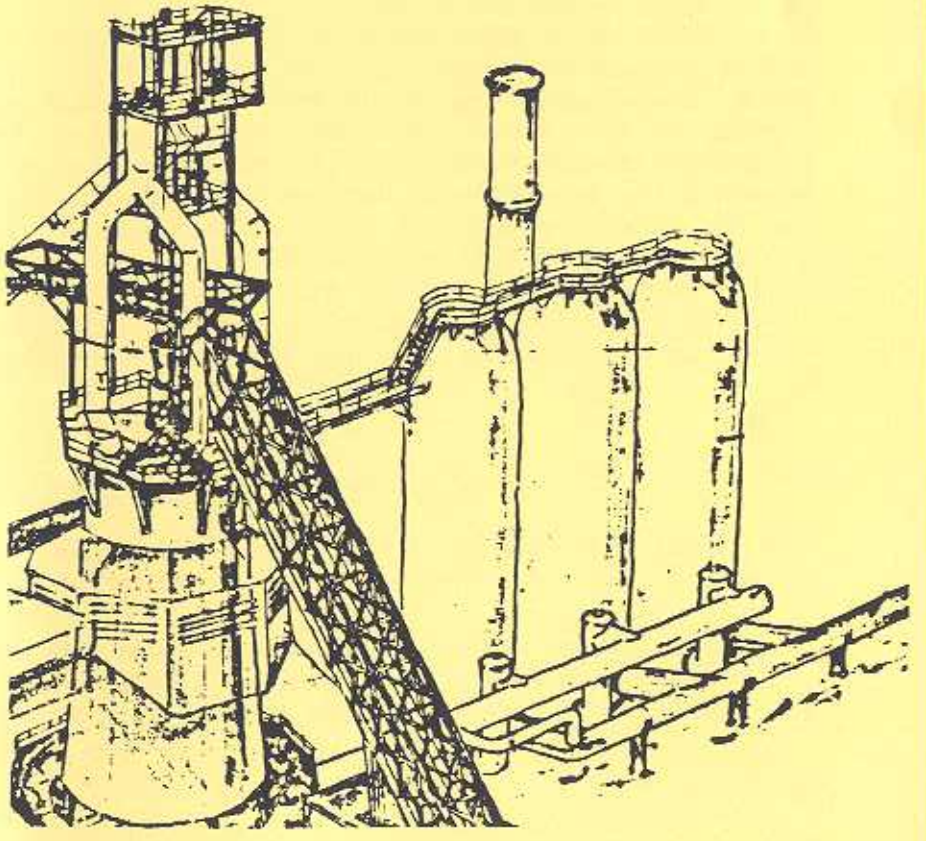
STEEL
McLOUTH

Emergency First Aid — 2012

Blast Furnace Department

STOVE TENDERS MANUAL



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INTRODUCTION

The purpose of this manual is to better acquaint the stove tenders on the various phases of stove and furnace operation. The stoves are used to heat the wind going into the furnace. The great discovery of blowing the hot blast was attributed to J. Nielson, a Scottish iron maker. Until his time most of the iron makers believed that cold air gave a higher flame temperature than hot air and they even went to the trouble of cooling air for their bellows in the summer time. Obviously it was the lower humidity of the cold air that gave them the higher flame temperature. After the discovery and the advantages of the hot blast, the production rates increased and the fuel rates decreased dramatically. As a result of improved stove design and operation, most stoves in the industry operate at 1700°F or higher.

We have a total of 7 stoves of Mckee design. Each stove is 118 feet high from foundation, 26 feet in diameter, 105 feet of checker work, 241,353 feet of heating surface. There are three main divisions inside each stove. (1) combustion chamber where the combustion of air and gas takes place. (2) Dome which is a roof over the combustion chamber and the checkers. (3) Checkers which is a mass of brick work with 2"x2" flues. The checker bricks absorb the heat from the hot gases while the stove is on gas and later while the stove is on furnace transfer the heat to the wind.

Mechanical parts of a stove:

1. Cold gate: A hand operated valve that admits the wind from the turbo blower into the stove bottom.

2. Hot blast valve: This connects the stove with the hot main. It is a disc type motor operated valve on the swing stove and hand operated mushroom type valve on the other stoves.

3. Mixer valve: This connects the cold blast to the hot blast line to regulate the hot blast temperature.

4. Burner door: This seals the opening between the stove and the air/gas main.

5. Pratt valve: (gas shut off valve) This lets the gas flow from the stove gas main into the stove.

6. Modulating valve: This is a butterfly valve located behind the pratt valve to regulate the flow of gas into the stove. This is not a positive shut off valve when closed.

7. Fan: This blows up to 50,000cfm of air into the combustion chamber.

8. Louvers: Located over the fan these are used to regulate flow of air into the combustion chamber.

9. Chimney valve: (2 per stove) These connect the stove bottom to the chimney stack to provide draft.

10. Blow off valve: This is used to relieve the pressure inside the stove after the stove is taken off the furnace.

11. Several inspection and clean out doors.

Wind: The wind to our furnaces is blown by steam operated Delaval turbines located at the power house. There are 3 turbines capable of blowing up to 115,000 cubic feet per minute (cfm) of wind each. In addition there is an electric turbo capable of blowing up to 40,000 cfm of wind. These are all low pressure turbos. They can blow the wind only below the 30 psi limit at the turbos. There is usually about 3 to 4 lbs. of pressure loss from the turbos through the stove to the furnace. Therefore the wind pressure at the furnace usually is below 27psi all the time.

