OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

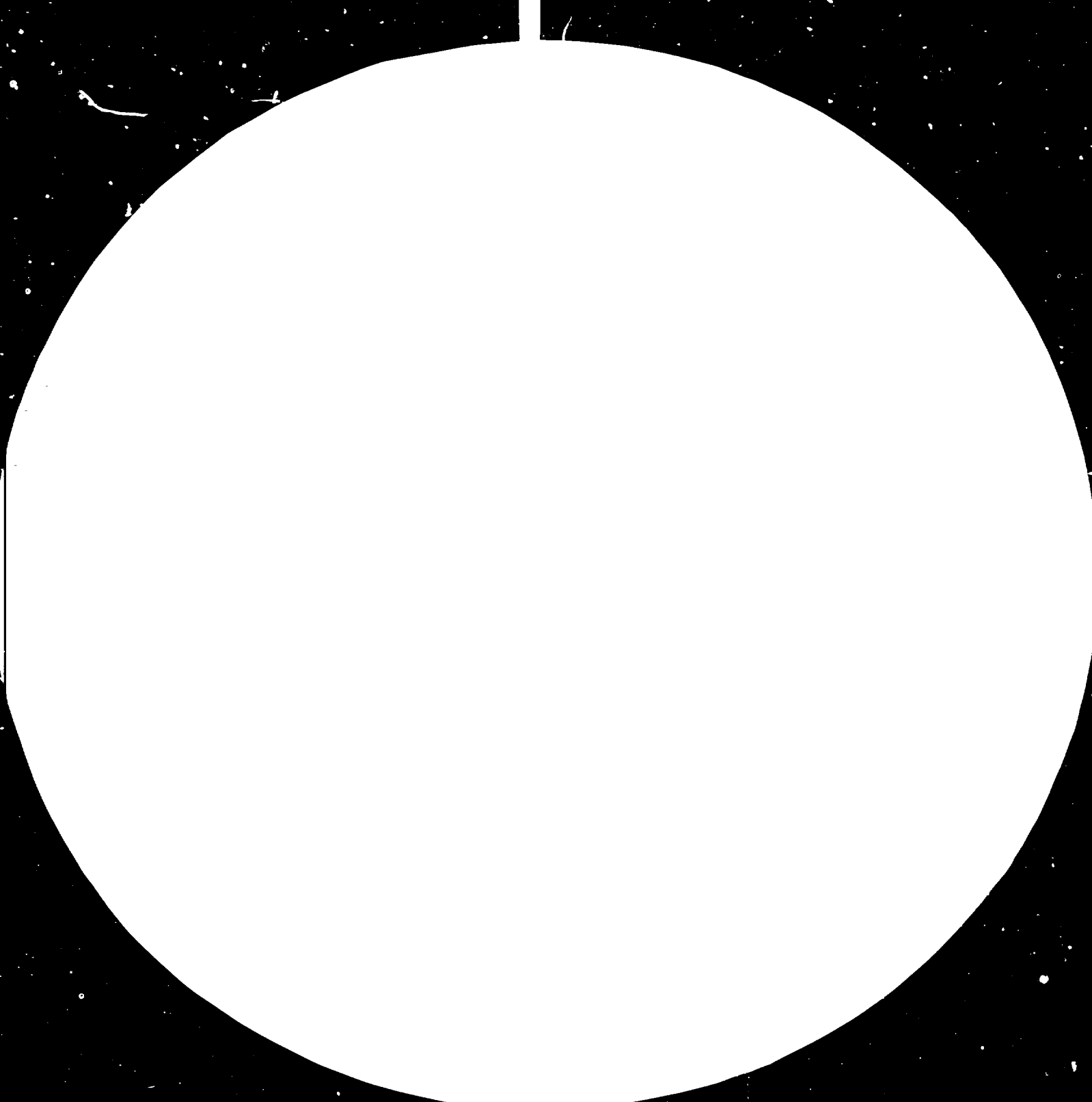
FAIR USE POLICY

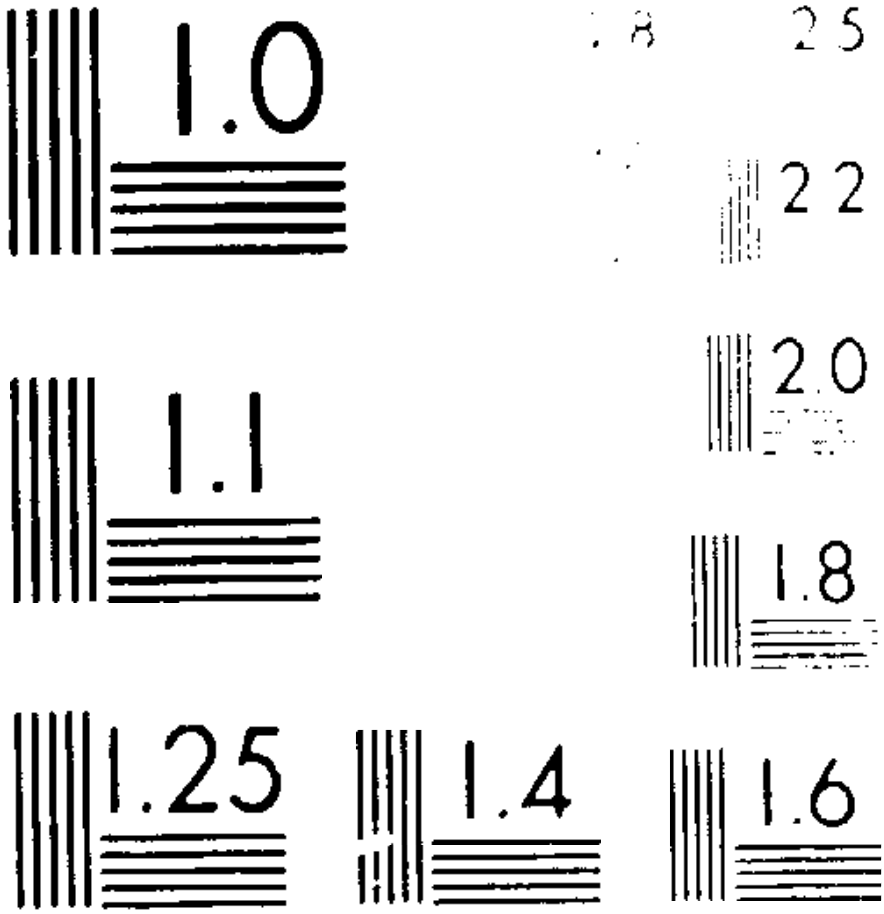
CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5

10202

Distr.
LIMITED

ID/WG.333/6
13 November 1980

ENGLISH

United Nations Industrial Development Organization

Interregional Meeting on Safety in Production,
Transportation and Storage of Fertilizers

New Delhi, India, 8 - 10 December 1980

IN-HOUSE TEAM IMPROVES SAFETY, PRODUCTION AND PROFITABILITY *

by

Saleh Ibrahim Quraidis **

* The views expressed in this paper are those of the author and do not necessarily reflect the views of the UNIDO secretariat. This document has been reproduced without formal editing.

** Technical Manager, Saudi Arabian Fertilizer Company, Dammam, Saudi Arabia

I - INTRODUCTION

The Saudi Arabian Fertilizer Company (SAFCO), located in Dammam, Saudi Arabia is essentially a urea producer commissioned in late 1969. The operating units are based on Chemico design and consist of a 600 Metric tons per day ammonia plant which feeds the 1000 MTD urea plant. The ammonia plant is characterized by centrifugal compressors, medium pressure synthesis loop and a MEA-CO_2 removal system. Two stage decomposition train in the urea plant was followed by crystallization, remelting and subsequent spray head prilling. Both of these units have been subjected to later day design modifications, salient points of which are included in this paper. In addition to the above, a 30 MTD Sulfur recovery unit alongwith a 50 MTD Sulfuric Acid plant were installed in conjunction with the sweetening process for the natural gas feed to the facilities. Safco has its in house fully integrated utilities system. Early this year, Safco has commissioned its newly installed 300 MTD SIM-CHEM Sulfuric acid plant.

