BETTER ACCURACY GENERATED BY GRAVIMETRIC FEEDERS RESULTS IN NINE KEY ADVANTAGES

1. **Savings in coal due to more exact control of excess air**

   - Excess air too low results in carbon loss
   - Excess air too high results in sensible heat loss

2. **Less stratification of excess air between burners**

   - Gravimetric feeders deliver equal coal to each pulverizer by weight in direct relation to "load signal" firing rate demand

3. **Better pressure and super heat control**

   - Fuel is kept accurately in step with loading signal even with widely swinging loads, as fuel rate is accurately weighed and as fuel rate fed is fed back to the control system in most cases

4. **Less slagging**

   - Better excess air control as a whole and less stratification results in more even gas temperatures, hence less slagging. This saves on soot blowers initial and operating costs, and also reduces outage time for cleaning.

5. **Less super heat and furnace wall corrosion due to complex sulphates**

   - Corrosion rates become rapid in zones of lower excess air
   - Fuel to air ratio, pulverizer by pulverizer, is more even with gravimetric feed

6. **Less NOX in the stack gasses**

   - Accurate control of excess air is needed to minimize NOX formation, especially when lower than normal values of excess air are used

7. **Faster starts**

   - Measured fuel is indicated for estimating air/coal ratio when oxygen is too low to be significant. Thus, hot spots on the furnace wall are avoided. This also applies to very low rating operation.

8. **Total cost is integrated on electronic counters**

   - This makes accurate accounting possible. Where replacement power or steam is purchased, the pounds of coal/kilowatt if often used to establish price paid.

9. **Optimum fuel/air ratio when changing loads**

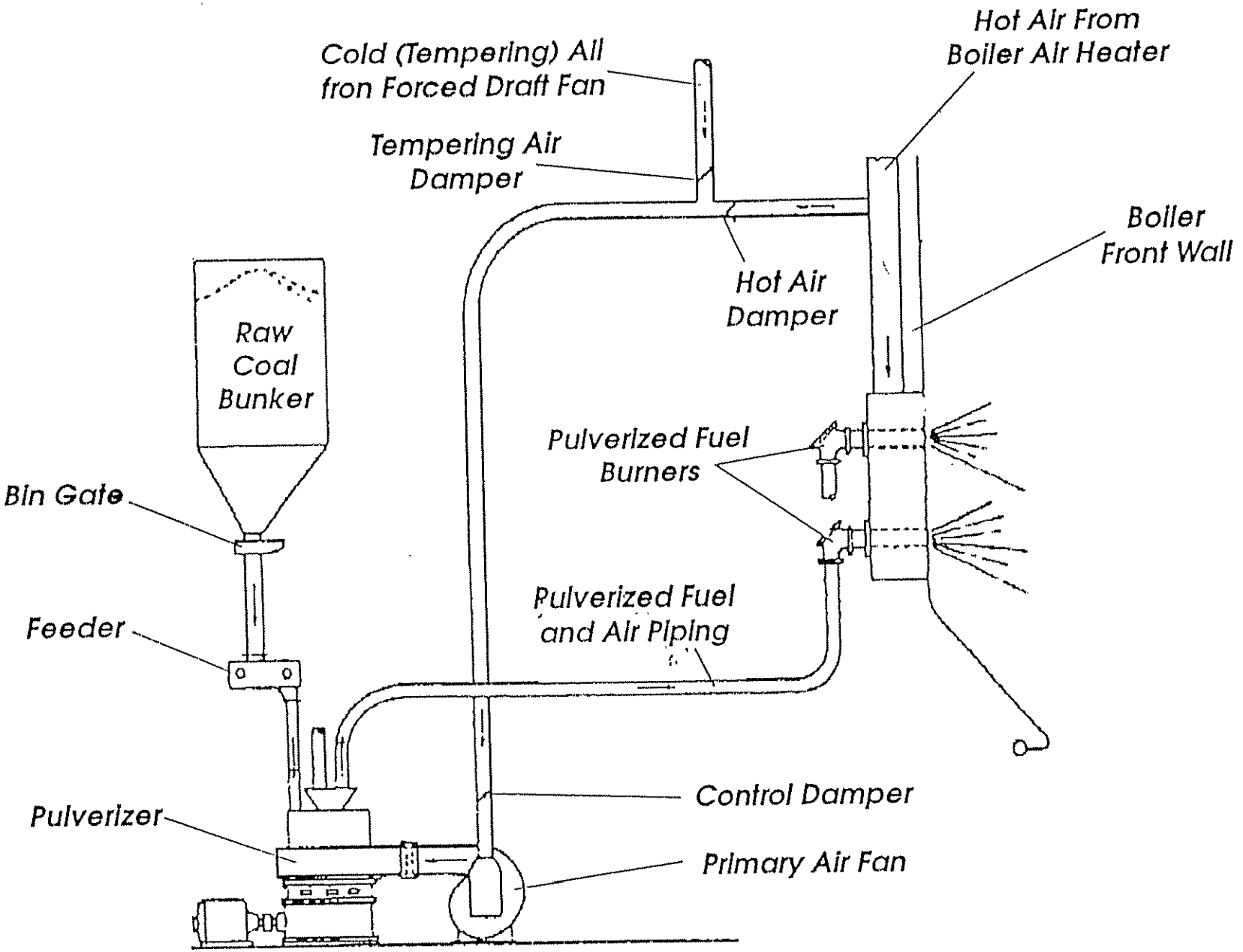
   - Coal and air are kept in parallel and can be controlled by loading signal. As an alternative, coal leveling pulverizer can be maintained relatively constant, ensuring proper distribution at the burner. If the combustion control malfunctions, the measured, indicated values of coal and air are the only indication of dangerously low air/coal ratios that are fast enough to trip the fuel and avoid furnace explosion.

