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AP-42 Section Number: 1.6

Reference Number: 4

Title: C-E Bark Burning Boilers

C-E Industrial Boiler Operations

Combustion Engineering, Inc.

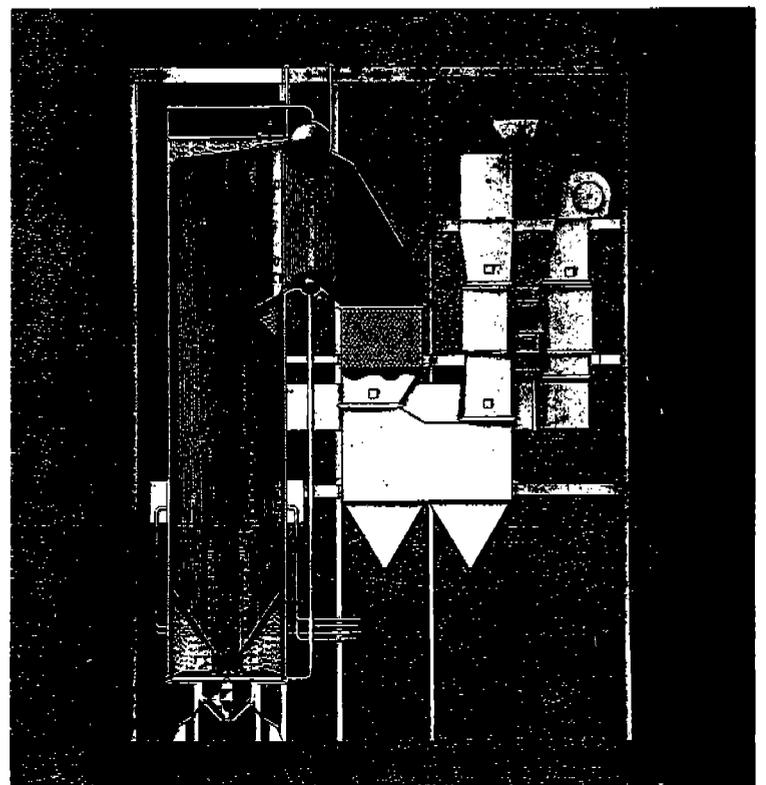
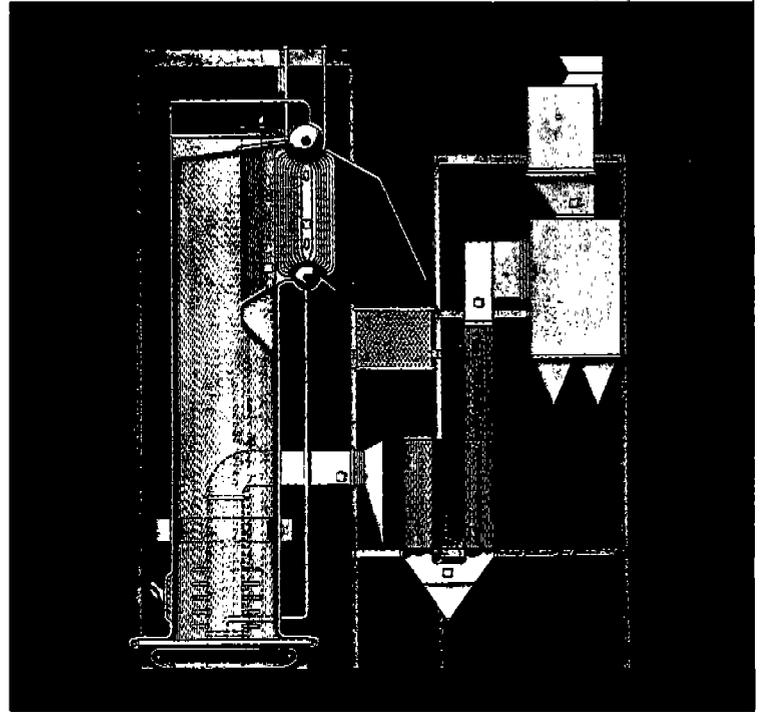
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C-E bark burning boilers

A AP-42
Section 1.6
Ref #4
4/93

WOOD WASTE
COMBUSTION IN
BOILERS

Chap 2^{Se} AP-42^{1.6}
Ref 3 3 Ref 4



C-E bark power boilers

**offer low cost steam generation,
fuel versatility and economical waste disposal
with acceptable environmental control**

Minimizing bark storage space, disposing of bark by burning and obtaining the maximum heating value when burning bark as fuel to produce steam have always posed problems to pulp and wood mills. Added to these is concern for maintaining environmental control in the community.

C-E Industrial Boiler Operations of Combustion Engineering, a major supplier of steam generating, chemical recovery and waste disposal equipment to the pulp and paper industry, has developed bark burning systems to meet modern mill requirements. The systems are especially designed to handle large volumes of bark with high moisture content and inclusion of sand in the bark supply. C-E bark power units also can be arranged to combine burning bark with other waste fuels, solid, gaseous or liquid, along with pulverized coal, oil or gas fuel.

Performance proven designs

C-E bark burning systems use a basic fuel firing concept pioneered by C-E. The bark is introduced into a highly turbulent, high temperature gas stream in the furnace. The zone of intense turbulence, created by high velocity streams of preheated air directed tangentially into the furnace at various levels, in effect uses the furnace as the burner and assures complete combustion. This burning technique provides high furnace efficiencies.

Effective and economical firing systems

Two methods for introducing the bark are available. Mechanical spreaders may be used to distribute the bark, utilizing a traveling grate stoker for continuous ash discharge, or dump grates for intermittent discharge. Or, the bark may be fired tangentially through corner nozzles, using a pneumatic fuel supply system. In the latter arrangement, the furnace is fitted with a small grate to achieve burn out of oversize particles.