Ever since plant commissioning and upto 1974, Safco urea production was limited on an average to half the design capacity. Major contributing factors included inherent design problems and poor operating and maintenance practices. Production was lost in some occasions due to fire in furnace or synthesis loop flanges or due to mal-function of unit security in some other occasions. Of course, the overall poor achievement was attributed to ineffective and unstable management.

Beginning 1974, Safco's higher management took positive steps and embarked on an all-out effort to restore plant capabilities. This included personnel changes in key managerial positions, undertaking plant modifications to remove bottlenecks and a clearly spelled out operating philosophy of maximizing profits through increased production at lowest cost.

This paper deals with major technical modifications carried out and the procedures implemented to secure tha plant and personnel safety. It may be emphasized that these were not achieved by the usual course of technology transfer from plant builder to owner. Rather Safco's own in-house technical and managerial resources were utiliized. Through their devotion, stability and self confidence, they quickly took over the organization and subsequently problems were gradually resolved. The following table clearly shows the fruit of their successful efforts:

Table 1 : Safco Yearly Performance

Year	Service Factor(1)	Capacity Factor(2)	Urea Production Metons	Profit (Loss) Million U.S.$
1970	23.3	28.0	24,436	(8.54)
1971	43.8	54.7	89,719	(8.49)
1972	39.9	50.2	75,187	(7.68)
1973	60.5	63.0	142,806	(3.95)
1974	66.8	70.0	175,197	22.27
1975	72.1	80.5	217,001	9.34
1976	71.0	66.6	177,438	(6.32)
1977	81.1	73.0	221,475	6.28
1978	83.0	83.7	260,033	11.08
1979	90.4	88.4	298,850	30.00
1980 (Pro-rata)	89.1	97.5	317,420	37.00

(1) - Percentage of time onstream regardless of production.
(2) - Ratio of onstream production to design production

Although quite a few modifications were implemented and various procedures were introduced, the following section deals with major items having an overall favourable impact on enhanced service factor and safety.