FUNCTION OF A FEEDER

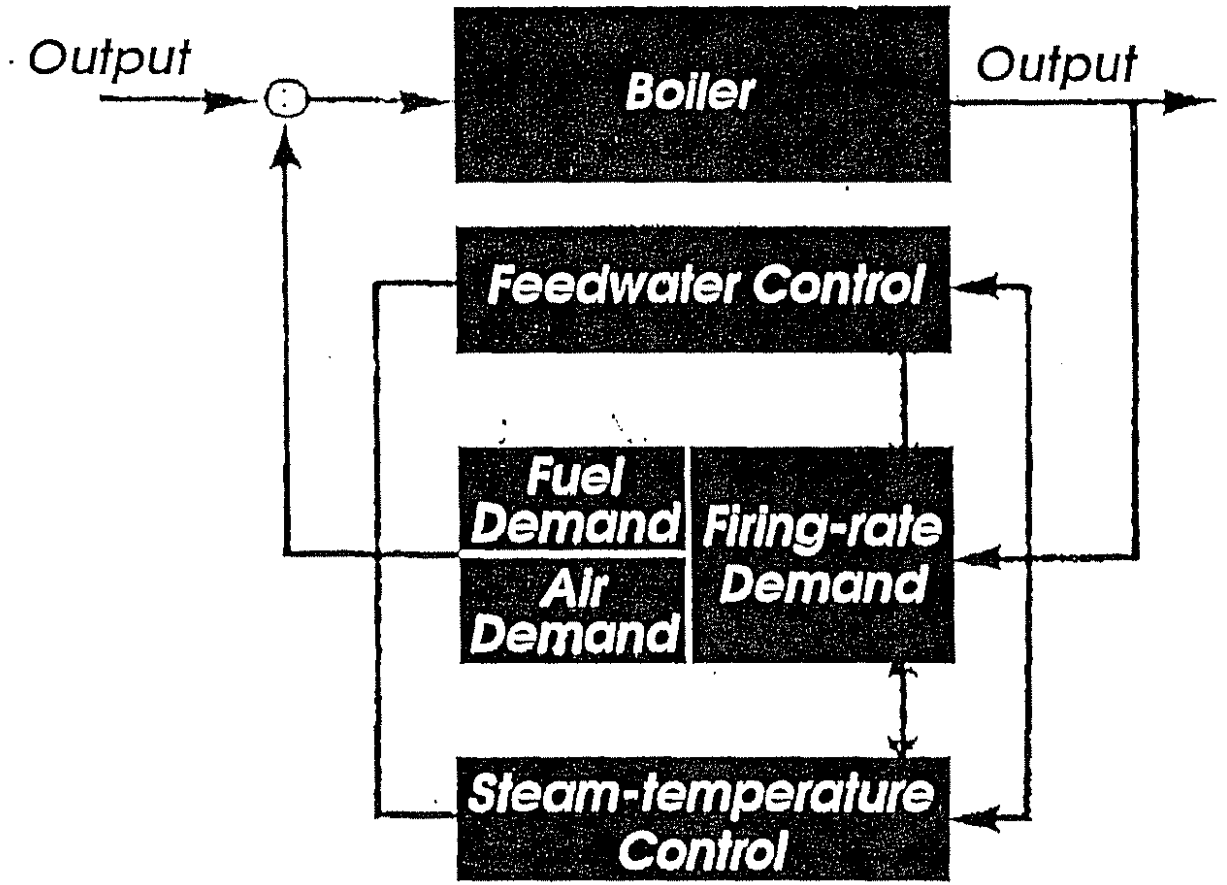
1. Move Coal From Bunker to Mill Reliably