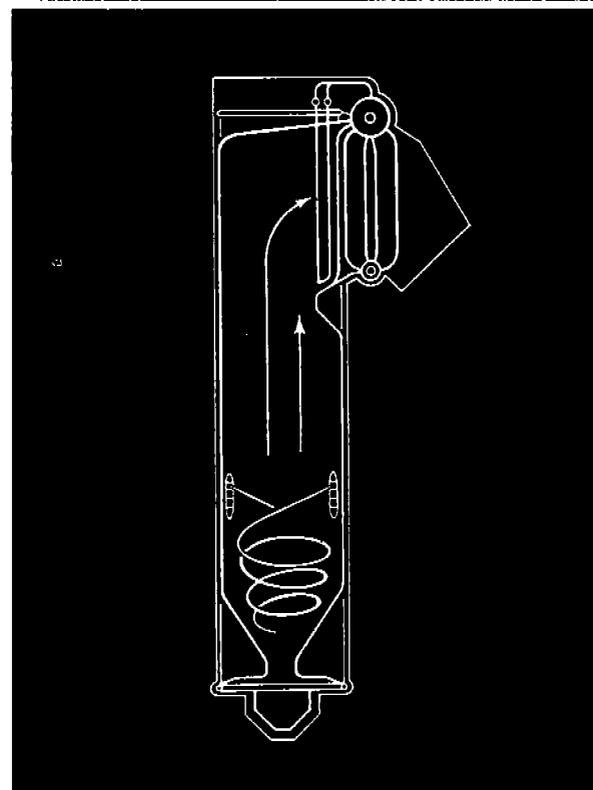
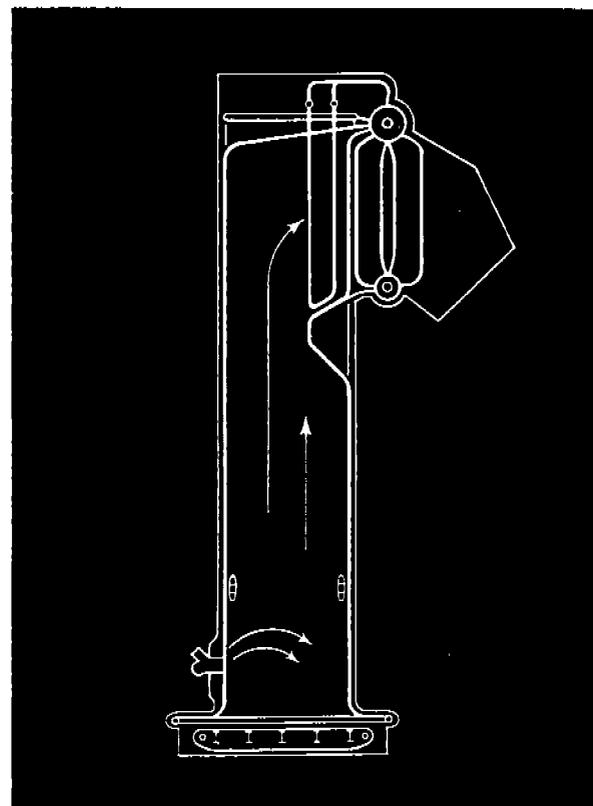
With either method, flash drying and burning in suspension provide complete combustion for effective disposal of bark, and economical steam generation. The high combustion efficiency attained is an important factor in obtaining environmental control.

Versatility and capacity to meet mill needs

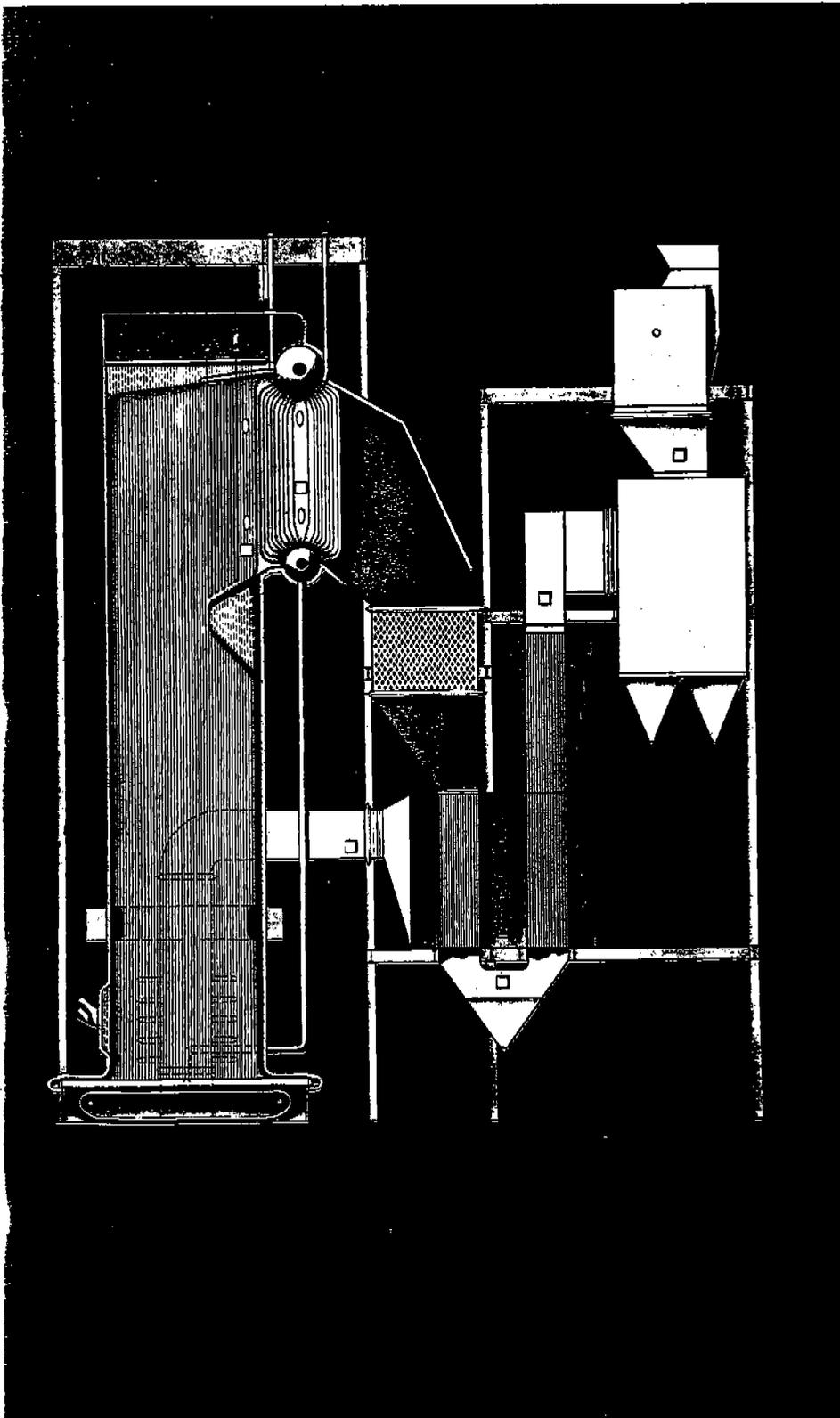
The alternate burning methods of stoker firing and tangential firing allow for many combinations and arrangements and permit tailoring the system to suit your mill's requirements.

Boiler capacities range up to 1,000,000 lb/hr of steam, design pressures up to 1800 psig, and temperatures up to 1000 F.

Many installations are proving the exceptional versatility, reliability and economy of C-E bark power boilers. These units are important components in pulp and paper mills for waste disposal and steam generation.



Stoker fired unit



Furnace and fuel firing system

The large volume furnace is completely water cooled, and fabricated of fusion welded walls pioneered by C-E. This construction, using a minimum of refractory, provides a gas-tight envelope and results in low maintenance.

The bark is fired into the furnace through distributors located high enough in the furnace walls to allow flash drying in a highly turbulent gas stream. Preheated secondary air is introduced tangentially to provide the high turbulence needed for complete mixing of air and gas. Most of the bark is burned rapidly in suspension before it reaches the grate.

Auxiliary, multi-fuel firing assemblies are located in the furnace walls above the level of the bark distributors and are arranged for tangential firing. The high position of the auxiliary fuel assemblies affords protection to the grates when burning the supplementary fuels alone.