II - ENGINEERING MODIFICATION

1. Primary Reformer

In the original design the two cell, side wall fired, Alcorn primary reformer furnace had top and bottom flanged catalyst tubes. The tubes were butt welded to 1" Sch 40 Incoloy 800 pigtails which were also butt welded to the outlet collection manifold. Details are shown in Figure 1. The original pigtails configuration is depicted in Figure 2, which shows that the center pigtails (total 16) had two bends and the regular pigtails (total 160) had only one bend.

Pigtail cracking posed a significant problem due to this configuration. Cracks were propogated as the tubes and header changed position due to heat during furnace operation. Cracking was first noticed in 1970 in the heat affected zone at both tube and outlet header with circumferentially and in some cases the cracks extended through the wall and the pigtail.

By 1975, the magnitude of furnace tube failures went on increasing and became such a serious problem that a special crew was assigned round the clock to nip pigtails.

This problem propagated and developed further failures. In 1974 a crack was discovered in the weld between the outlet "Tee" and the reducer to the transfer line on west box as shown in Figure 3. In 1975, the first catalyst tube failed due to a 8" vertical split. Fortunately this tube was located ¼" from the north wall away from other tubes.

Safco had considerable problem with refractory on the vertical walls of the reformer in the area between the top and bottom burners. In this region refractory bulged and the bricks around burners collapsed.

Failure of the arch bricks supported from roof structure, caused the bricks to fall down and leave a wide gap. The hot gas would weaken the support of other bricks causing them to fall thereafter.

The reformer furnace was modified in June 1977 and the following changes were made:

a) Pigtail material was changed to Sch 80 Incoloy 800 Gr H (ASTM-B-409, grain 5 or larger) instead of the original Sch 40 (ASTM-B-407). The bottom flanges of the catalyst tubes were replaced with a cap and straight pigtails were installed connected to the refractory lined header outside the firebox. The modified arrangements are detailed in Figure 5. The new design allows the pigtail to expand with the tube and as such the stress is reduced.

b) The outlet manifold material was changed from Manaurite 800 (High nickel alloy) to refractory line C - ½ Mo (ASTM-A-204 Gr. C.). The insulation on outlet manifold was removed and Incoloy 800 Gr. H caps were welded on top to receive the furnace outlet pigtail. Thus the metalic area remained relatively cool and twisting of pigtails was minimized.

c) The reformer catalyst tube top seal arrangement was modified as shown in Figure 4 by using Kaowool blanket to provide maximum flexible roof seal. The fire bricks inside the furnace box were replaced by Kaowool blankets with stablizer spray to counter the draft effect.

These modifications were carried out in two weeks and the furnace was commissioned successfully. Occurrence of failure, leaks and fires were completely eleminated.

Study is presently in progress to evaluate the need of any modification required on the convection section coils in order to achieve an optimum flue gas temperature at various furnace operating conditions.

2. Urea Plant Revamp:

Urea crystallization had brough alongwith it too many heavy moving equipment like centrifuges, crystal dryers, bucket elevators, conveyors, cyclones, melters and spray heads which required frequent maintenance and caused operating problems. Almost weekly backend shut down was experienced for cleaning, inspection and repairs. The four melters and 48 spray heads on top of the Prilling Tower created unsafe and unpleasant working environment due to dust, heat, fumes and gases.

The Urea Revamp project carried out consisted essentially of two falling film evaporators which receive 78% urea solution after second stage decomposition and concentrate it sufficiently for prilling using the tuttle bucket. As a result of this modification, all equipment associated with crystallization have been made redundant and completely removed.

The above was commissioned in 1978 successfully and backend down time has been reduced significantly. The prilling tower has now become a healthy and safe place to perform work comfortably.

Safco has also made arrangements for incorporating a third stage decomposition system in the urea plant during early 1981 in which ammonia concentration in the urea solution flowing to the evaporator will be reduced to 0.2% by weight compared to existing 1.5%. This modification will reduce the ammonia consumption in urea plant by 13 MTD which, in turn will yield about 22 MTD of additional urea.

3. Ammonia Storage Tank

The refrigerated storage tank safety standards call to inspect the 10,000 MT atmospheric refrigerated ammonia tank every 8-10 years period. To achieve this, Safco had installed another 2,500 MT atmospheric single wall insulated refrigerated ammonia tank. This tank was tied-in early 1979 in order to spare the main tank for complete inspection which was achieved in three months period and the tank was recommissioned in January 1980.