The wind comes out of the atmosphere, from outside the power house. Although it is a cold wind, the compression of it during the blowing process makes it warm, about 175°F. There is always some humidity in the atmosphere depending on the temperature and the relative humidity. The wind in the winter is generally dry and dense. During the summer the humidity can be as much as 15 grains. A grain is one seven thousandth of a pound of water per cubic foot of wind. The following table may be useful:

Atmospheric temp °F	Relative humidity grains	
	50%RH	100%RH
30	1	2
40	2	3
50	2	4
60	3	6
70	4	8
80	6	11
90	8	16
100	11	21

These are the grains of humidity in the atmosphere before the wind enters the power house. We generally regulate the humidity at 10-15 grains as the wind goes into the furnace by adding steam into the cold blast main.

It is the wind that causes the furnace to "move", that is the burden to go down the stack. The wind burns the coke into gas and the gas in turn reduces the iron ore into iron as it travels up the stack. The moisture in the wind also burns the coke into gas thus increasing the driving rate of the furnace.

The wind from the power house passes through a valve called snort valve before it enters the stoves. The snort valve when open simply bleeds the air into atmosphere. To deaden the noise there is a muffler installed on it. When we want to take the wind off the furnace we open the snort valve, by turning a wheel in the gun room. The snort valve while unattended should be pegged in place because the wind pressure can move the valve.

After the snort valve in the cold main, there is a McCarthy drop safety valve which set to drop open in case the power house turbo stops suddenly. Years ago there was an accident in the industry when the turbo kicked out and the furnace gas swept back into cold main and into the power house causing an explosion. The McCarthy valve when it drops open will vent any furnace gas into the atmosphere.

The cold main then branches into a large and a small branch. The large branch takes the wind into the cold gates to the stoves. The small branch, called the mixer line, goes around the stove and connects to the hot air leg of the stove before the hot blast valve. The purpose of the mixer line is to mix the hot blast with the cold blast to regulate the heat to the furnace. There are usually two butterfly valves operated automatically (or manually when desired) in these two branches known as mixer valves. In addition there is a hand operated mixer valve to each stove in the mixer line. When you take a stove off gas this valve should be closed.

Changing stoves: When you put a hot stove on the furnace its dome is hot, say 2200°F. The wind coming out of it is usually about 50°F lower than this, say about 2150°F. Now if we are carrying the hot blast at 1600°F this hot blast is mixed with the cold air from the mixer line at a proper proportion so that resulting temperature is 1600°F. As the stove dome cools off less of the cold air is mixed with the hot air. As the dome reaches 1650°F the

small mixer closes completely, blanking off the mixer line. After this point the hot blast will start to fall below the 1600°F line and it is time to change stoves.

When you change stoves it is very important to follow the exact sequence given on pages 7 & 8. One mistake can be very expensive and very dangerous. For example, if you forget to put a hot stove on the furnace before taking the cold stove off, and if that was the only stove on the furnace, the wind to the furnace would be cut off. The blow pipes would be filled with slag and the turbo would go into the surge. Opening the burner door with the wind in the stove would cause the hot air to rush off the fan and ruin it. closing the burner door when the stove is on gas would cause the gas to leak out of the elbow, fan opening and flood the area with gas.

After changing stoves for several years, it is human nature for anyone to get lax at it. For example while putting a stove on gas, the gas must be lit before turning the fan on. There is a peep sight to make sure it is lit. The ignition temperature of CO gas is 1128°F. If the cumbustion chamber is colder than this, or for some other reason such as damp gas, steam etc, the gas may not light. Now if you can turn on the fan, the gas and air rush up the combustion chamber and come up to the dome which can light the mixture and set off an explosion!

When you put two stoves on furnace it is called parallel operation. Be sure to close one of the manual mixer valves so that the hot air does not start a circulation in the mixer line.

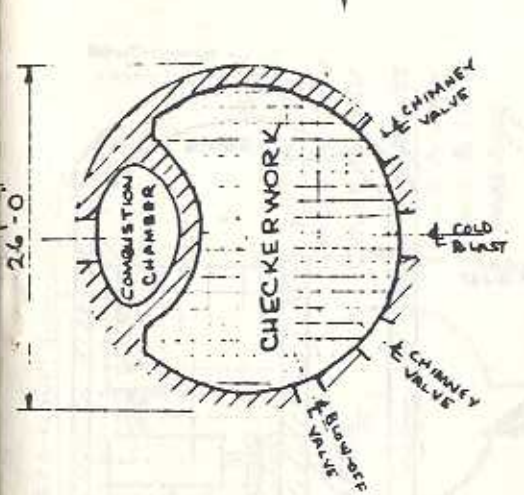
Immediately after changing stoves, check the blast pressure to make certain the situation is normal. A decrease in pressure means an open chimney, blow off or a hot blast valve. A sudden increase in pressure means that a stove is closed or partially closed against the blast.

Back drafting: When a furnace is shut down the snort valve is wide open and the cold gate of the stove is closed so that there is no wind going into the furnace. At this time there is some gas coming out of the tuyeres due to some direct reduction. This gas should not be allowed to build up and leak around the furnace. In order to suck this gas out of the tuyeres and vent it to atmosphere, open the chimney valves. Now the furnace is said to be back on draft. When you know in advance that the furnace will be going down, try to get No. 1 stove on furnace if possible. If that stove is cold then select another stove. At the end of the cast, when the blower gives you the magic word after the wind is off, just close the cold gate, mixer, and open the chimney valves on that stove. Then open up about 8 peep site caps to burn up the gas.

Also prior to shut down take the gas off the stoves and bottle them up. Make sure the peep sight glasses are clean because we need to know if the tuyeres are sloppy before shutting down.

After the shut down if the top is being lit everyone should be cleared off the cast house just in case of a kick.