With this arrangement, any combination of fuels can be used. Assemblies can be supplied to handle other waste fuels, solid, liquid or gaseous, and/or pulverized coal, oil or gas.

Normal moisture content of the bark presents no burning problem, the bark is flash dried on entering the furnace. With much of the burning done in suspension, a change in fuel and air supply will produce a correspondingly quick change in steam output.

Boiler arrangement

The boiler section is a two drum, baffle-less tube bank. Gas flow across the tubes provides substantially high heat transfer rates. The single pass, vertical arrangement keeps gas velocities low and does not promote stratification of dust or sand particles. This minimizes potential erosion problems. The absence of baffles increases the amount of tube surface that can be cleaned by retractable soot blowers. Low gas temperatures entering the boiler bank also help to prevent ash deposits. These design features provide for extended periods of continuous operation without shutdown for cleaning.

Steam drums are equipped with simple, trouble-free internals that provide high quality, dry steam. Final driers are placed high in the drum to take full advantage of natural moisture separation.

Auxiliary equipment

Platen or panel type superheaters are widely spaced to permit free gas flow with low draft loss and to provide for easy cleaning.

A fin tube economizer, a C-E tubular or Ljungstrom® air heater can be added as the economics of the application dictate.

Tangentially fired unit

Furnace and tangential firing system

The same large volume furnace design used for the stoker fired unit is utilized for this unit. The furnace is also completely water cooled. It is constructed with fusion welded water walls and minimum refractory for low maintenance.

Bark is introduced into the furnace through C-E fuel-air firing assemblies located high in the furnace. Preheated secondary air is supplied at high pressure to provide intense turbulence for complete air and gas mixing. Firing assemblies are arranged tangentially in the furnace corners to impart a rotary action to the fuel-air streams. The impinging and scrubbing action of the streams upon one another produces the intermixing of fuel and air within the furnace necessary for rapid and complete combustion. In effect, the entire furnace becomes a burner, assuring uniform heat absorption in the furnace and increased safety at all inputs. Also, with the inherent lower peak flame temperatures, the production of NO_x is held to a minimum. The bark is flash dried as it enters the furnace, and the bulk of the fuel is burned in suspension. A small dump grate provides for finish burning of over-size particles.

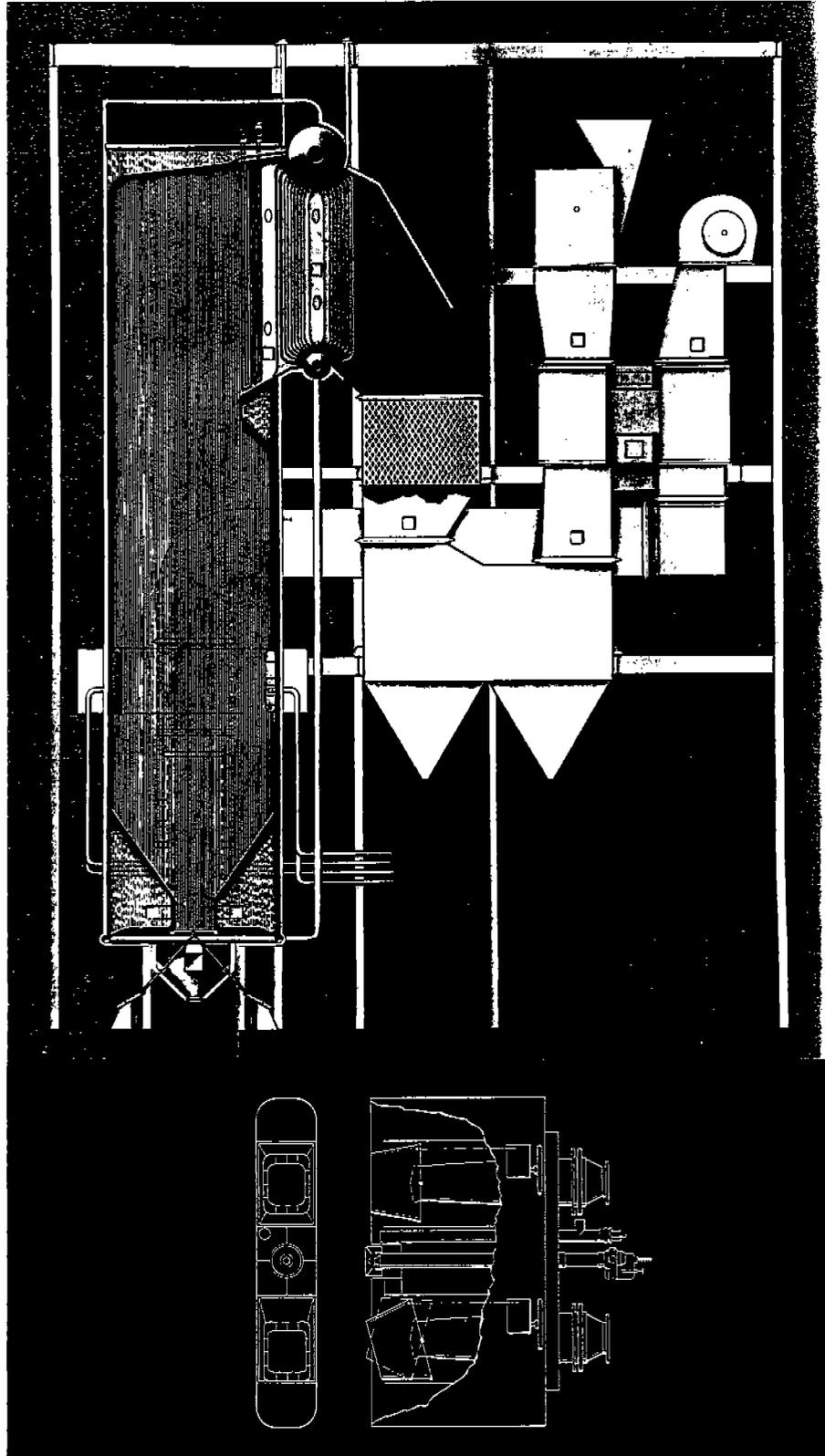
Multi-fuel firing assembly, integral windbox

C-E multi-fuel firing assemblies are designed for the C-E tangential firing technique of mixing fuel and air in the furnace, using the furnace as a single burner. The firing assemblies can be arranged to fire other waste fuels also, and/or conventional fuels in any combination required. These additional fuels may be solid, liquid or gaseous.

Each fuel compartment has an individual air supply, with symmetrical, controlled air distribution in relation to the fuel injector. This assures absence of pressure pulsations in the furnace and minimum excess air requirements. The bark or solid fuel nozzles can be tilted individually to provide proper mixing of the air and solid fuel in the furnace for complete combustion.

Boiler arrangement and auxiliary equipment

The boiler, superheater and heat recovery equipment design and arrangements described for the stoker fired unit also are applicable for the tangentially fired unit.



