day, nitrogen supply was not available as the unit was under shut-down. The boiler was filled with DM water by the shift personnel. Subsequently it was found that DM water entered in the nitrogen header and from there into connected cable junction boxes and process pipings.

On investigation it was found that proper information was not passed on from general shift to shift and from shift to subsequent shifts. Thus COMMUNICATION GAP was the main reason for the incident.

Remedial action:-

a) All important information regarding operation are recorded in the log book and the detail of events are passed on from shift to shift to avoid communication gap.

b) The practice of operation check list is followed.

c) Nitrogen is introduced from the top point of the equipment for such purpose and not from the bottom as in this case.

d) The practice of disconnecting temporary nitrogen connections are followed when the same is not in service.

Introducing a non-return valve on nitrogen supply line can reduce the possibility of foreign fluid entry into the nitrogen header.

The above incident was detected well in time and precautionary measures were taken, otherwise the water entered would have caused damage to the electrical equipment and process system.

CASE-III

Potassium amide splash on maintenance personnel :-

One spectacle blind in a 1" process line handling potassium amide solution was being reversed from close to open position after due clearance from process side. While loosening and lifting the flange of the blind, amide solution splashed on a technician. Inspite of his washing under the nearest drench shower immediately, he sustained first degree burn injury on his arm. The above process line was isolated and depressurised through vent points (as shown in the Fig-3a) before opening the flange. On investigation, it was understood that the splashing of the liquid was due to locked up pressure inside, though the vent points were

clear. Similar problem was faced on earlier occasions also. When vent point tappings are located away from the isolation on a vertical pipe handling cold amide solution, such locked up pressure can develop (as shown in the Fig-3b). This happens due to formation of amide solid over the hold up liquid surface during venting. This is predominant in smaller dia pipes.

Remedial Actions:-

1) The upper side vent tapping are relocated nearest to the isolations to minimise any liquid hold up above tne isolation during release.

2) For undertaking maintenance of such job, wearing of full protective suit is enforced.

The above measures have not only reduced the rate of such accident but developed confidence among the maintenance personnel.

CASE-IV

GB101 (Booster Compressor) Trip :-

The centrifugal type booster compressor for the inlet synthesis gas (N_2+$3H_2$) from the Fertilizer Plant tripped due to seal oil head tank "too low level" which in turn caused the trip of heavy water plant. Head tank seal oil level is maintained by seal oil pump which stopped on its own due to loose connection in the Emergency Motor Control Center. The auxiliary seal oil pump took auto start on "low level". but the alarm for the same appeared after the appearance of "too low level" alarm to which the trip of booster was connected and hence the trip of the compressor.

On investigation, cause for the delayed appearance of the low level alarm was attributed to the following:-

The low level alarm was taken from the level transmitter through a pressure switch whereas too low level signal was taken from an independant mercury float switch (as shown in the fig-4). There had been a sluggish response from the level transmitter. Later, while checking the functioning of the level controller the response was found poor due to partial chocking in the pilot relay. On cleaning the pilot relay, the response was quick and the problem did not repeat.

Remedial action:-

i) Emphasis is given for checking electrical contact at every opportunity to avoid unwarranted trips of machineries.

ii) Periodical cleaning of the pilot relay is being carried out. Simulation check is also being carried out at every opportunity to check the integrity of such vital control systems.

CASE-V

Explosion in effluent system

Process equipment drains and vents in the plant are connected to effluent system. This closed effluent system is balanced with stack and atmosphere at different locations (Ref. Fig 5).

In the past, there were instances of mild explosions in the above effluent header and stacks, followed by the bursting of ammonia cooler rupture discs in a few cases. This resulted in large amount of ammonia release, thereby causing pollution in the working atmosphere.

Investigation revealed that the presence of potassium amide, synthesis gas, water and air in the stack and effluent led to such explosion .This explosion has caused an impact on the rupture disc leading to reverse buckling of the same and its failure.

Since the stack and effluent header is supposed to handle water, synthesis gas and amide disposed from process equipment, avoiding air entry in to the system was the only choice.