Interlocks: We have had, in the past, instances of gas escaping from the fans through operators closing the burner doors while the pratt valves were open, by negligence. We have installed interlocks to prevent this from happening. When the pratt valve is closed all the way it will trip an electrical limit which will permit the closing of the burner door. When the pratt valve is open this limit is not tripped and the door can not be closed. In addition if the fan stops, when stove is on gas, the modulating valve is set to close automatically. Although the modulating valve is not a positive shut off, the small amount of gas leaking out of the modulating valve will be burned and exausted through the natural draft of the chimney stack.



TAKING THE STOVE OFF GAS

1. CLOSE GAS VALVE
2. SHUT OFF FAN
3. CLOSE BURNER DOOR
4. CLOSE BOTH CHIMNEY VALVES

THE STOVE IS NOW BOTTLED

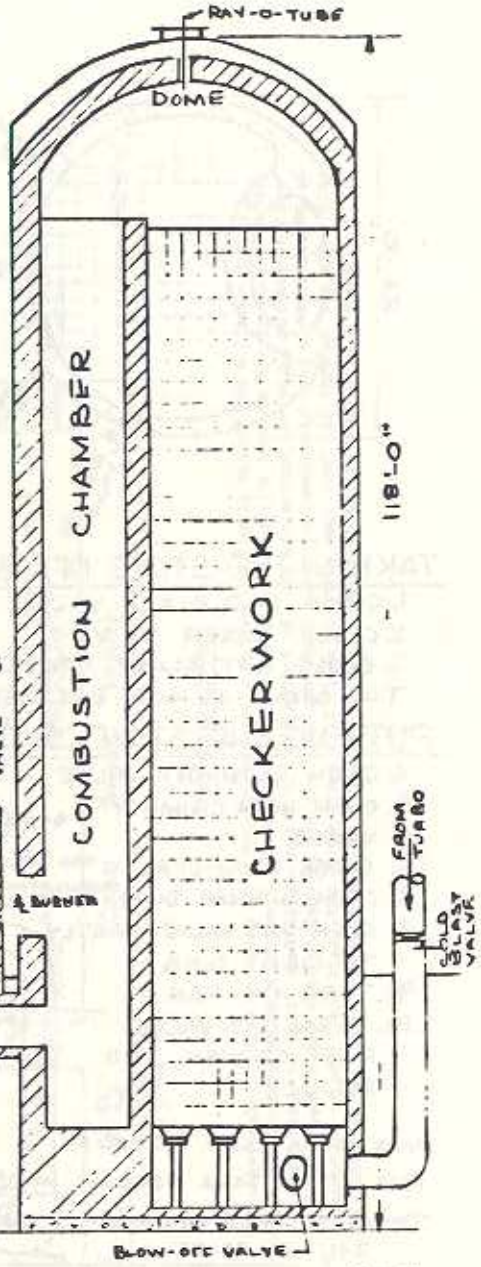
PUTTING THE STOVE ON BLAST

5. CRACK OPEN COLD BLAST VALVE TO FILL STOVE
6. OPEN COLD BLAST VALVE AFTER STOVE IS FULL
7. OPEN HOT BLAST VALVE
8. OPEN MIXER VALVE

THE STOVE IS NOW ON BLAST

MAX. DOME TEMP - 2300°F
MAX. STACK TEMP. - 800°F

TOTAL HEATING SURFACE - 241,253 SQ. FT.



CHANGING THE STOVE FROM GAS TO BLAST

CHANGING THE STOVE FROM BLAST TO GAS

MAX. DOME TEMP. - 2,300°F
MAX. STACK TEMP. - 800°F
TOTAL HEATING SURFACE - 241,353 SQ. FT.