Fuels, distribution, and air supply

Representative analyses of cellulose fuels, oven dry (S and N—zero or trace)

Bark	HHV	C	H	O	Ash
Balsam	9100	52.8	6.1	38.6	2.3
Beech	7640	47.5	5.5	38.5	7.9
Birch	9870	57.4	6.7	33.8	1.8
Elm	7600	48.9	5.3	39.1	8.1
Hemlock	8890	53.8	5.8	37.9	2.5
Maple	8180	50.4	6.9	39.1	4.1
Pine	8930	53.4	5.9	38.8	2.0
Poplar	8810	51.8	6.5	38.0	3.4
Spruce	8580	52.1	6.7	38.9	3.1
Tamarack	9010	55.2	5.9	34.0	4.2

Source: The Steam and Steam Power Committee, Technical Section, C.P.P.A.

Wood	HHV	C	H	O	Ash
Ash	8920	49.7	6.9	43.0	0.3
Birch	8650	49.8	6.5	43.5	0.3
Cedar (white)	8400	48.9	6.4	44.5	0.4
Cypress	9870	56.0	6.5	38.1	0.4
Fir	9050	52.9	6.3	40.5	0.8
Hemlock	8820	50.4	6.8	41.4	2.2
Hickory	8870	49.7	6.5	43.1	0.7
Maple	8580	50.8	8.0	41.7	1.4
Oak (white)	8810	50.4	6.6	42.7	0.2
Pine (yellow)	9810	52.8	7.0	40.1	0.6
Poplar	8920	51.8	8.3	41.5	0.7
Redwood	9040	53.5	5.9	40.3	0.2

Source: "Combustion Engineering" Revised Edition 1968.

Bark and Wood as Fuel

Bark or wood varies in fuel characteristics with geographic location and mill practices. Species, type soil, transport and debarking method also influence fuel quality. Bark from trees harvested in coastal areas and around the Great Lakes contains significant amounts of sand. These factors must be considered in the boiler design.

Moisture in bark is also a factor of log transportation, handling and mill practice in debarking and preparing for burning. Approximate moisture content resulting from hydraulic debarking is 60 to 75 percent; from drum debarking with wet handling it is 45 to 65 percent, or with dry handling it is 35 to 50 percent. Air drying will reduce moisture content to about 20 percent.

Solid fuel distribution system

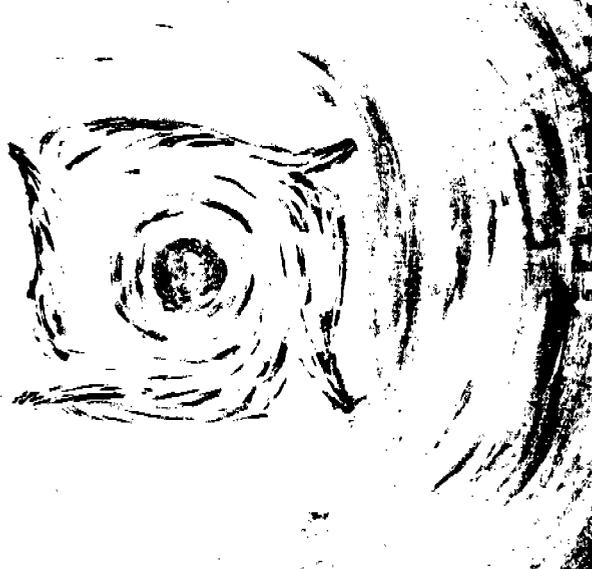
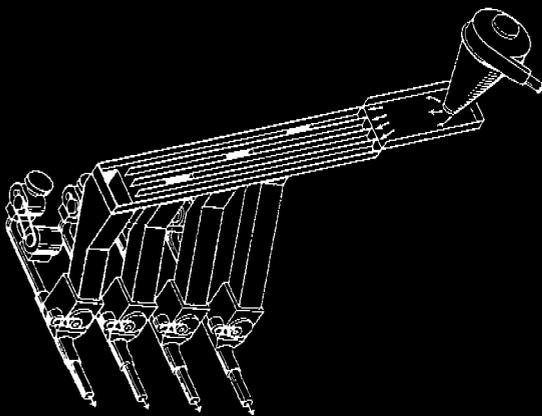
Bark, conveyed from the woodyard to a cyclone separator, is discharged to a vibrating distribution conveyor. The conveyor then distributes the fuel equally to each of four or more supply lines. Each supply line is equipped with a positive displacement blower and air lock feeder to provide direct, pneumatic transport of the fuel to the firing assembly. The pneumatic system also enables bark preparation, storage, and metering to be located at a remote distance from the boiler, assuring boiler house cleanliness.

Firing assembly and overfire air arrangement

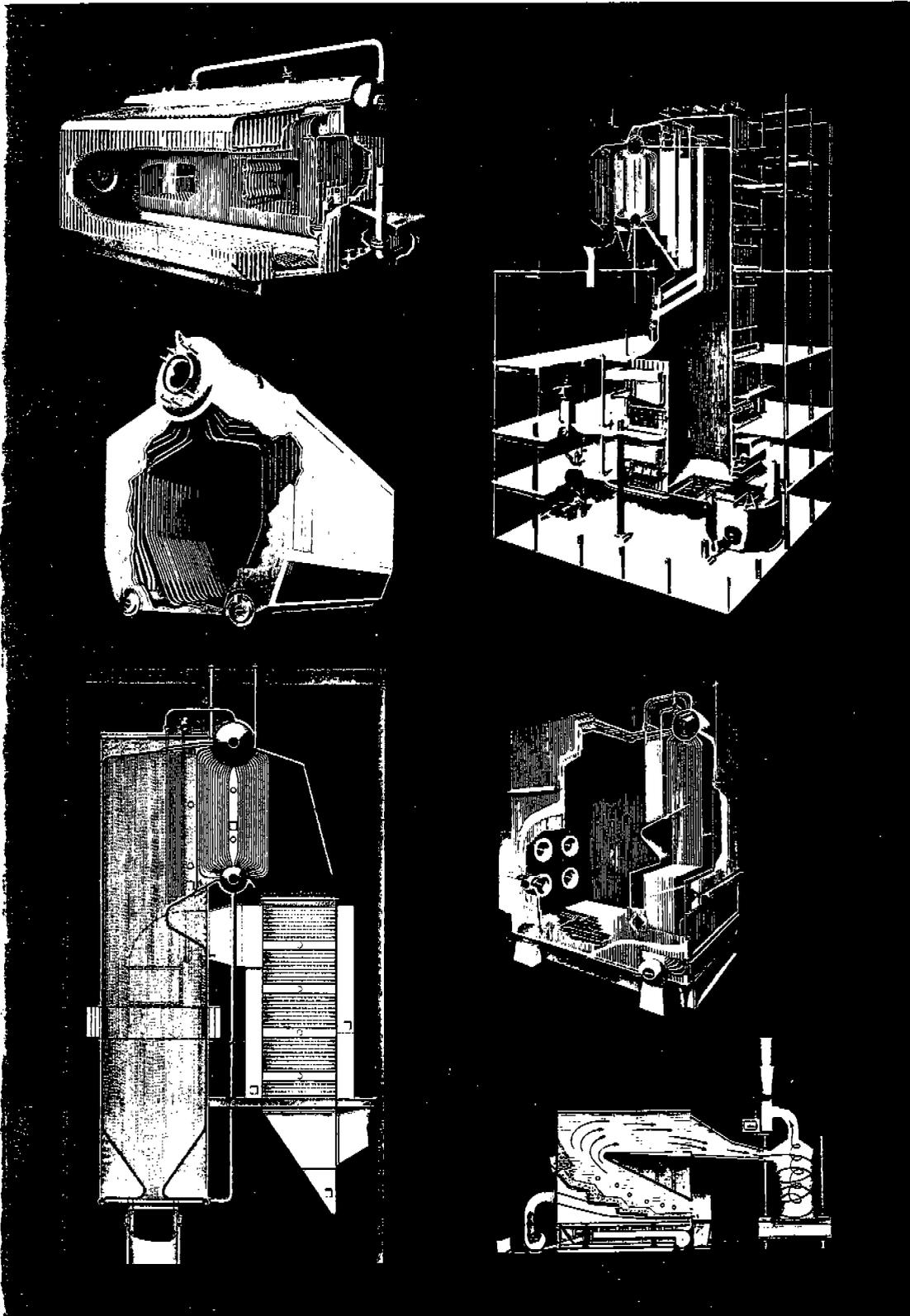
Fuel injectors are located and arranged for the most effective firing of the various fuels alone or in combination. The tangential arrangement of overfire, preheated air supply creates the turbulent conditions required for flash drying and suspension burning of the bark. This C-E method of firing into a high temperature, intensely turbulent zone of the furnace has proven highly successful with all kinds of fuels.