Remedial action :-

a) Construction of a weir in the inspection pit (shown in fig.5)

b) U-seals were provided to bleeders open to atmosphere.

c) N_2 introduced at various points to avoid air pocket.

d) Physical examination of rupture discs for its integrity during ATA.

Since the incorporation of the above modifications there has been no such incident of explosion and rupture disc bursting due to the same in the plant.

Conclusion :-

Monitoring, recording, comparing and analysing the healthiness of process equipment from parameters is utmost essential in an industry as it is done in the case of human health. Unsafe conditions and unsafe acts should be identified and eliminated at the earliest to keep accidents at bay. Needless to say, quick corrective action can save beyond praise.

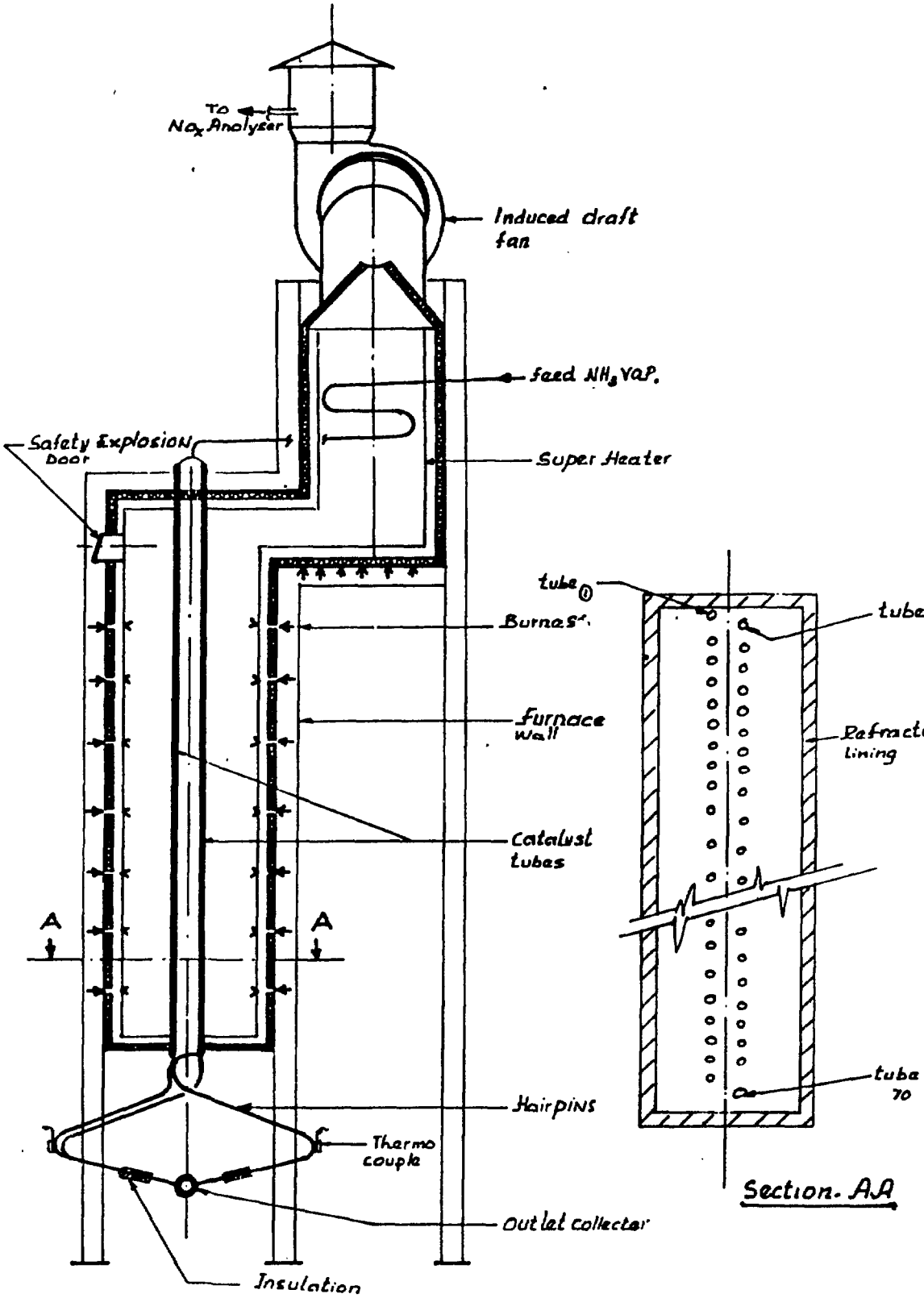

To
NO_x Analyser
Induced draft fan
feed NH_3 VAP.
Safety Explosion Door
Super Heater
tube
Burner
Furnace Wall
Catalust tubes
A
A
Hairpins
Thermo couple
Outlet collector
Insulation
tube
Refract
lining
tube
70
Section. AA

Fig. 1

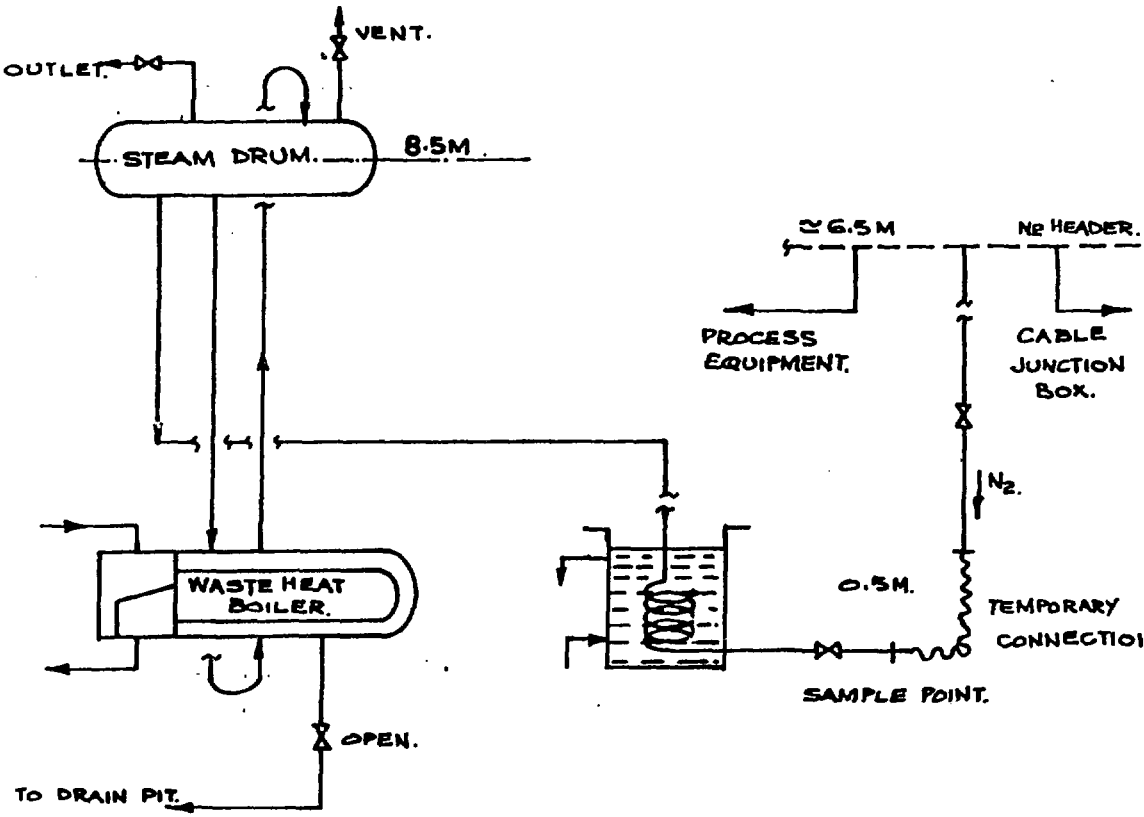


FIG. 2.