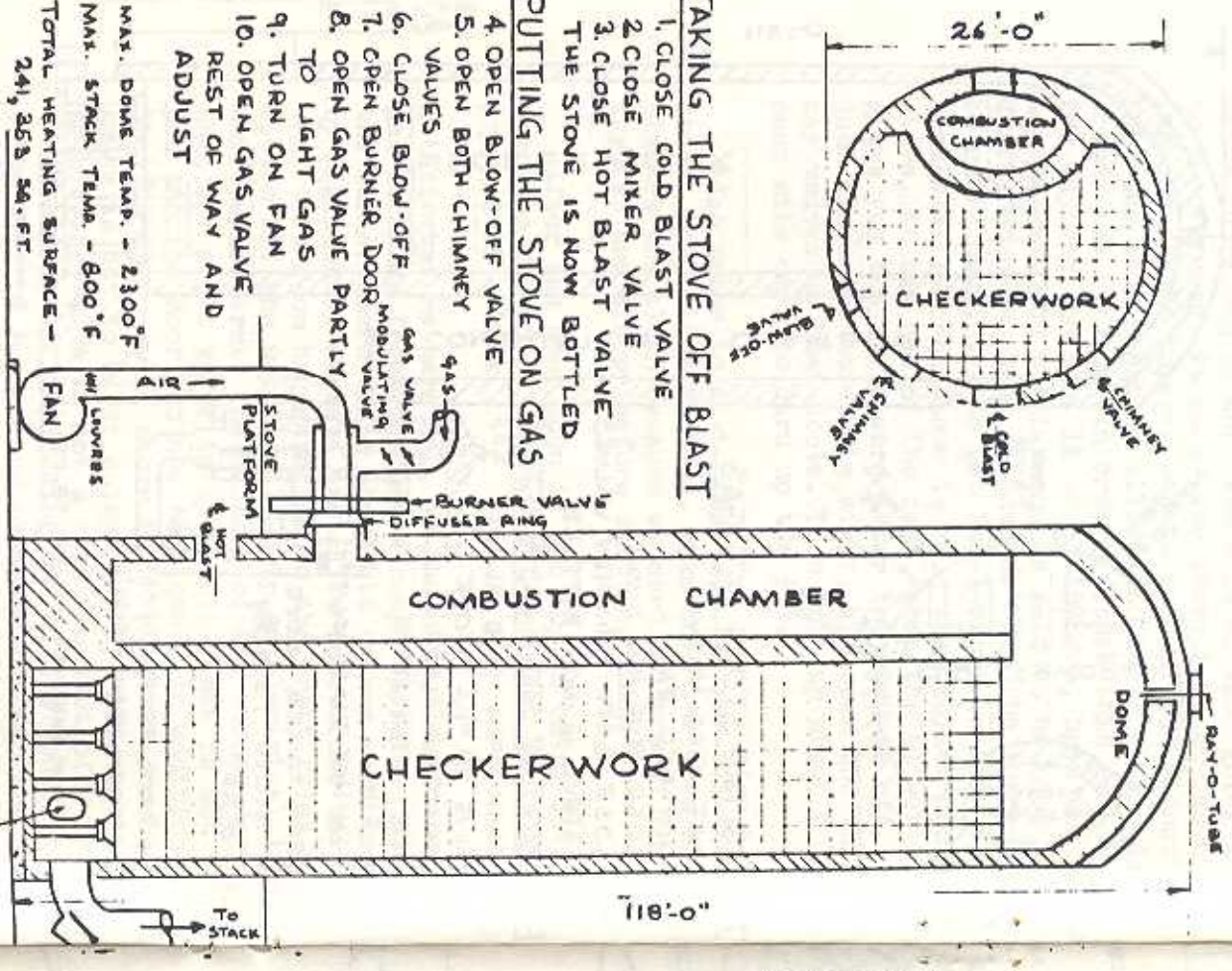
TAKING THE STOVE OFF BLAST

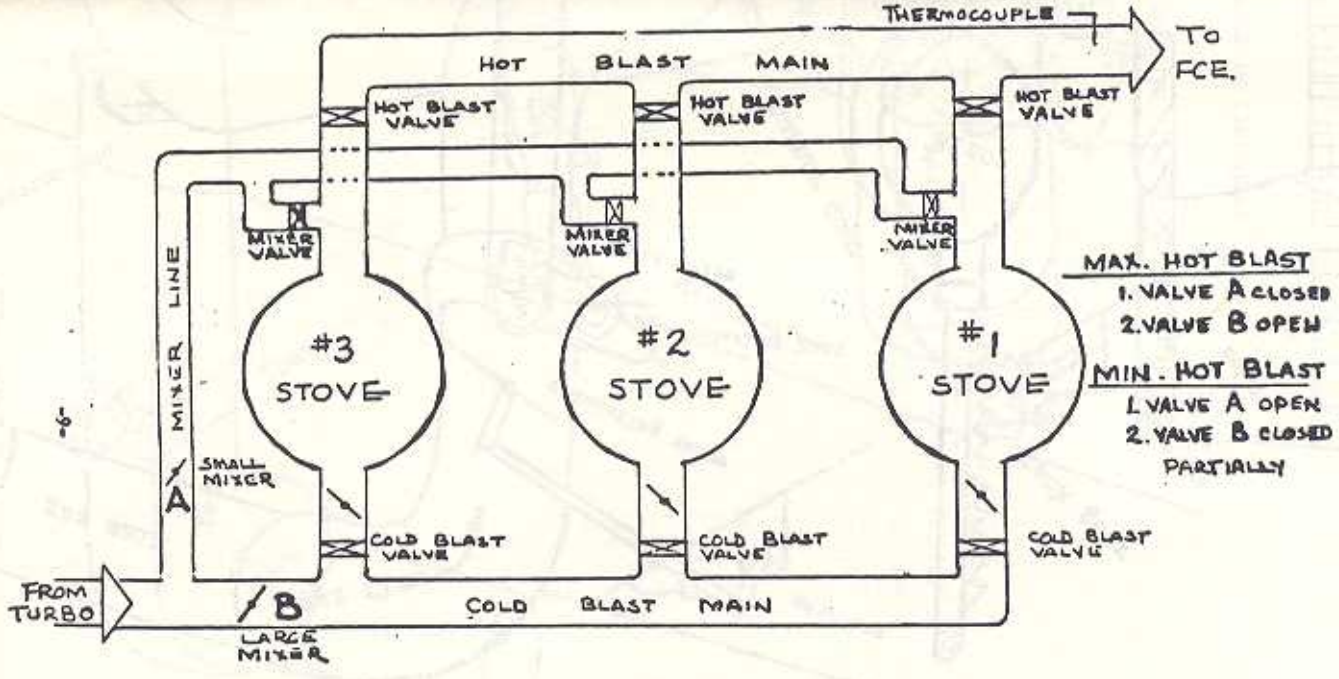
1. CLOSE COLD BLAST VALVE
2. CLOSE MIXER VALVE
3. CLOSE HOT BLAST VALVE

THE STOVE IS NOW BOTTLED

PUTTING THE STOVE ON GAS

4. OPEN BLOW-OFF VALVE
5. OPEN BOTH CHIMNEY VALVES
6. CLOSE BLOW-OFF VALVE
7. OPEN BURNER DOOR
8. OPEN GAS VALVE PARTLY TO LIGHT GAS
9. TURN ON FAN
10. OPEN GAS VALVE REST OF WAY AND ADJUST