Tangential fuel-air firing pattern

The thorough mixing action of high pressure streams of preheated air and fuel, rotating tangentially in the furnace, is shown in the drawing at the left. As a result of the turbulent mixing action, the hot gases are swept around the perimeter of the furnace. This assures even convective heat transfer to the waterwalls, thus providing peak flame temperature reduction, conducive to lower NO_x formation.



Other C-E products for pulp and paper mills



- 1. Chemical recovery boilers with flexible air-liquor systems.**
Designed to burn kraft liquors for chemical recovery, steam generation and environmental control. Air-liquor supply system tailored to mill needs.
- 2. VP shop assembled boilers.**
Burn oil, gas or waste sulfite liquor (with Loddby furnace). Capacities range from 10,000 to over 400,000 lb/hr. Design pressures to 1600 psig and temperatures to 900 F.
- 3. Type A shop assembled boilers.**
Burn oil or gas. Capacities extend from 30,000 to more than 200,000 lb/hr, with temperatures to 800 F and design pressures to 1550 psig.
- 4. VU-40 multi-fuel boilers.**
Burns practically any fuel, solid, liquid or gaseous, including waste sulfite liquor, alone or in combination with other fuels. Available with design pressures to 1800 psig, temperatures to 1000 F and capacities to 1,000,000 lb/hr.
- 5. VU-60 pre-engineered, modular boilers.**
Field erected of shop-assembled components, permitting custom tailoring at standardized boiler costs. Burns oil and/or gas. Can deliver over 800,000 lb/hr of steam at 1000 F, at up to 1600 psig design pressure.
- 6. Combustopak™ incinerators.**
Compact, on-site waste disposal of industrial mixed refuse combined with materials handling, residue removal and pollution control. Burns up to 75 tons per day.

For more information on C-E bark burning boilers, steam generating equipment, chemical recovery and odor abatement air-liquor systems, sulfite burning boilers, shop-assembled boilers, or pollution free incinerators, contact the nearest office listed below, or C-E Industrial Boiler Operations, Combustion Engineering, Inc., Windsor, Conn. 06095. Tel. (203) 688-1911

OFFICES

Atlanta, Ga. 30342 / 53 Perimeter Center, East / (404) 252-2080
Boston, Mass. 02110 / 75 Federal Street / (617) 426-6650
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Chicago / 300 Windsor Drive, Oak Brook, Ill. 60521 / (312) 325-6720
Cincinnati, Ohio 45227 / 3814 West Street / (513) 272-0686
Cleveland, Ohio 44116 / 20800 Center Ridge Road / (216) 333-9696
Denver, Colo. 80202 / 240 Hilton Office Building / (303) 534-7651
Detroit / 17500 W. Eight Mile Road, Southfield, Mich. 48075 / (313) 444-8500
Honolulu, Hawaii 96813 / Amfac, P.O. Box 229 / (808) 533-0111
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Kansas City / Bryan Bldg., Prairie Village, Kan. 66208 / (913) 362-7313
Los Angeles / One City Boulevard West, Orange, Calif. 92668 / (714) 639-7511
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New York, New York 10017 / 277 Park Avenue / (212) 826-7100
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COMBUSTION ENGINEERING, INC.