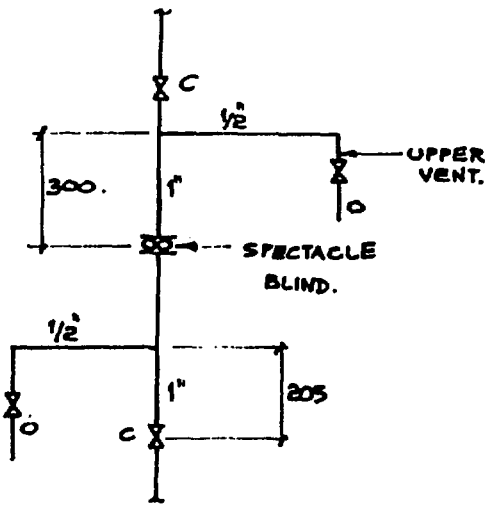


FIG. 3a.

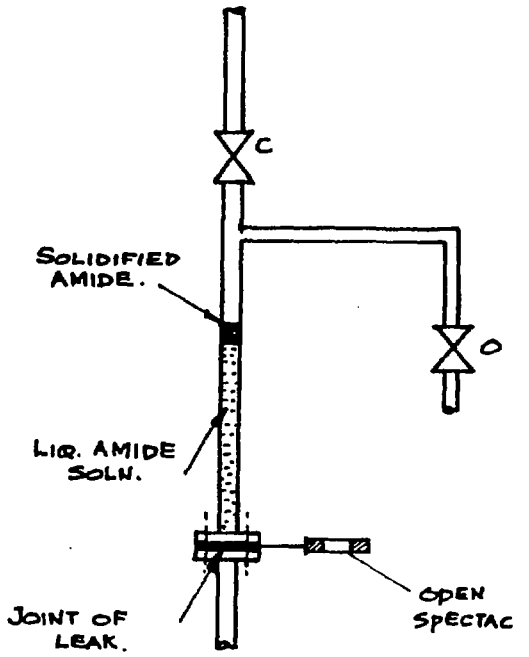
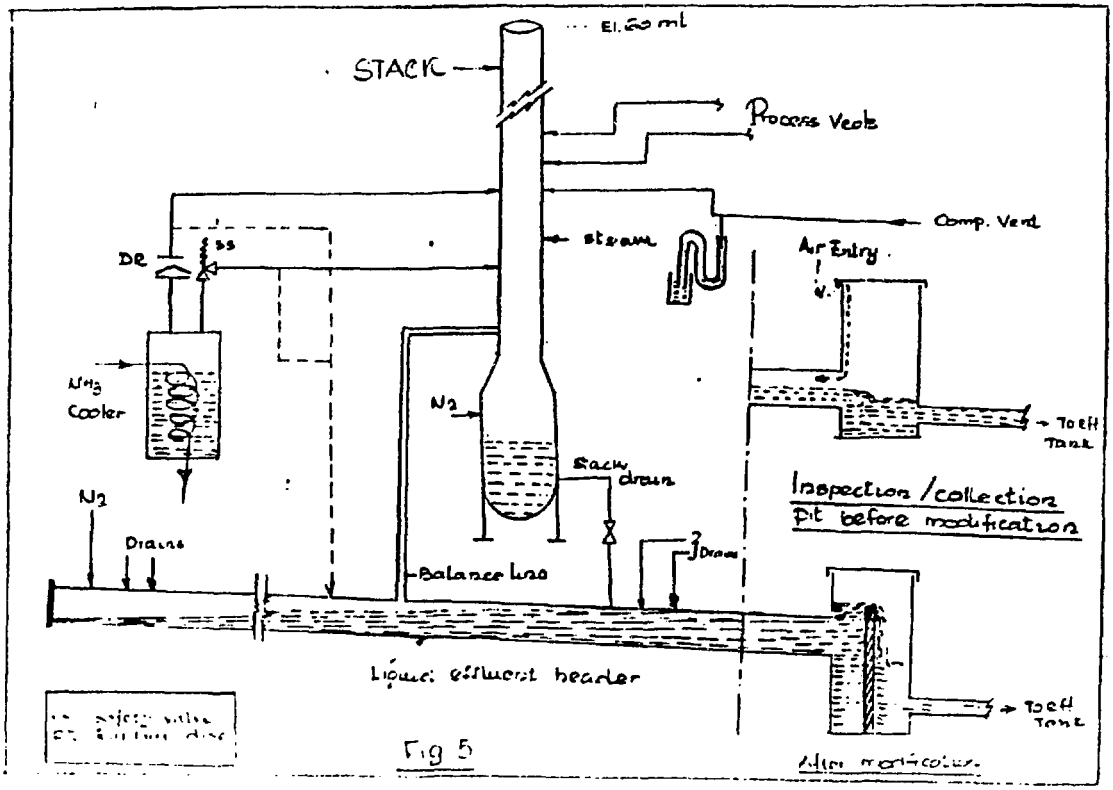