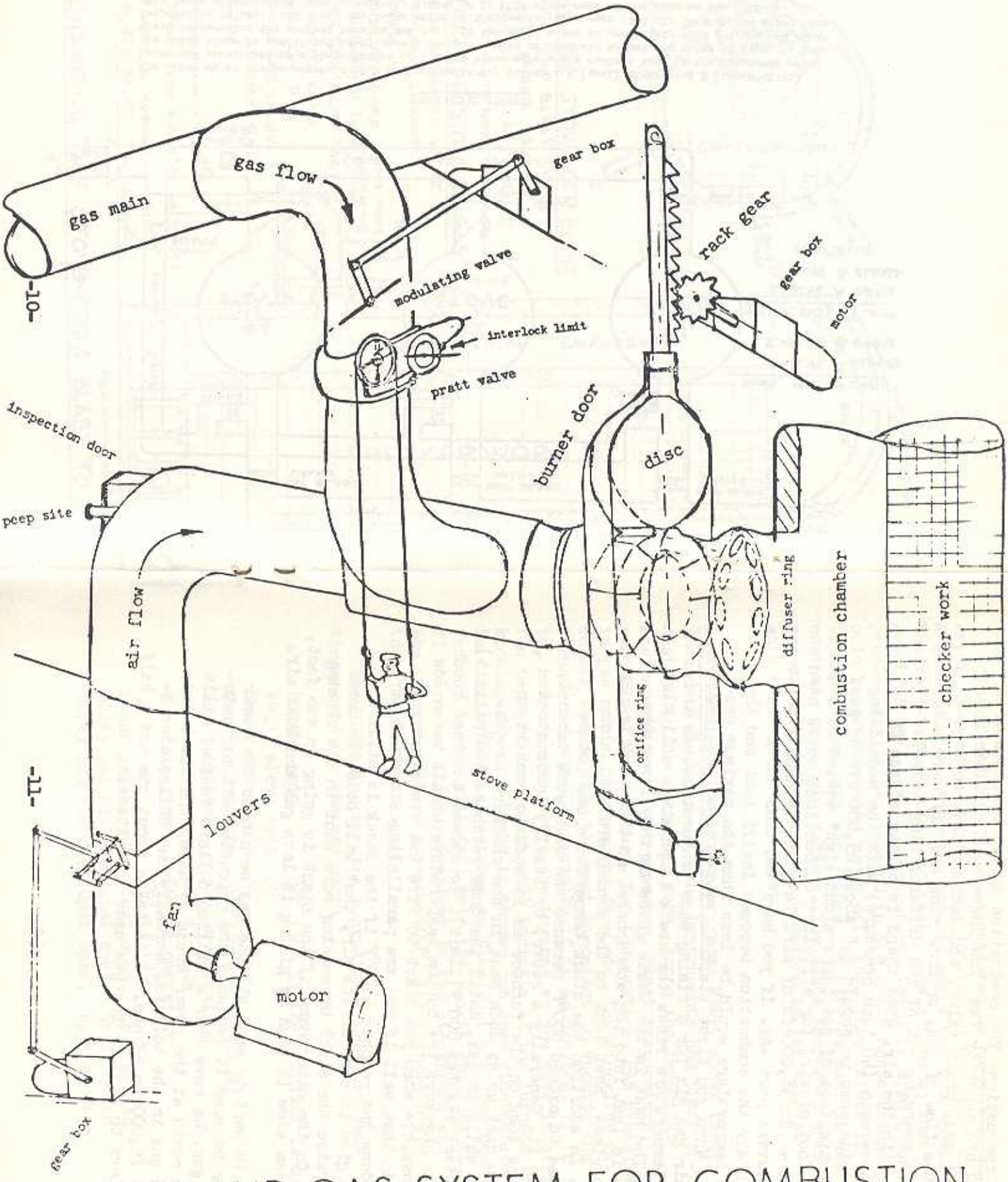


MAX. HOT BLAST
1. VALVE A CLOSED
2. VALVE B OPEN

MIN. HOT BLAST
1. VALVE A OPEN
2. VALVE B CLOSED PARTIALLY

THE MIXER SYSTEM

The mixer valve system consists of 2 control butterfly valves - A (small mixer) and B (large mixer) which are positioned by a thermocouple in the hot blast main and a control knob in the pyrometer room. The small mixer is positioned to by-pass a certain amount of cold air around the stove to form the hot blast temperature the control know is set for. If the small mixer is completely open and the hot blast temperature is still too high, the large mixer will close to force more cool air through the mixer line. This large mixer should never completely close, or it will close most of the wind to the furnace.



AIR AND GAS SYSTEM FOR COMBUSTION

Stove combustion: The combustion system consists of a 50,000 cfm capacity fan, fan louvers to regulate the flow of gas, pratt valve, modulating valve to regulate the flow of gas, orifice ring and diffuser ring. The gas emerging out of the diffuser ring nozzels burns with the air. When there is plenty of gas in the stove main (40 inch pressure) with the modulating valve wide open we should get about 45,000 cfm of gas. Each cubic foot of gas takes about eight tenths of a cubic foot of air, for efficient combustion. so we need 45,000 x .8= 36,000cfm of air. To get this simply close the louvers part way. If you have too much air or not enough air the combustion becomes inefficient and the flame temperature would be less than the maximum possible. When you first start to fire a stove regulate the air gas mix for a rising dome temperature. As the dome temperature rises the stack temperature will also rise. The heat in the waste gases as they leave the stack is lost into the atmosphere. As the stack temperature rises, heat lost to the atmosphere will also rise. In addition the stack temperature can not be allowed to exceed 800°F because the brickwork can not handle it. Generally a stove, by itself, lasts about half as long on the furnace as it took to heat it up. Try to soak up as much heat in the checkers as possible while on gas, until the dome reaches 2300°F(limit) and stack reaches 800°F(limit). To spread the heat good in the checkers the bottom temperature should be as low as possible when you start to fire the stove and you can do that well if you are paralleling stoves. After the dome has reached 2300°F if the stack is still low just give it some excess air, that will hold the dome and raise the stack by soaking more heat in the checkers. On the other hand if the stack is going up too fast, you can slow it down by giving it less gas and less air.

