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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

This Issue

STEEL MILL LUBRICATION

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LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

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STEEL MILL LUBRICATION

ANYONE visiting a steel mill is impressed with the immensity of the operation and the spectacular way in which tremendous quantities of steel are processed.

Machines are of gigantic size; speeds and pressures are often very high. Adverse operating conditions such as shock loading, exposure to water, mill scale and high heat are normal. And yet the machines must operate with great precision.

Adequate lubrication is probably more vital in the steel industry than in any other.

This article will describe briefly the processes of making steel from the raw materials to the finished product as diagrammed in Figure 1. The major types of lubricants involved will be discussed along with methods of application and problems connected with this field of lubrication.

MANUFACTURE OF PIG IRON

The first "pig" or cast iron was manufactured in this country in a small blast furnace in Massachusetts about 300 years ago. Production was less than a ton in a 24-hour period. A modern furnace can now produce 2000 tons or more in the same time.

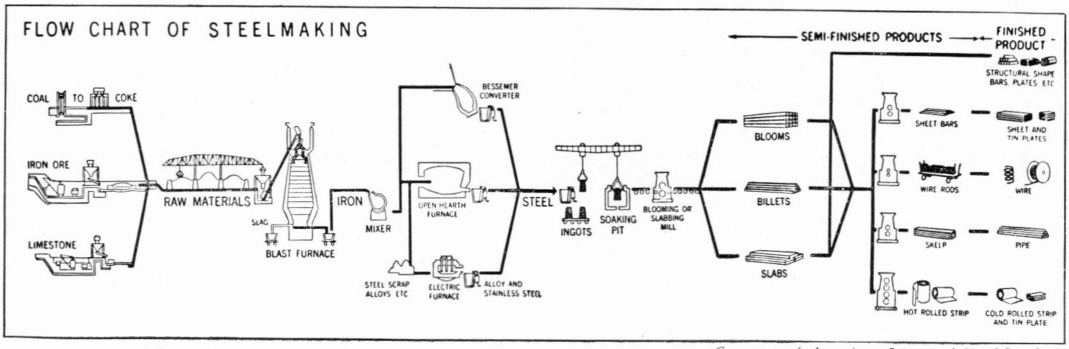
As illustrated in Figures 2 and 3; a blast furnace consists of a circular steel shell lined with fire brick and having a height of about 100 feet and a diameter at the hearth of 25 to 30 feet.

To smelt iron four ingredients are necessary: *iron ore, coke, limestone* and *air.* The first three are carried into the top of the blast furnace by means of "skip cars" shown in Figures 2 and 3 and are charged in alternate layers to promote even melting and descent of the charge. The charging is a continuous operation and ingredients are added at regular intervals. For best economy and highest production a blast furnace is operated continuously until overhaul (such as replacement of fire brick linings) forces a shut down. The furnace "stack" when completely full will hold about 400 tons.

The fourth ingredient is air which is preheated to 1000-1500°F. in the furnace's "stoves" then forced by blowers (illustrated in Figure 4) into the bottom of the furnace through ports known as tuyeres. The oxygen in the hot air burns the coke to make heat and carbon monoxide gas. This gas "reduces" the iron oxide (takes away its oxygen) to form metallic iron. The high heat (approximately 3000°F.) melts the iron which gradually trickles to the bottom of the furnace (the hearth). The heat also changes the limestone into lime which in turn combines chemically with most of the undesirable portions of the ore and coke to form "slag". This molten material also trickles to the bottom of the furnace where it floats on top of the heavier iron.

Molten slag is drawn off into slag cars where it is quenched and then hauled to the slag dump. Formerly a waste product, it is now used to make cinder block, rock wool insulation, road ballast, cement and other materials.

Molten iron is drawn off at regular intervals of 4 to 6 hours into "hot metal cars" illustrated in Figure 5, and delivered to refractory-lined recep-



Courtesy of American Iron and Steel Institute

Figure 1 — Flow Chart of Steelmaking.

tacles called "hot metal mixers". The mixers are held at uniform high temperature until hot iron is needed in steel making furnaces. The molten iron is also poured into the pig machines or molds shown in Figure 6 to form "pigs" for shipment or for cold charging of steel furnaces.

Chemical Compositions of Raw Materials

Ore

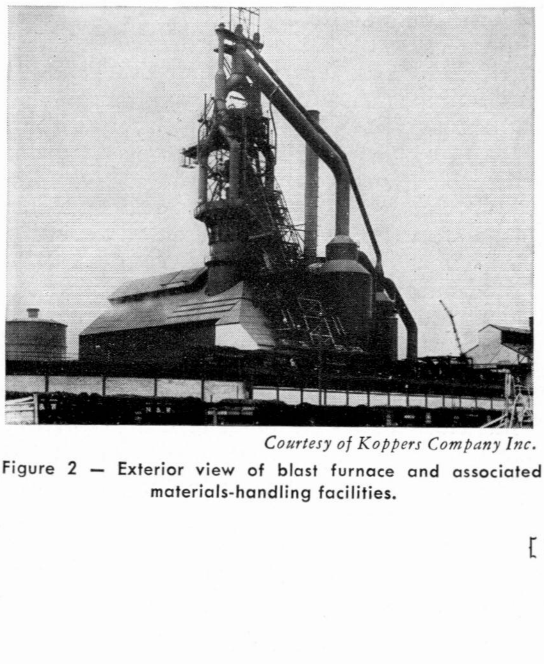
Merchantable iron ores consist chiefly of oxides such as Fe_2O_3 or Fe_3O_4 and also the carbonate $FeCO_3$ with smaller amounts of other materials such as water, silica, silicates, aluminum oxide, calcium, magnesium, phosphorus, manganese, sulfides, carbonates and sulfates.