2. Control Coal Flow

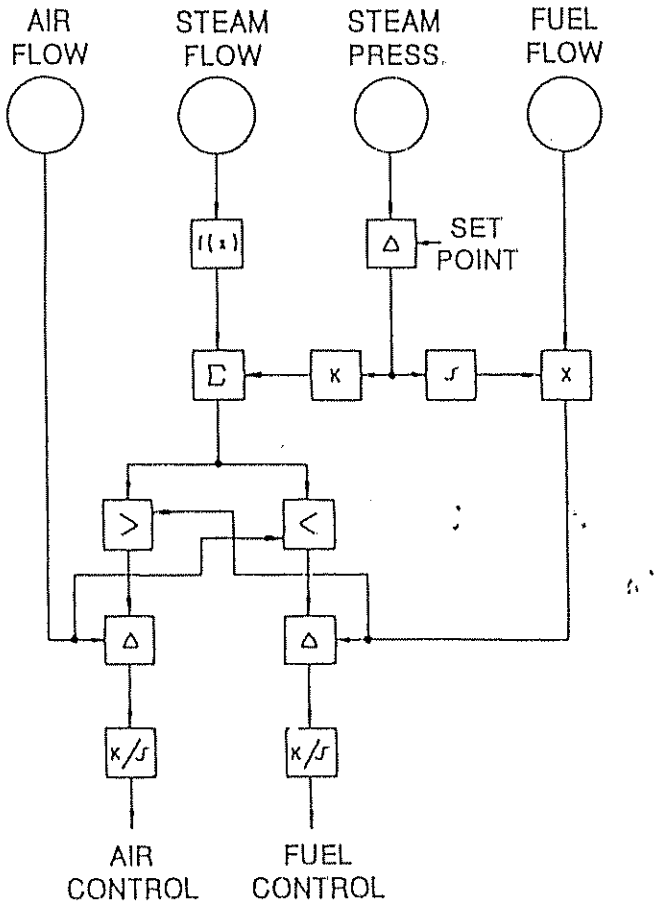
3. Measure Coal Flow

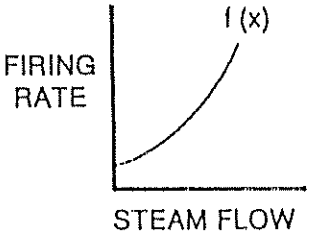

Cold (Tempering) All
fron Forced Draft Fan
Hot Air From
Boiler Air Heater
Tempering Air
Damper
Boiler
Front Wall
Hot Air
Damper
Raw
Coal
Bunker
Pulverized Fuel
Burners
Bin Gate
Pulverized Fuel
and Air Piping
Feeder
Control Damper
Pulverizer
Primary Air Fan