We want to send all the gas we can to the power house because it replaces the expensive oil and natural gas. We save over a million dollars in fuel bills in a month at the power house by using the blast furnace gas in the boilers. Normally one boiler uses about 25,000cfm of gas. So it takes about one and a half boilers to replace the gas used in a stove.

CHIMNEY VALVES

The dome temperature is measured by an optical pyrometer known as a "rayo-tube", located on the stove dome. A small stream of compressed air keeps the tube cool. The rayo-tube should be cleaned once a turn so that it measures the correct temperature. There is also a compressed air filter located in the hoist house which should be occasionally blown off. When this filter is full of impurities, oil etc., they get carried past it and coat the rayo-tube surface. The stack temperature is measured by a thermocouple inserted in the exhaust main near the chimney valve.

Instruments in the pyrometer room: Every stove tender Should be familiar with the instruments and their operation in the pyrometer room. Among the important instruments are blast pressure, blast temperature, stockline, top pressure, top temperature, gas pressure in gas mains, igniter gas flow etc. The stockline recorder is probably the most important in knowing the furnace behavior, especially if it is hanging. If it is, have someone watch the tuyeres as you move it off. The top pressure chart will indicate if the furnace is kicking. When it kicks it throws out some fine materials into the dust catcher as flue dust and some unreduced burden will fall into the hearth chilling it. If there are filling problems in the stockhouse and the top temperature exceeds 600°F the furnace needs to be checked down.

The following are the approximate pressure settings used for the gas main:

Boiler main	32" (35" if the A boiler is used)
No. 1 stove main	35"
No. 2 stove main	42"
Swing stove main	35" (located outside)
No. 1 igniter	55" in operation
	60" if idle
No. 2 igniter	50" in operation
	55" if idle
Clean gas bleeder	6psi open, 4psi closed
Dirty gas bleeder	11psi open, 9psi closed
Dirty gas bleeder	10psi open, 8psi closed

INTERLOCKS ON THE SWING STOVE ELECTRICAL VALVES

TO OPERATE		VALVES MUST BE
MIXER # 1	OPEN	CV-1, CV-2, CB-2, HB-2, MX-2, CLOSED
	CLOSE	--
COLD BLAST # 1	OPEN	CV-1, CV-2, CB-2, HB-2, MX-2, CLOSED
	CLOSE	--
HOT BLAST # 1	OPEN	CV-1, CV-2, CB-2, HB-2, MX-2, CLOSED
	CLOSE	--
MIXER # 2	OPEN	CV-1, CV-2, CB-1, HB-1, MX-1, CLOSED
	CLOSE	--
COLD BLAST # 2	OPEN	CV-1, CV-2, CB-1, HB-1, MX-1, CLOSED
	CLOSE	--
HOT BLAST # 2	OPEN	CV-1, CV-2, CB-1, HB-1, MX-1, CLOSED
	CLOSE	--
COLD BLAST MODULATING	OPEN	AUTOMATIC
	CLOSE	AUTOMATIC
RELIEF VALVE	OPEN	--
	CLOSE	--
CHIMNEY VALVE # 1	OPEN	--
	CLOSE	--
CHIMNEY VALVE # 2	OPEN	--
	CLOSE	--
BURNER SHUTOFF VALVE (DOOR)	OPEN	CV-1, CV-2, OPEN. HB-1, HB-2, CLOSED MAN. GAS VALVE CLOSED, MAN. CB VALVE CLOSED.
	CLOSE	BURNER SLEEVE RETRACTED
BURNER SLEEVE	RETRACT	--
	EXTEND	BURNER SHUTOFF VALVE OPEN
BURNER FAN	RUN	SELECTOR SWITCH ON STARTER MUST BE IN FAN RUN POSITION. BURNER SHUTOFF VALVE MUST BE OPEN.
GAS MODULATING VALVE	OPEN	AUTOMATIC OR MANUAL BY P.B. PROVIDING BURNER FAN IS RUNNING. IF FAN STOPS GAS VALVE IS AUTOMATICALLY DRIVEN CLOSED
	CLOSE	

Legend: CV - chimney valve
CB - cold blast valve
HB - hot blast valve
MX - mixer valve

BLAST FURNACE STOVES
GENERAL SAFETY PRECAUTIONS

1. Always make certain that the gas valve (pratt valve) is shut tight when the stove is off gas. If this valve is not shut tight, blast furnace gas will leak out the stove fan opening.

2. Always make certain that a stove is completely on the furnace before taking another stove off.

3. In case of a power failure, immediately close the gas valves. If a fan stops with a gas valve open, gas will pour out the fan opening.

4. Always make certain the gas lights immediately when put into a stove. Never put gas in a stove that isn't hot enough to ignite. If a gas/air mixture is put in a stove which is too cold to ignite, an explosi will result when the gas/air mixture finally ignites. In case of doubt, build a fire in the back draft door opening and drift blast furnace gas until the combustion chamber is hot enough to keep the gas lit.

5. Do not exceed the maximum dome and stack temperature settings.

6. In case that two stoves are being used on the furnace at one time (parallel operation), only the mixer valve on the hot stove should be opened. If both mixer valves are opened, a circulation of hot blast will make the mixer line red hot.

7. Familiarize yourself with the gas equipment in the pyrometer room.

8. There is an interlock between the gas burner door and the gas shut-off valve (pratt valve) so that the burner door cannot be closed electrically unless the gas valve is shut. Check this out periodically.

9. Drain the valves on the bottom of the burner doors regularly.

10. Immediately after changing stoves, check the blast furnace pressure chart to make certain the situation is normal. A decrease in pressu means an open chimney, blow-off, or hot blast valve. A sudden incre in pressure at the blowing room means that a stove is closed or partially closed against the blast.