Another improvement in this system was the efficient recovery of ammonia vapor which used to build up pressure in the tank and caused safety valves lifting and ammonia release to atmosphere. This created safety hazard and resulted in considerable waste of ammonia. The improvement was achieved in 1977 when the 3.2 MTD York Shipley ammonia refrigeration unit was replaced with a 13 MTD HTI unit.

III- IMPROVED OPERATIONAL, MAINTENANCE AND SAFETY ORIENTED PROCEDURE:

In addition to the numerous projects which involved major modification to the original design of which only a few examples have been mentioned above, Safco has also implemented certain operational and maintenance practices which has contributed to reliability of the plant with special emphasis on safety.

1. At time any unit is shut down for any planned repairs, all associated instrument securities are tested and their set points are recorded.

2. The vibration readings for all rotating equipment are taken and recorded at least once a snift and the irregularities are reported promptly.

3. Fire water supply was made reliable and can be supplied from three independent sources supplying water any any time even if the main generators and the emergency generators are completely down.

4. The TMTs of the furnace and Zno heater as well as the explosivity readings on natural gas and synthesis gas lines flanges are checked regularly.

5. Vessel entry permit procedure was revised to ensure adequate blinding, proper oxygen check and usage of a 24 V lighting system.

6. Failure of any of the eight cell cooling tower fans had caused an extensive damage to the cooling tower wooden structure and therefore a monthly routine inspection on each fan has been started. This involves inspection of hub, blades, tip clearance, center disc, bearings alignment, gearbox assembly and thightening of bolts and nuts of the fan blades.

7. All the safety valves on the ammonia synthesis and refrigeration are connection to discharge into an atmospheric surge tank with pumping arrangement to transfer any unusual split of liquid ammonia into the product line.

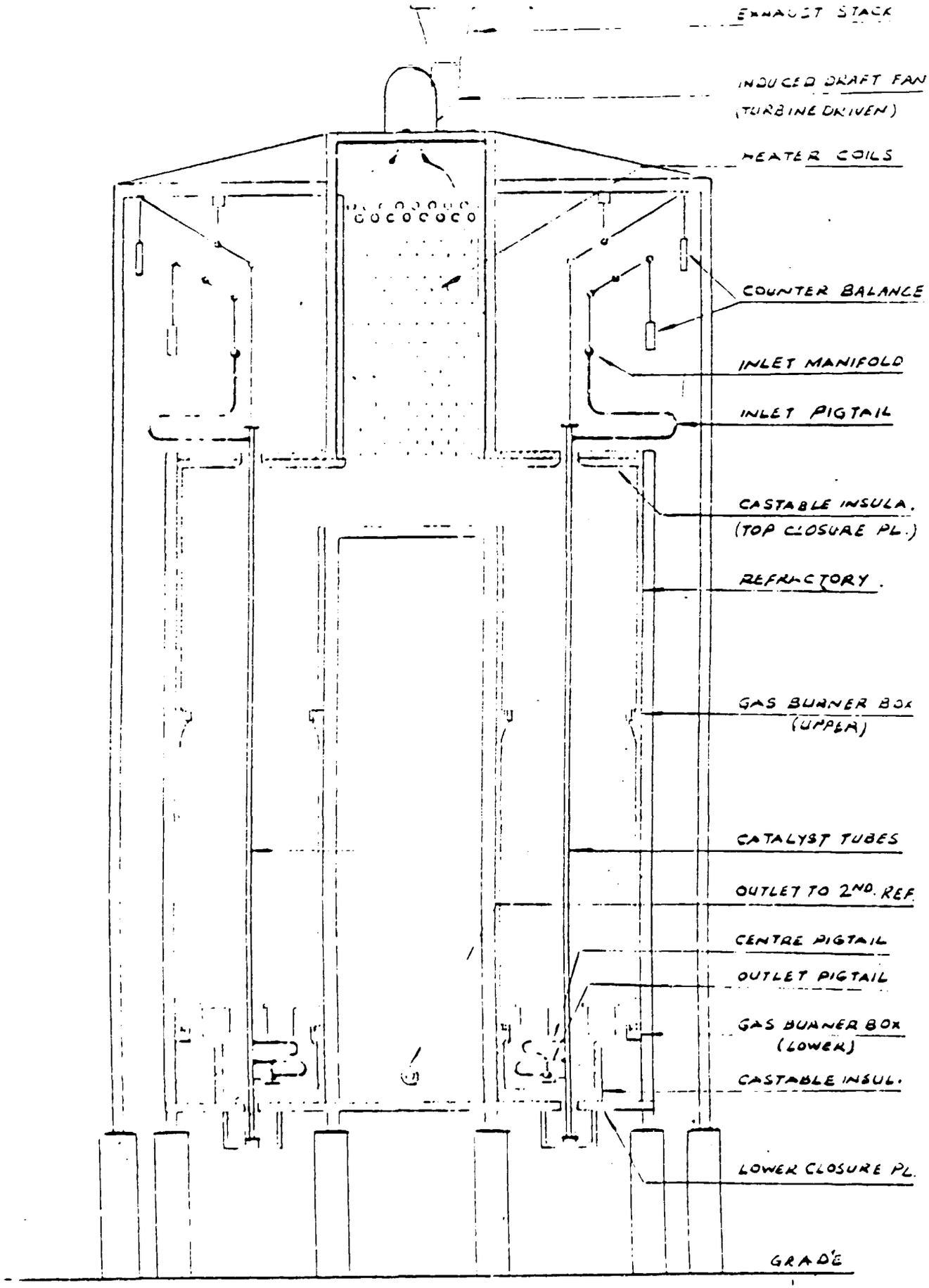
8. Pollution monitoring which involves analysis of pollution in air and drainage effluent are regularly checked and appropriate actions are usually taken.