Boiler-loop elements are coordinated into overall control system

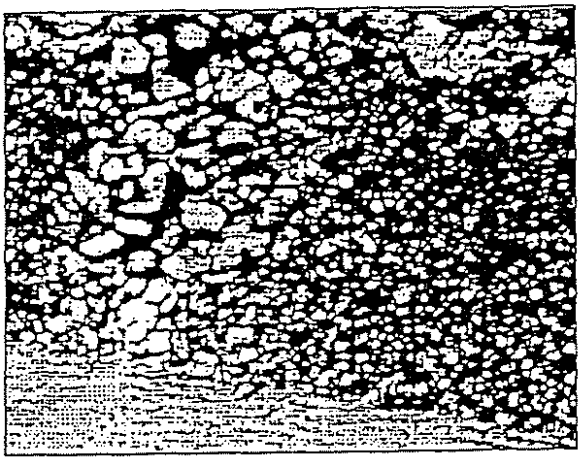


FEED FORWARD BOILER CONTROL

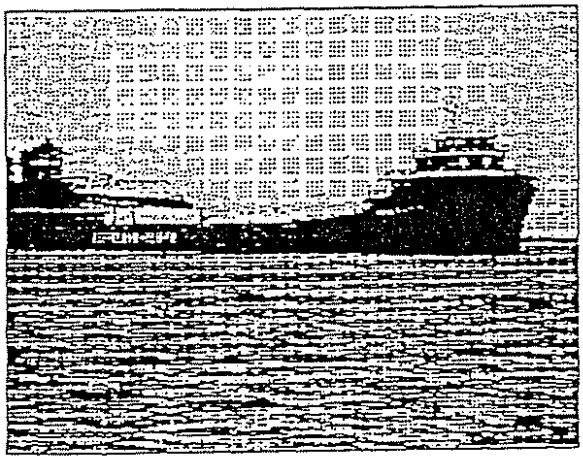




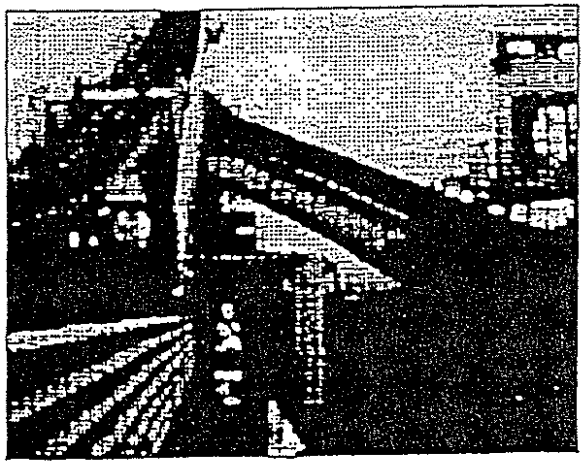
TRANSPORTATION AND HANDLING



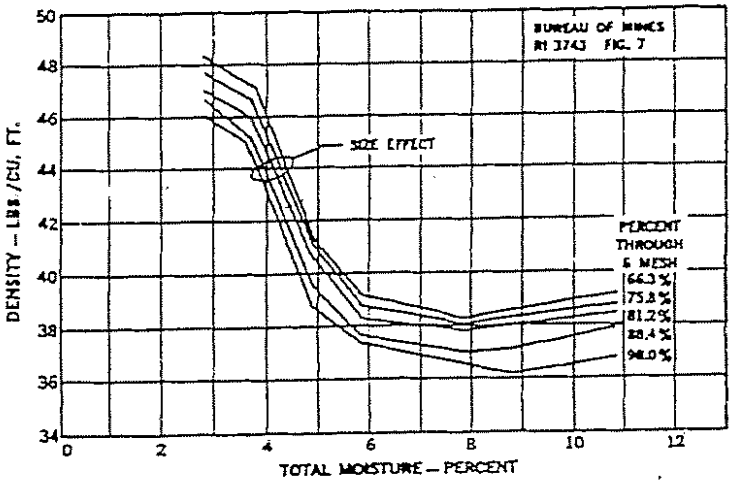
Coal Segregation
If you were to take the coal as typically received at the plant and pour it into a pile, the coal would segregate with the large sizes rolling to the outside and the small pieces staying near the center. This nonuniform distribution of the coal directly affects the handling, characteristics and density of the fuel.



The various handling activities involved with the mining, transport, conveyance, and storage all promote this type of action, resulting in segregation throughout the system.

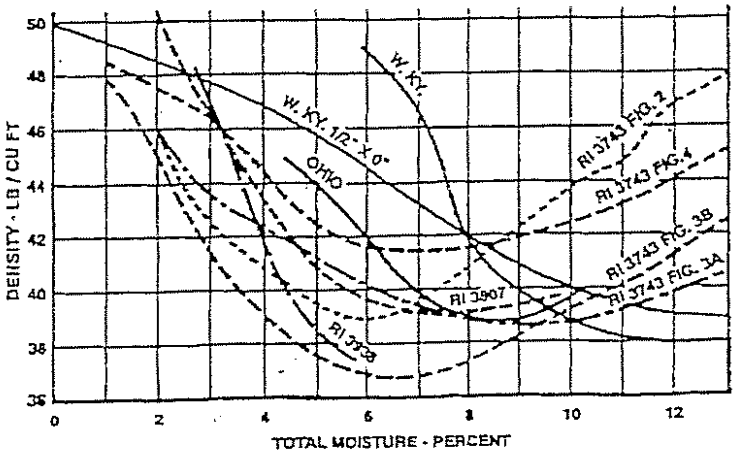


IMPACT OF MOISTURE AND SIZE ON DENSITY



Density

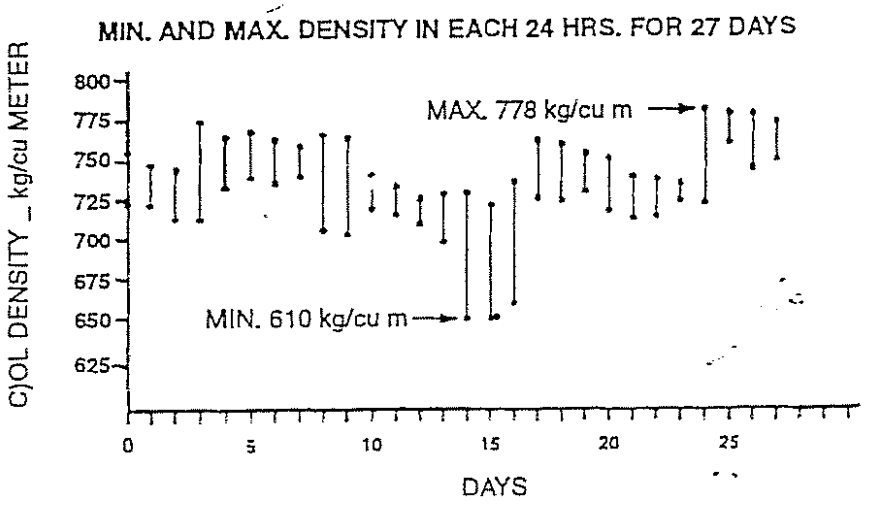
The combination of size and moisture can result in significant changes in density as evidenced by this U.S. Bureau of Mines study. For many bituminous rank coals, a surface moisture change of 3 percent can result in a density change of 7-1/2 percent.