Blast Furnace Gas

One of the hazards inherent in the blast furnace operation is the gas. The wind entering the tuyeres burns the coke into carbon monoxide which is the "working gas" of the furnace. As the gas travels up the stack, some of the carbon monoxide is transformed into harmless carbon dioxide in the reduction process but a large part of the carbon monoxide remains in the top gas. It is this carbon monoxide that makes the gas a fuel for stoves and boilers.

Blast furnace gas sometimes has an oder, but the carbon monoxide itself is colorless, oderless and tasteless. Everyone should learn the symptons of inhaling the gas: nausea, dizziness, headache, weak knees, unconsciousness and death. The gas is heavier than air and tries to settle on the floor unless it is a clear day for the wind to blow it away. If the pratt valve is not closed tight when you take a stove off gas, some gas can leak out the stove fans. When the dust is dumped out of the dustcatcher some gas can blow. When the furnace makes a kick, gas seals can blow and flood the area with gas. There is usually some gas leaking out of the hearth around the furnace which needs to be kept lit all the time.

The other danger with the blast furnace gas is its ability to cause explosions with air in the gas mains. When the gas pressure goes down in the main, as when we shut down the furnace, we inject steam into the main to pressurize it so that the air does not leak in it. Just incase some air did leak in the main we do not want to light it by sparks, heat caused by welding on the outside etc.

THE M.S.A. PNEOLATOR

The purpose of the pneolator is to give automatic artificial respiration to victims of the Blast Furnace gas. When a person is asphyxiated, ie, inhaled suffient quantities of carbon monoxide, immediate artificial respiration is necessary. The pneolator can function either as a respirator or as an inhalator. For a victim who has stopped breathing the pneolator can be used as a respirator. The pneolator "breathes" for a person by inflating the lungs to a predetermined pressure and then allowing exhalation by the natural recoil of the chest. When the victim starts to breathe the pneolator can function as an inhalator by simply opening the airway below the mask.

There are two valves that must be opened during the artificial respiration. One is the cylinder valve. When this is open the high pressure gage indicates the cylinder pressure. The other is the pneolator control valve. This is an adjusting valve to set the oxygen flow for an infant, child or adult as indicated on the low pressure gage. It compensates for the lungs of varying capacities without harming them.

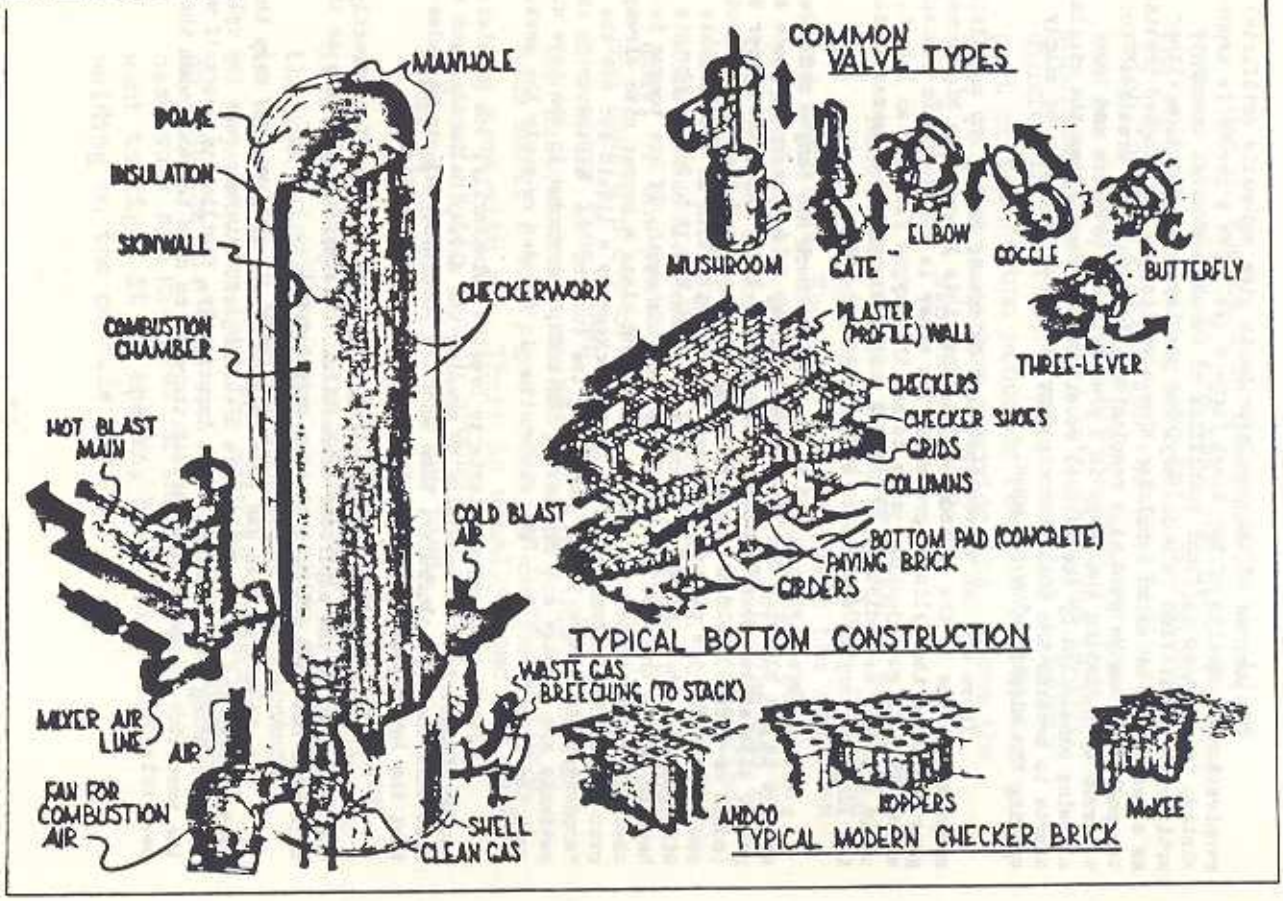
Before giving oxygen to the victim check his tongue and make sure it is not blocking his air passage. It may be necessary to place a proper size airway over and behind his tongue. Then, using the proper mask (adult or infant) hold it tight over the victims face. The pneolator will now breathe for the person. If there is an obstruction in the patients wind passage, then the valve below the face mask will chatter. If this happens remove the mask and check the patients mouth. If his tongue is obstructing straighten it with an airway and place a proper size airway over and below the tongue. If it is a blockage by a liquid etc use the "aspirator" to remove it. By inserting the tube of the aspirator in the patients air passage and depressing the knob, the vacuum in the tube will suck the liquid out. When the obstruction is removed re-apply the mask.