9. Safety record is maintained for Industrial injury and by the end of the year an additional incentive by way of bonuses are given to those employees who had no industrial accident during the year. Accident rates at Safco are now quite below the average industrial rates reported by the National Safety Council, U.S.A.

10. Training on safety equipment and fire drill has been enforced which takes place every week for the entire plant shift crew.

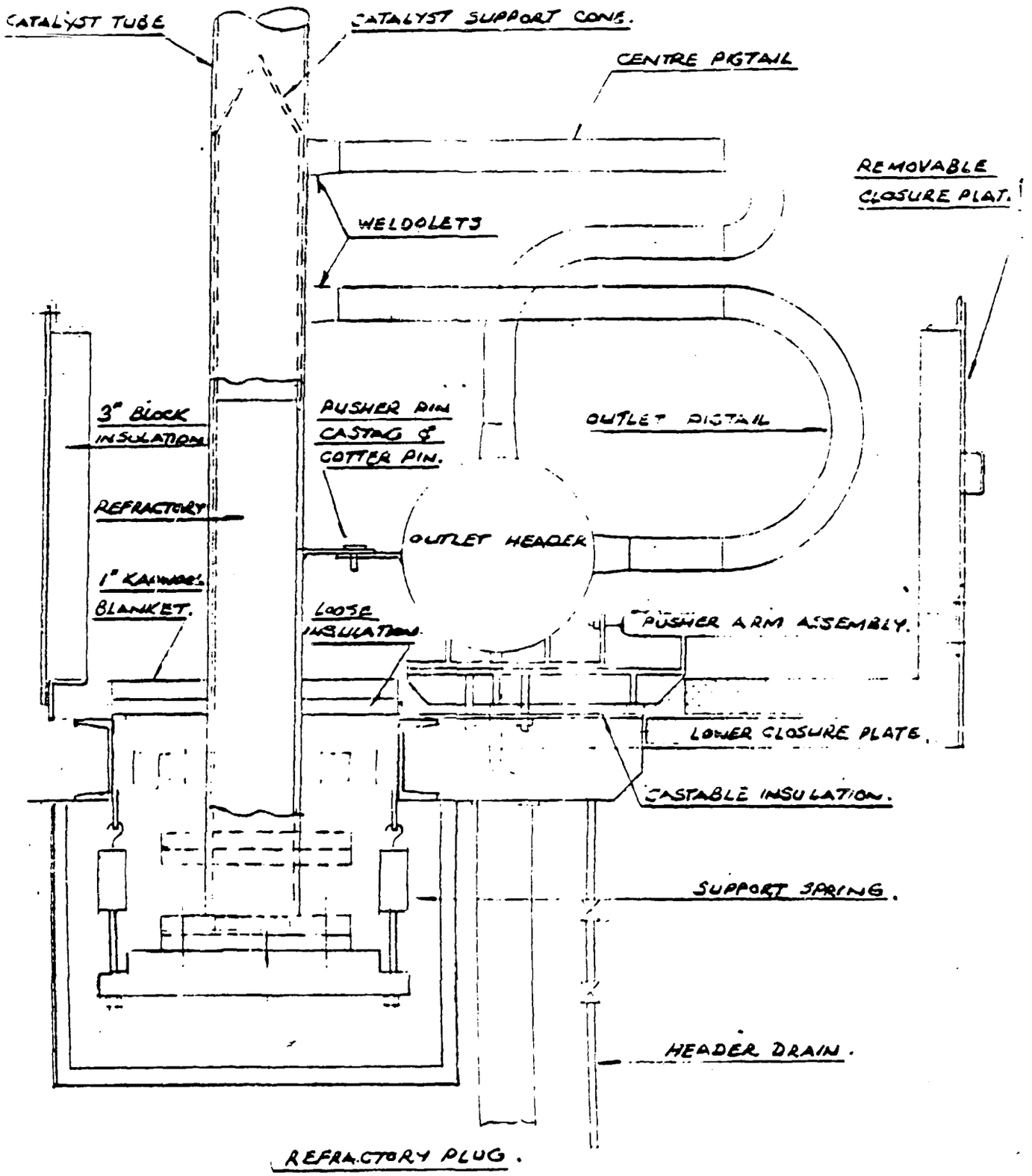
11. Safety and Housekeeping teams are selected on monthly basis to inspect the safety and tideness of each area and winning area is presented with a prize for each employee.