However, it should be understood that there is no 'typical' or 'standard coal' and each exhibits its own unique characteristics.

COAL DENSITY VARIATIONS

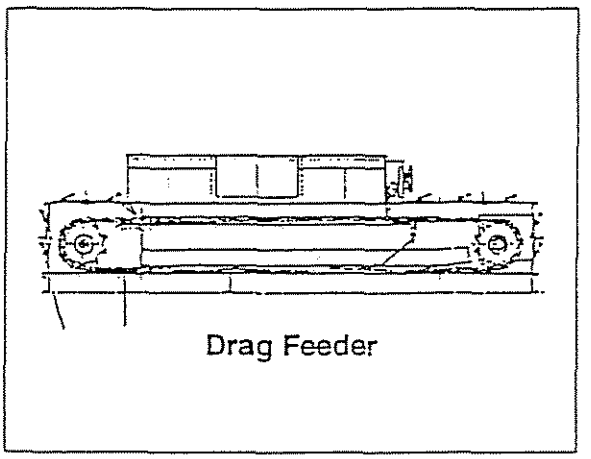
VARIATION IN COAL DENSITY AT FEEDER 3,
UNIT 7, BAILLY STATION OF NIPSCO



Coal size segregation and moisture result in variations of density throughout the coal supply system.

These density variations change in time and vary between the different coal bunkers on a random basis.

FUEL DELIVERY VARIATIONS
DRAG LINK

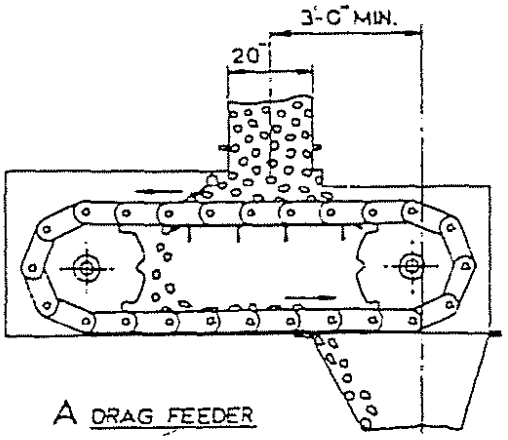


Drag Feeder

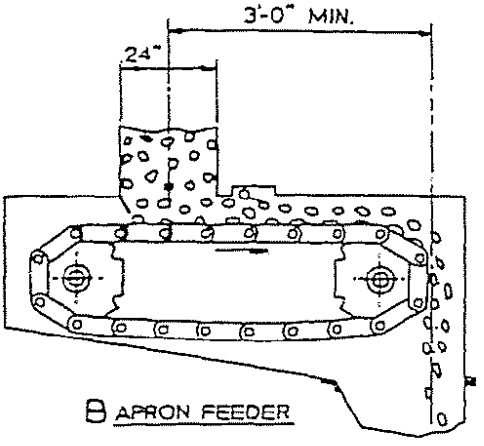
Drag feeder efficiencies are reported by their manufacturers to be ±5% of actual volume delivered. This efficiency to deliver coal on a constant basis, when combined with changes in density due to moisture, results in the following coal feed variations.

FEEDING ERROR - DRAG FEEDERS

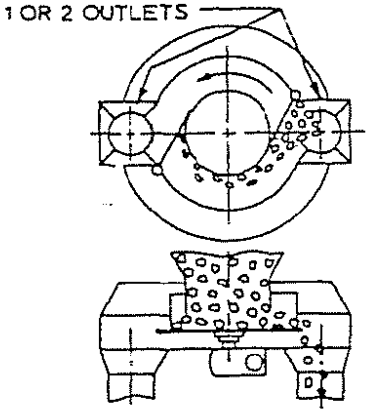
±15%	Due to density variations
±2-1/2%	Heating value variations
±5%	Due to volumetric efficiency
±22-1/2%	Feeding Error (Heat Input Basis)