Once the patient starts to breathe voluntarily, the pneolator can be changed into an inhalator by opening the airway below the face mask. Just turn the knob clockwise. Then turn the pneolator adjustment valve such that the low pressure gage needle is at "assistor" position.

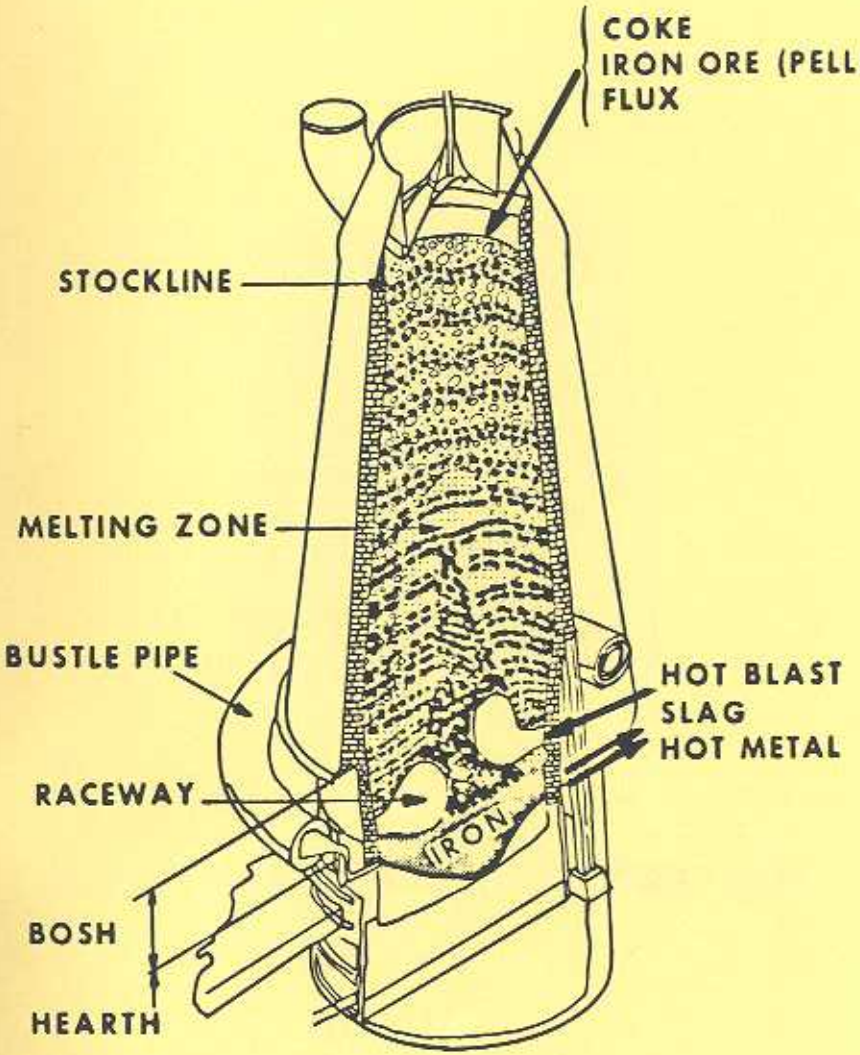
An auxiliary unit is available and may be connected directly to the main unit at the aspirator connection. It is exactly the same as the main unit but does not have its own oxygen supply.

Select an area gas free to give oxygen to a victim. Keep the patient warm and watch closely his breathing effort. Make sure the cylinder is not running out of oxygen. Most importantly, familiarize yourself with the pneolator in spare time so that there is no need to panic when the need arises.

the stove


MANHOLE
SHELL
INSULATION
SKINWALL
COMBUSTION CHAMBER
CHECKERWORK
HOT BLAST MAIN
COLD BLAST AIR
MIXER AIR LINE
AIR
FAN FOR COMBUSTION AIR
SHELL
CLEAN GAS
WASTE GAS BREECHING (TO STACK)
COMMON VALVE TYPES
MUSHROOM
GATE
ELBOW
COCCLE
BUTTERFLY
THREE-LEVER
PLASTER (PROFILE) WALL
CHECKERS
CHECKER SHOES
GRIDS
COLUMNS
BOTTOM PAD (CONCRETE)
PAVING BRICK
ORDERS
TYPICAL BOTTOM CONSTRUCTION
ANDCO
HOPPERS
McKEE
TYPICAL MODERN CHECKER BRICK

NOTES


COKE
IRON ORE (PELLETS)
FLUX
STOCKLINE
MELTING ZONE
BUSTLE PIPE
HOT BLAST
SLAG
HOT METAL
RACEWAY
IRON
BOSH
HEARTH