Sec 1.6

Ref 3

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C-E bark burning boilers

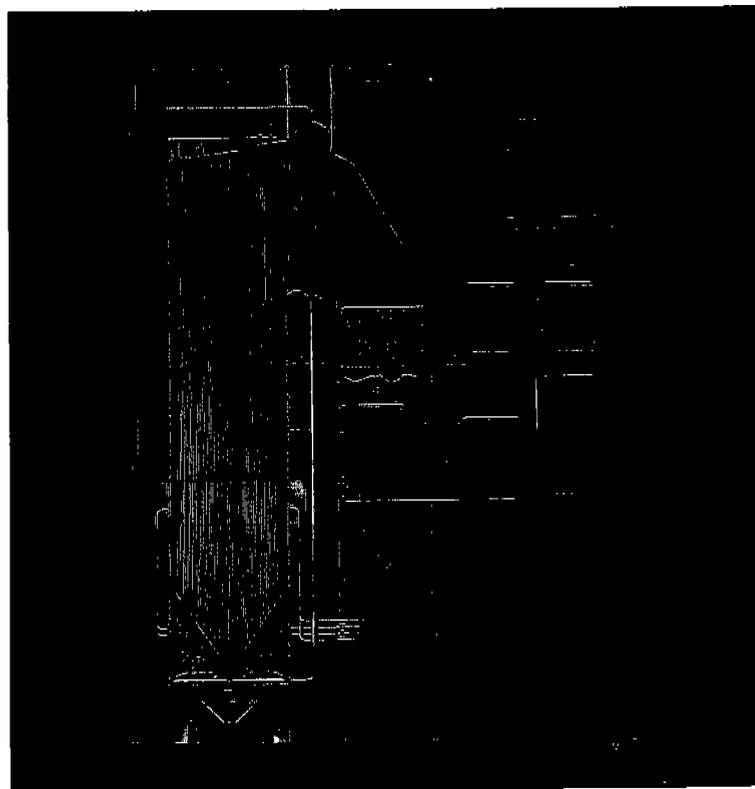
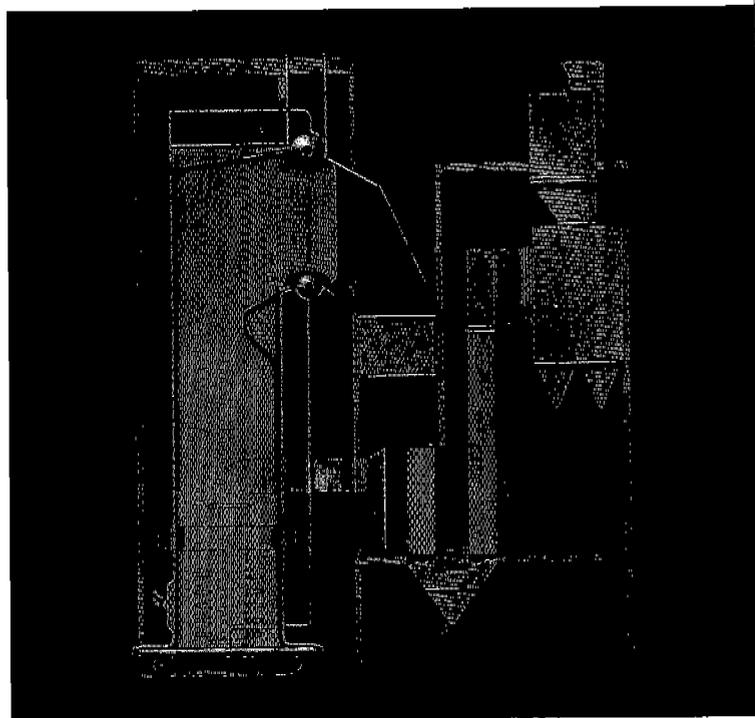
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WOOD WASTE
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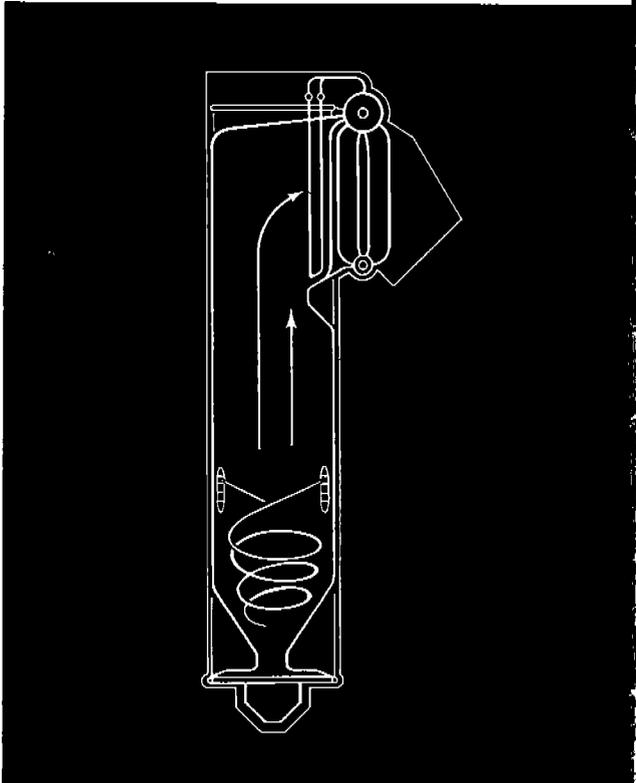
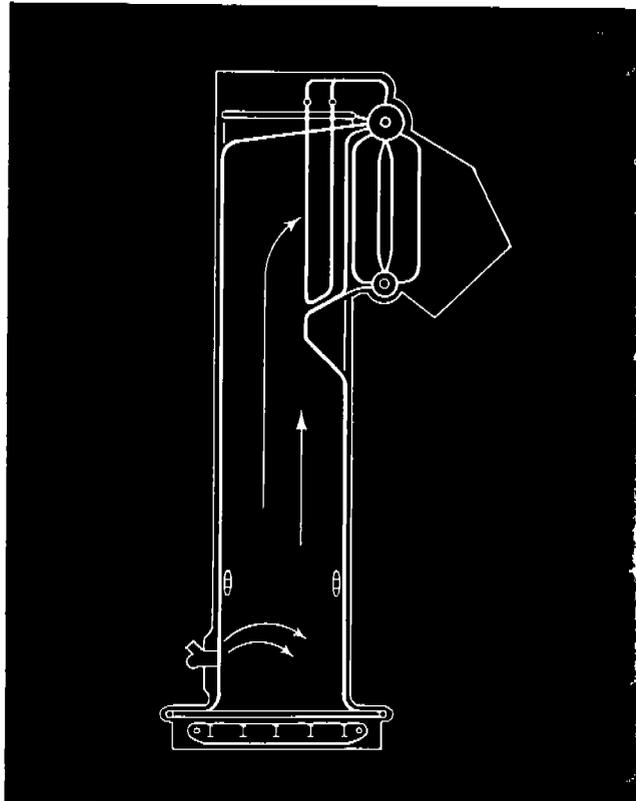
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Versatility and capacity to meet mill needs

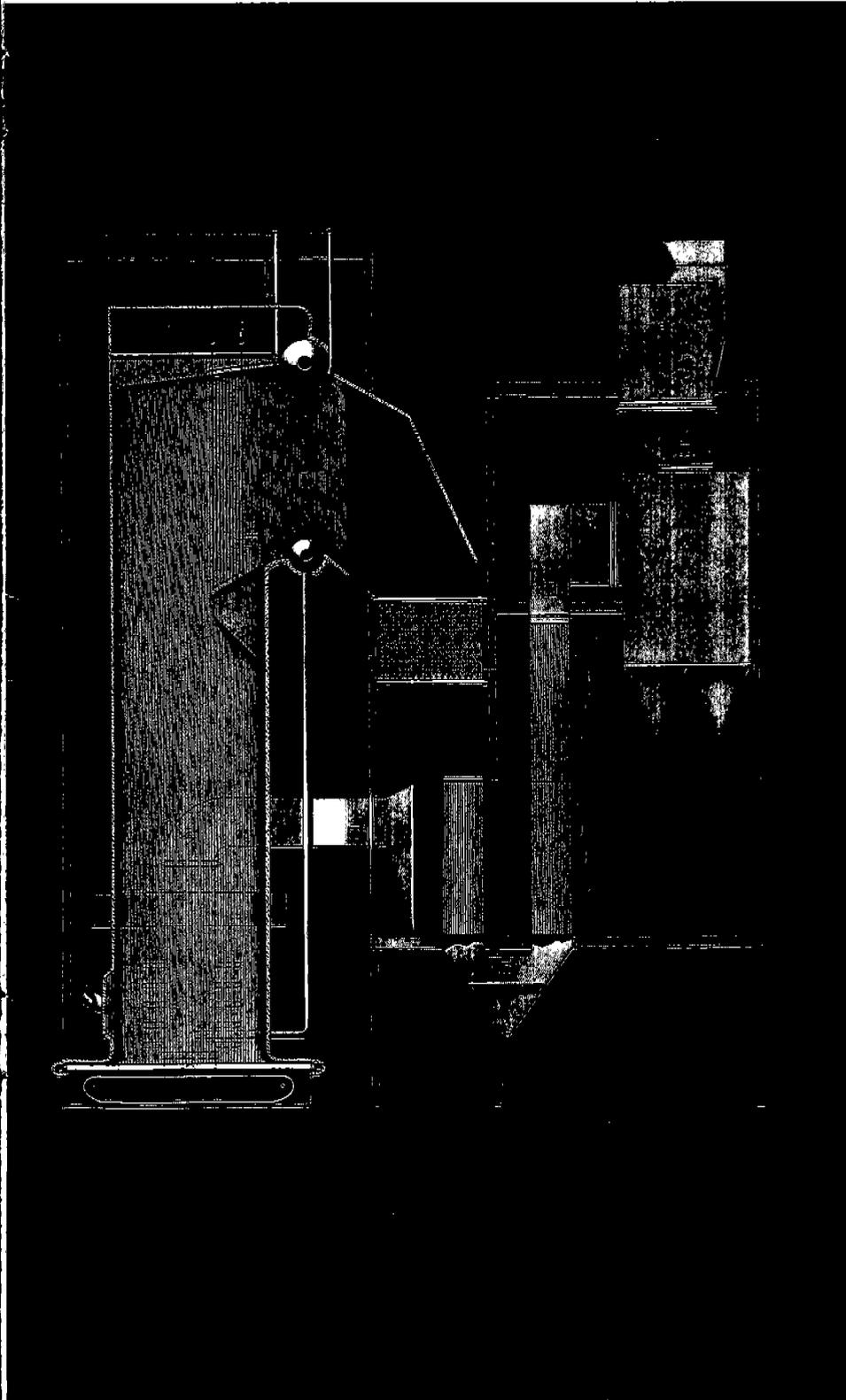
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Stoker fired unit