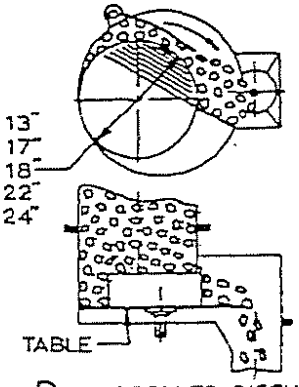
A DRAG FEEDER



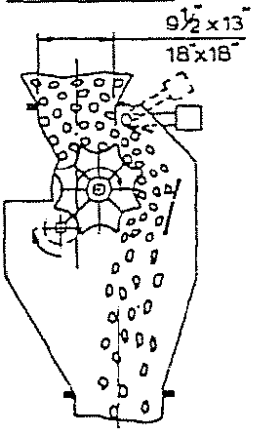
B APRON FEEDER



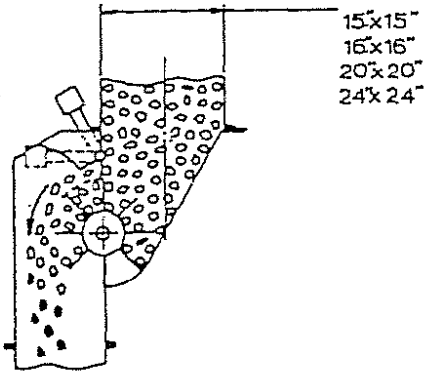
C DOCTOR BLADE TYPE TABLE FEEDER



D CONTROLLED DISCHARGE AREA TYPE TABLE FEEDER



E SELF CLEANING POCKET FEEDER



F STATIONARY DRUM POCKET FEEDER

Conventional Coal Feeders

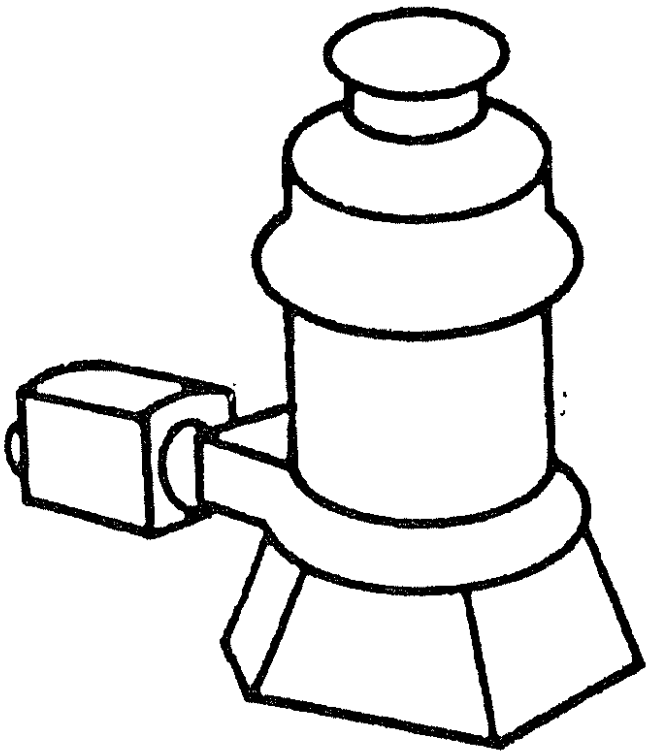
IMPROVEMENT IN PLANT EFFICIENCY

- Gravimetric feed reduces fuel input variations due to density changes (typically 15-20%)

- Each 5% variation in fuel or excess air input represents a 1% variation in oxygen