FIG. 3b.


STACK
El. 60 m
Process Vents
Comp. Vent
Steam
Air Entry
DE
SS
NH3 Cooler
N2
Stack drain
Drains
Balance line
Liquid effluent header
To ETP Tank
Inspection / collection pit before modification
To ETP Tank
Fig 5

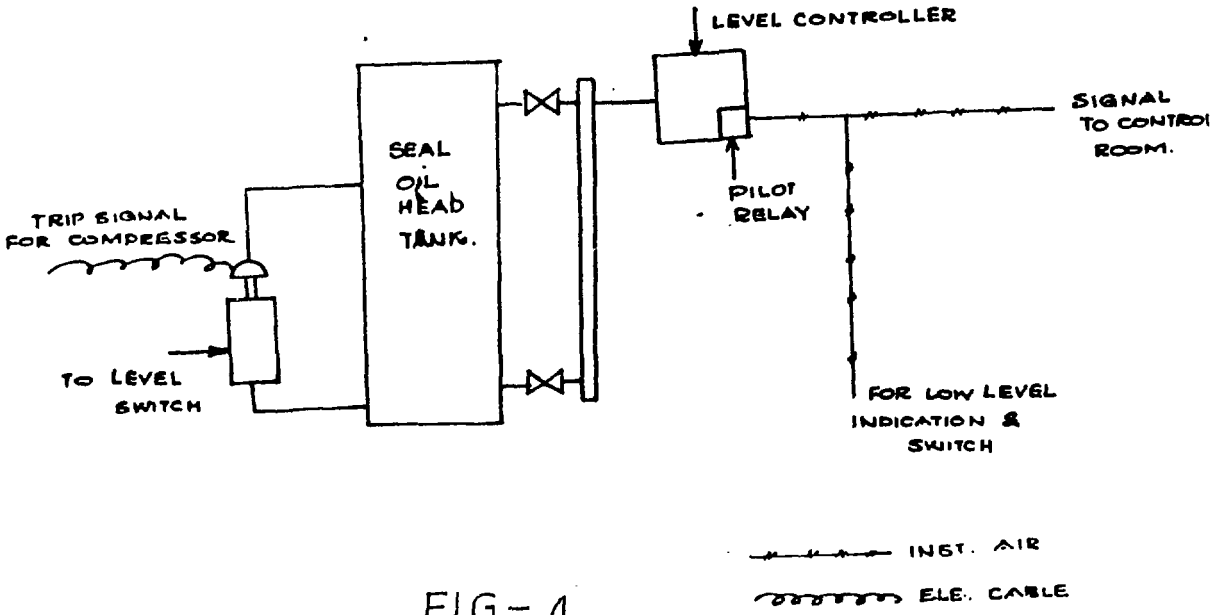

LEVEL CONTROLLER
SIGNAL TO CONTROL ROOM.
SEAL OIL HEAD TANK.
PILOT RELAY
TRIP SIGNAL FOR COMPRESSOR
TO LEVEL SWITCH
FOR LOW LEVEL INDICATION & SWITCH
INST. AIR
ELE. CABLE

FIG.- 4