Furnace and fuel firing system

The large volume furnace is completely water cooled, and fabricated of fusion welded walls pioneered by C-E. This construction, using a minimum of refractory, provides a gas-tight envelope and results in low maintenance.

The bark is fired into the furnace through distributors located high enough in the furnace walls to allow flash drying in a highly turbulent gas stream. Preheated secondary air is introduced tangentially to provide the high turbulence needed for complete mixing of air and gas. Most of the bark is burned rapidly in suspension before it reaches the grate.

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A fin tube economizer, a C-E tubular or Ljungstrom® air heater can be added as the economics of the application dictate.

Tangentially fired unit

Furnace and tangential firing system

The same large volume furnace design used for the stoker fired unit is utilized for this unit. The furnace is also completely water cooled. It is constructed with fusion welded water walls and minimum refractory for low maintenance.

Bark is introduced into the furnace through C-E fuel-air firing assemblies located high in the furnace. Preheated secondary air is supplied at high pressure to provide intense turbulence for complete air and gas mixing. Firing assemblies are arranged tangentially in the furnace corners to impart a rotary action to the fuel-air streams. The impinging and scrubbing action of the streams upon one another produces the intermixing of fuel and air within the furnace necessary for rapid and complete combustion. In effect, the entire furnace becomes a burner, assuring uniform heat absorption in the furnace and increased safety at all inputs. Also, with the inherent lower peak flame temperatures, the production of NO_x is held to a minimum. The bark is flash dried as it enters the furnace, and the bulk of the fuel is burned in suspension. A small dump grate provides for finish burning of over-size particles.

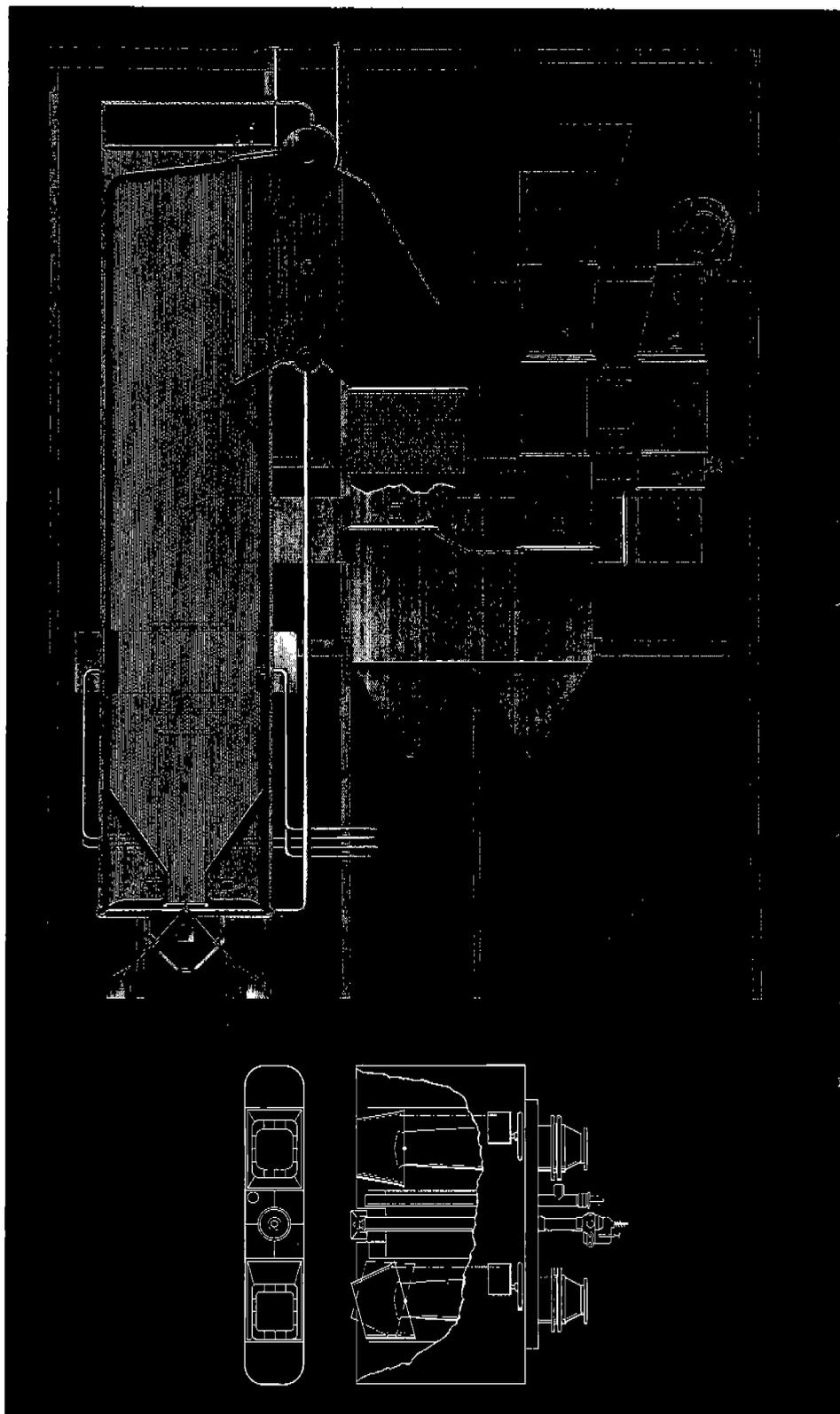
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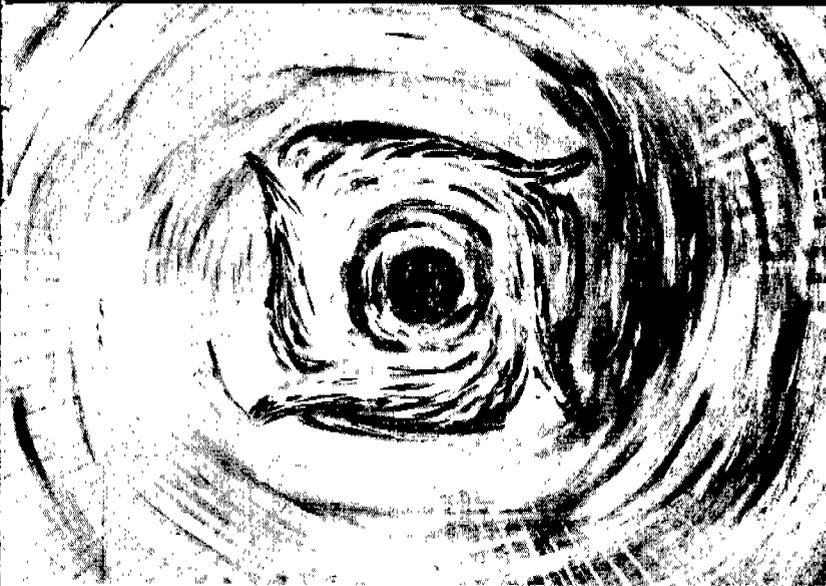
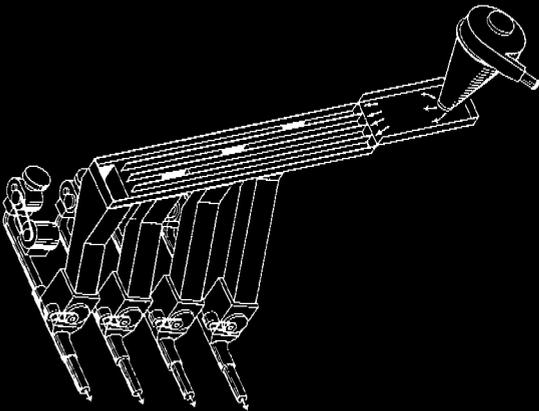
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Firing assembly and overfire air arrangement