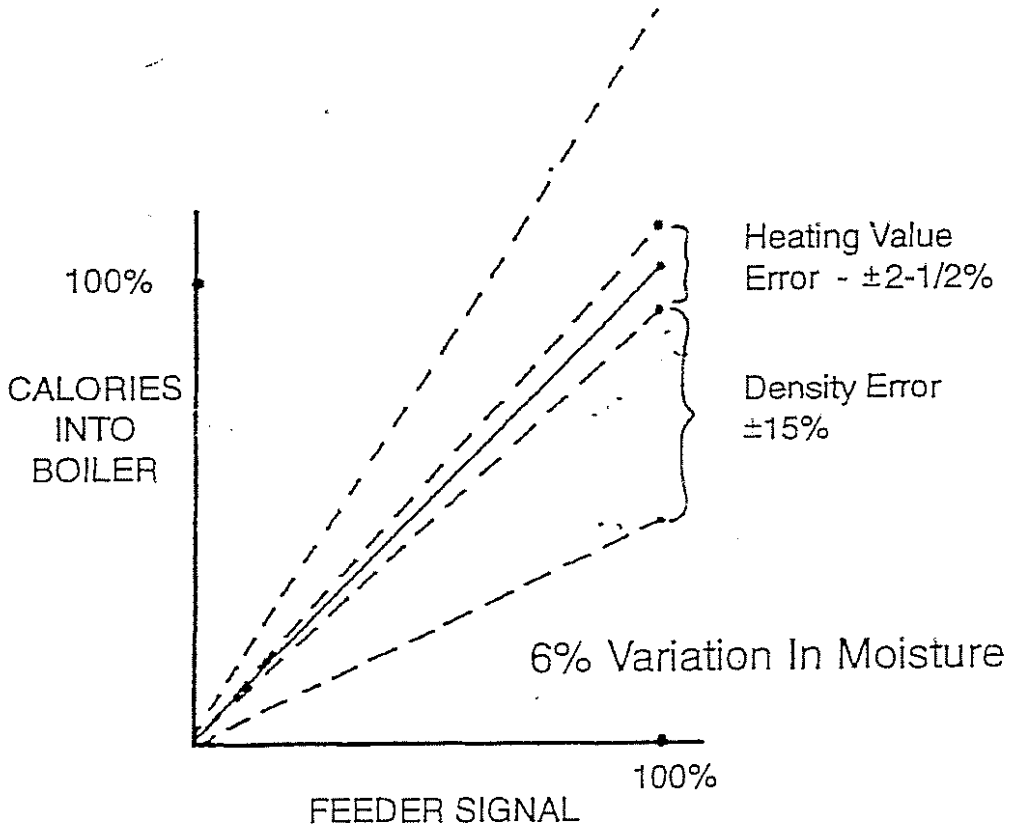
- Each 1% variation in oxygen represents 0.25% variation in boiler efficiency

Pulverizer Operation

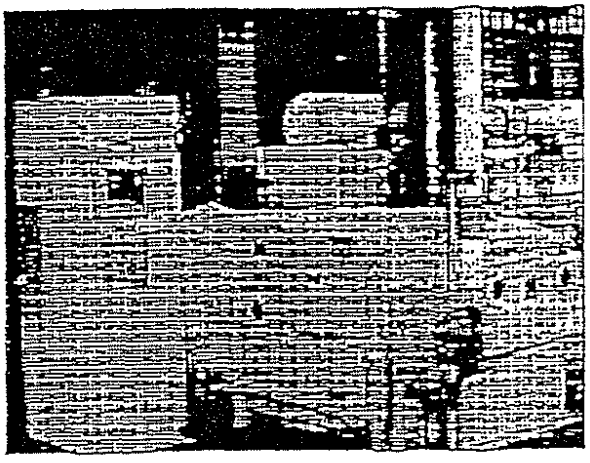


1. Maintain Fuel-Air Ratio at Boiler Demand Level
2. Drying Control
3. Fineness Control
4. Velocity Control
5. Burner Stability

VARIABILITY OF HEATING VALUE DELIVERED

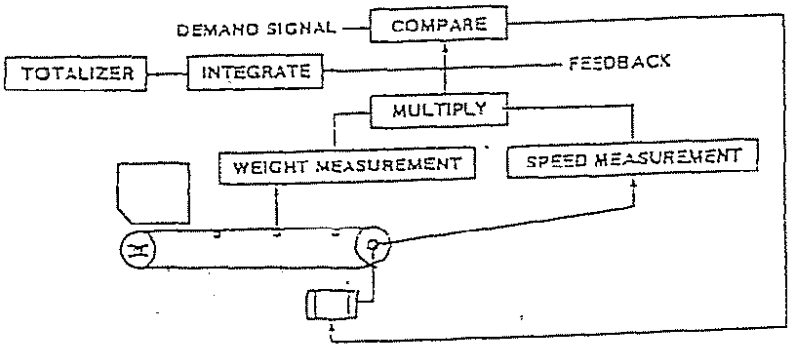


FUEL DELIVERY VARIATIONS
STOCK® GRAVIMETRIC FEEDERS



STOCK® gravimetric feeders provide coal delivery on a weighted basis in order to more closely match the combustion control requirement for heat impact (calories) into the boiler. The gravimetric feeder automatically compensates for density variations and feeds to within ± ½%. of the true weight.