These glimpses show how Safco has improved from an unsuccessful and unhealthy organization to a very efficient and successful enterprise comparable to any similar plant else where in the world. This tremendous improvement can be clearly noticed by people who were closely associated with Safco in its early stages and the modern Safco now-a-days.

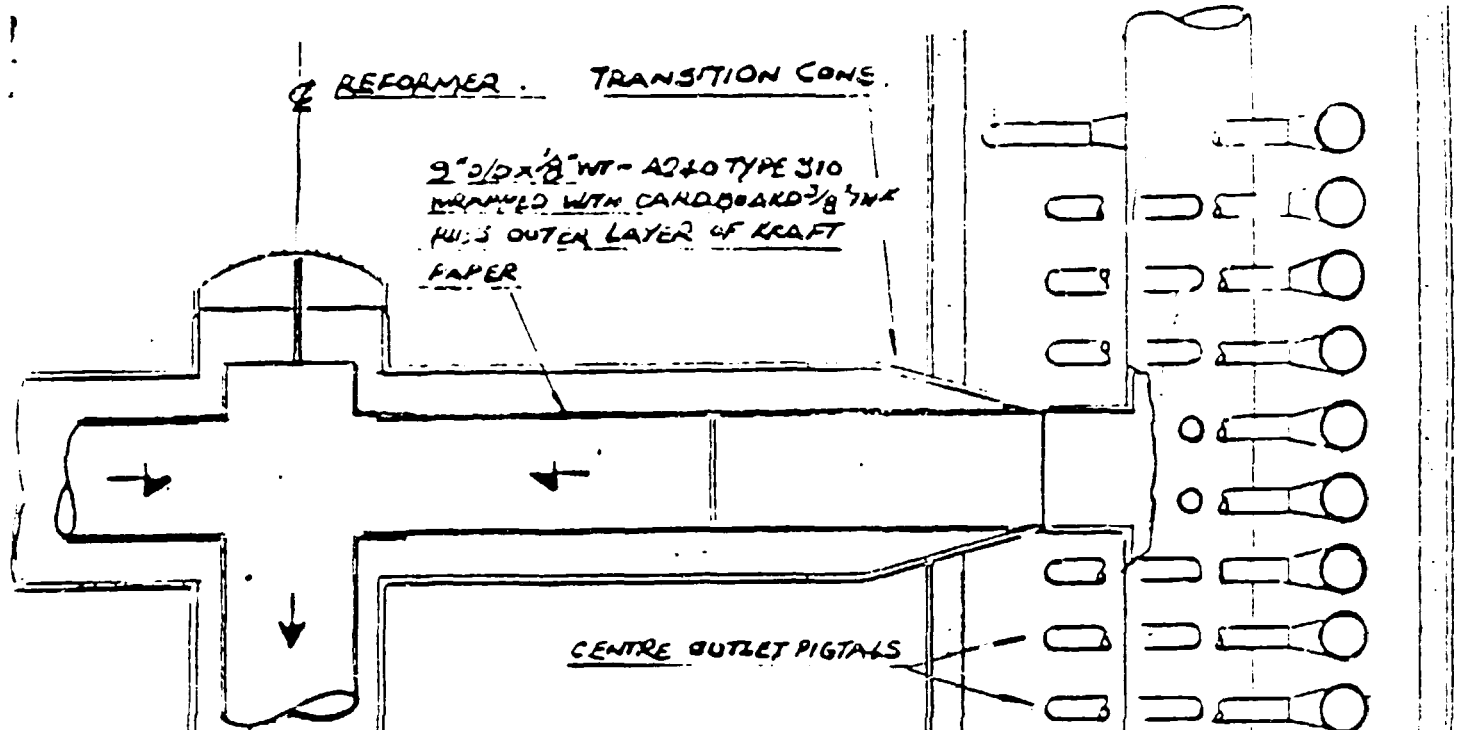


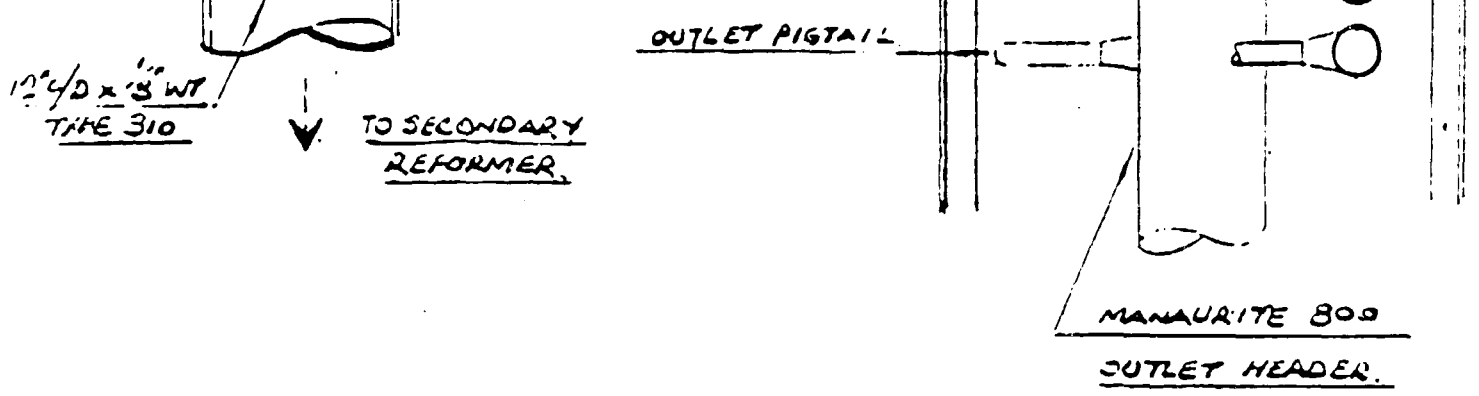
SECTION THROUGH PRIMARY REFORMER

FIG. 1

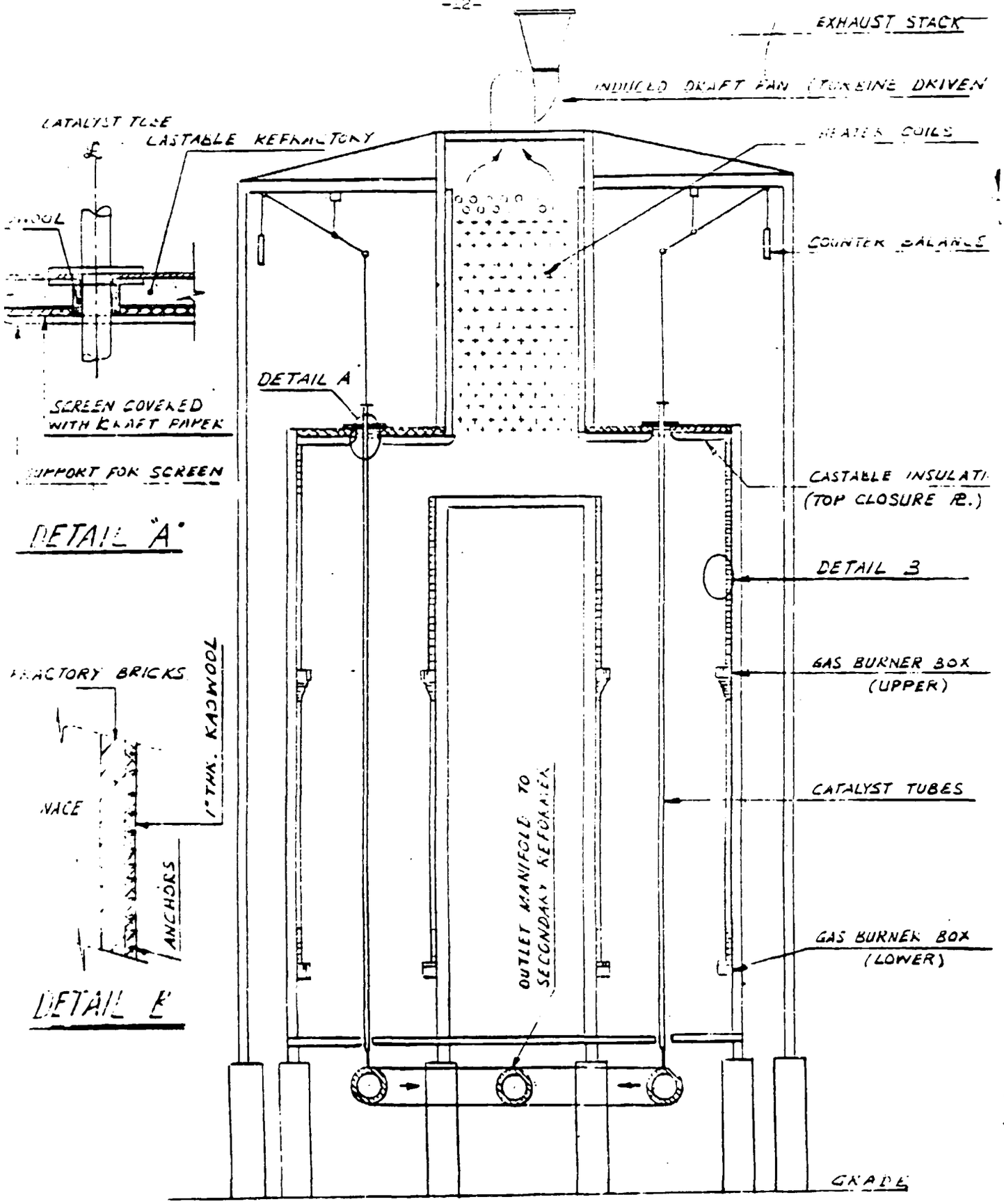


SECTION THROUGH OUTLET SUPPORT & DUSHER SYSTEM. FIG. 2


℄ REFORMER.
TRANSITION CONE.