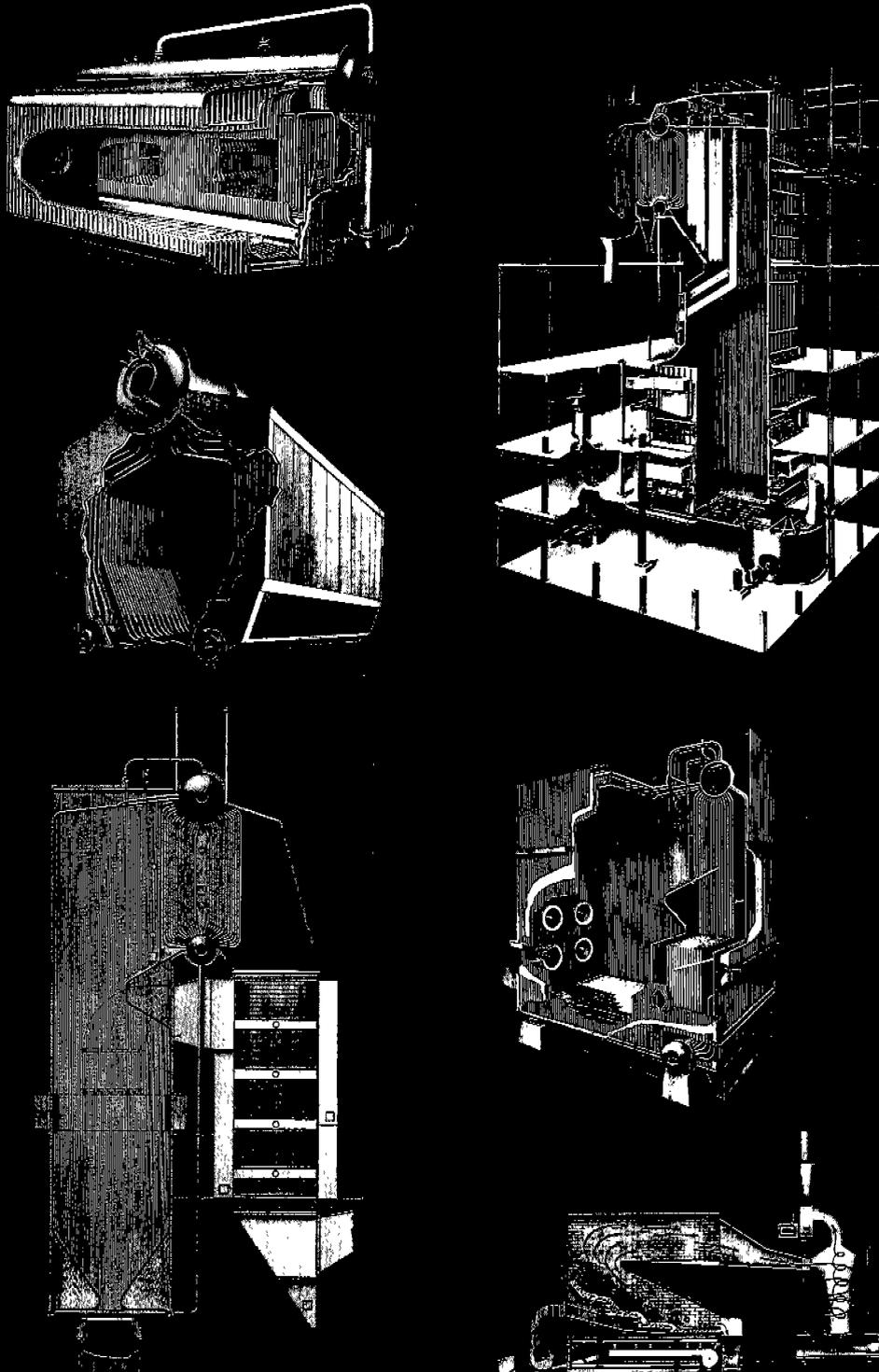
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Other C-E products for pulp and paper mills

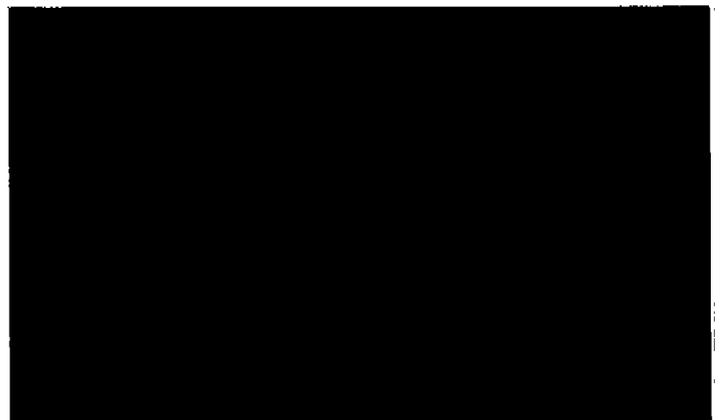


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