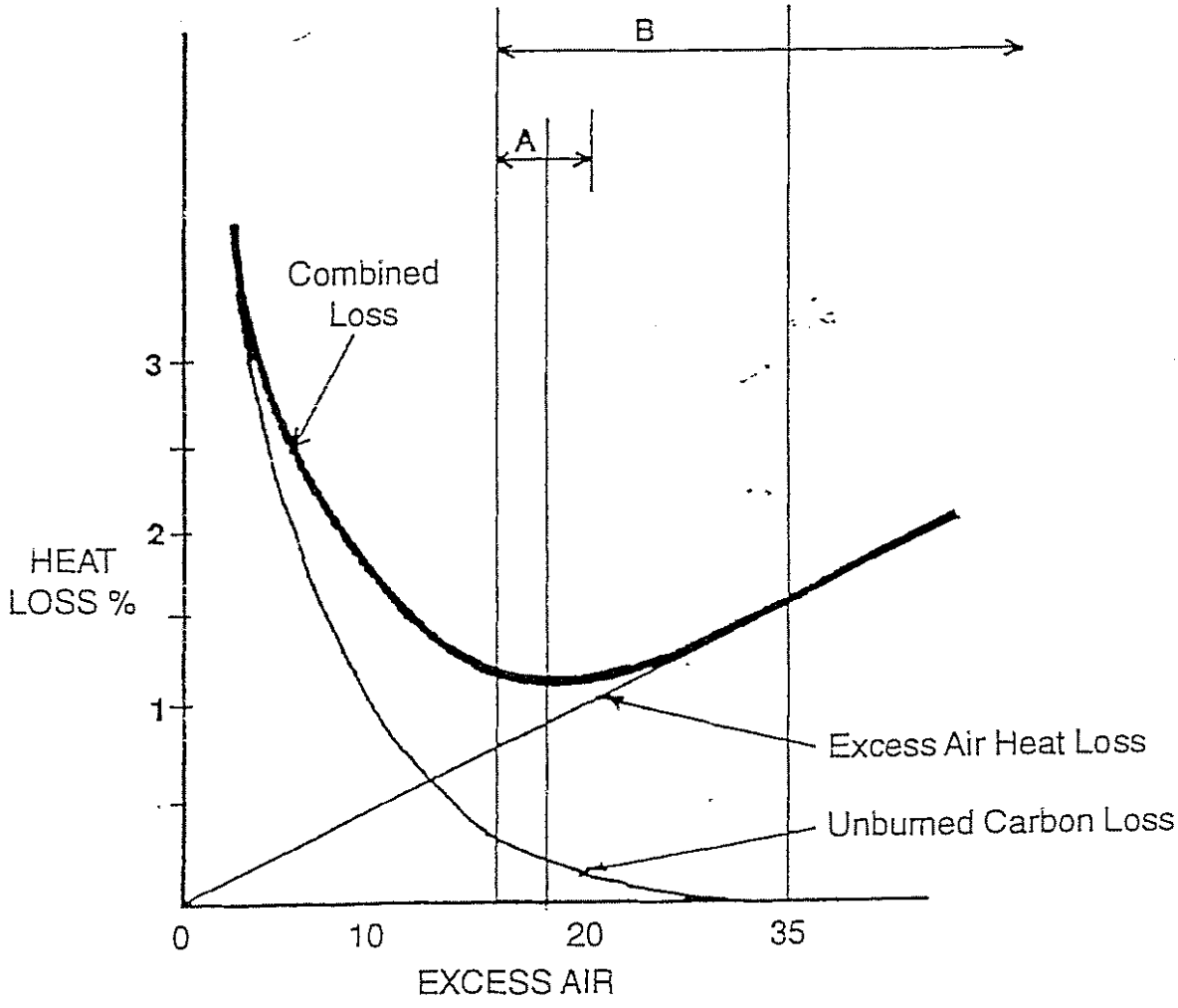
GRAVIMETRIC FEED



±1/2%	Weighing accuracy
±2-1/2%	Heating value variations
±3%	Feeding Error (Heat Input Basis)

IMPACT OF EXCESS AIR ON BOILER EFFICIENCY

A. Gravimetric Feeder
B. Volumetric Feeder



PARAMETERS FOR EFFICIENT COMBUSTION

- Flue gas must be oxidizing (typically approximately 3 percent excess oxygen)
- Fuel and flow distribution from the pulverizer should be within ±5 percent from burner to burner
- Fuel fineness from pulverizers of at least 82 percent passing through a 200 mesh (82 percent less than 75 micron)
- Maintain a defined primary air-to-coal ratio to within ±5% (typically 1.8:1) from the pulverizer
- Fuel to each pulverizer must be measured and controlled to within ±½ percent or better
- Fuel feed rates must be constant with smooth rate changes during load changes

IMPROVEMENT IN PLANT EFFICIENCY

- Gravimetric feed reduces fuel input variations due to density changes (typically 15-20%)

- Each 5% variation in fuel or excess air input represents a 1% variation in oxygen

- Each 1% variation in oxygen represents 0.25% variation in boiler efficiency

SUMMARY OF BENEFITS

1. Fuel Savings

2. Improved Combustion Efficiency

3. Improved Pressure and Superheat Control

4. Less Slagging

5. Less NOx

6. Less Corrosion

7. Improved Response to Demand For Over and Under Firing

8. Actual Usage Record

9. Less Boiler Control Action

10. Safety