2" O/D x 1/8" WT - A240 TYPE 310
WRAPPED WITH CARDBOARD 3/8" THK
W/S OUTER LAYER OF KRAFT
PAPER
CENTRE OUTLET PIGTAILS

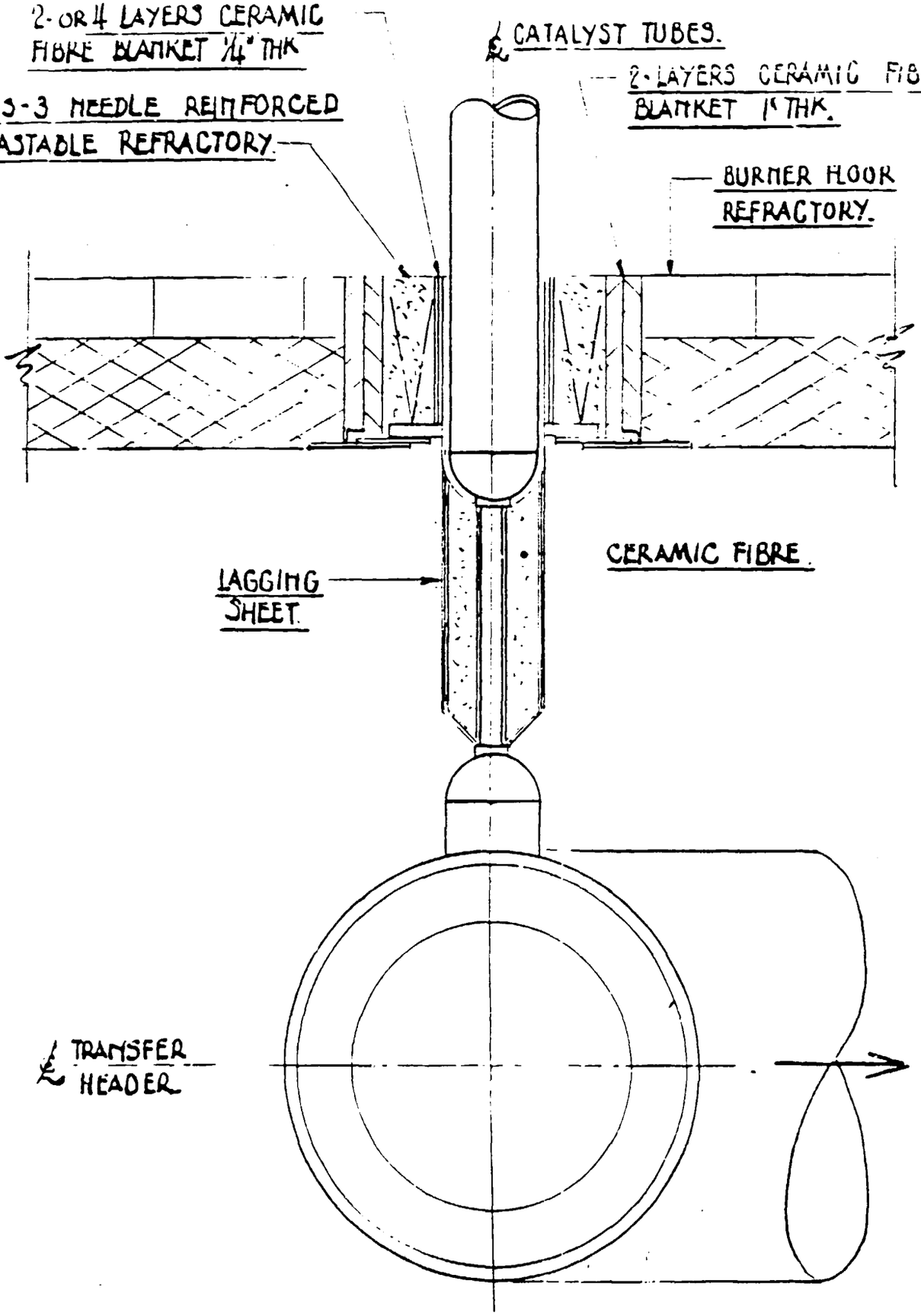


SECTION THROUGH OUTLET TO SECONDARY REFORMER. FIG 3.



SECTION THROUGH PRIMARY REFORMER
NEW ARRANGEMENT

FIG. 4



CATALYST TUBE BOTTOM OUTLET. FIG 5.