Coke

Blast furnace coke is made by heating special "coking coals" in closed ovens. It consists chiefly of carbon with small amounts of water, volatile matter, sulfur and ash.

Limestone

This consists chiefly of calcium carbonate with smaller amounts of magnesium carbonate. But it may also contain small amounts of silica, alumina, sulfur, iron and phosphorus.



Courtesy of Koppers Company Inc.

Figure 2 — Exterior view of blast furnace and associated materials-handling facilities.

Air

The active ingredient of air is oxygen (21%) but it also contains nitrogen, water, carbon dioxide and small amounts of inert gases.

Chemical Composition of the End Products

Pig Iron

The chemical composition of pig iron will vary from one type of ore to another but the following is an approximate analysis:

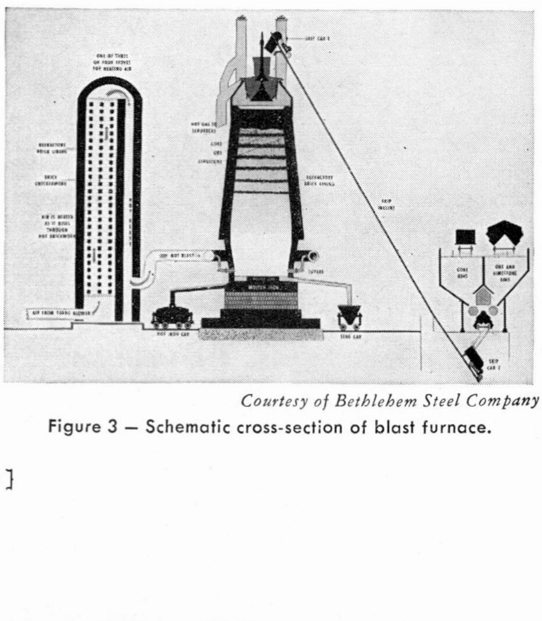
Iron	93.0
Carbon	4.1
Manganese	1.4
Silicon	1.1
Phosphorus	.3
Sulfur	.05

Slag

Slag is an accumulation of most of the undesirable ingredients of the operation. Complex chemical reactions take place at high furnace temperatures, but slag usually contains aluminum, calcium and magnesium oxides, silica, sulfur and phosphorus.

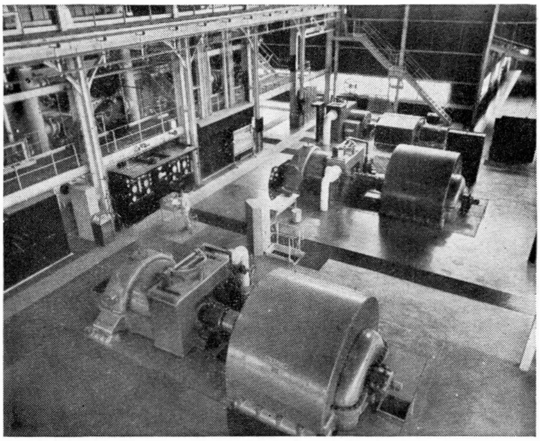
Flue Gas

Flue gas, drawn from the top of the furnace, usually consists of a mixture of carbon monoxide, hydrogen, carbon dioxide, nitrogen, water and sulfur dioxide. The carbon monoxide and hydrogen



Courtesy of Bethlehem Steel Company

Figure 3 — Schematic cross-section of blast furnace.



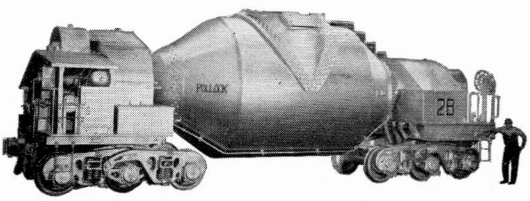
Courtesy of DeLaval Steam Turbine Company

Figure 4 — Steam turbine driven blast furnace blowers.

portions are combustible hence flue gas is used in blast furnace stoves for preheating air, for reheating furnaces, for steam generation, and as fuel in some large internal combustion engines.

Flue Dust

A large amount of iron ore, coke and limestone dust is carried over mechanically with the flue gas and must be removed before the gas can be used for combustion purposes.



Courtesy of The William B. Pollock Company

Figure 5 — 150 gross ton hot metal car.

Materials Balance

The following equation shows the approximate tonnage of materials involved in producing 1 ton of pig iron.

Iron Ore + Coke + Limestone + Air =
(1.93) (0.96) (0.48) (3.95)
Pig Iron + Slag + Gas + Flue Dust
(1.0) (.55) (5.68) (0.09)

It is interesting to note that the blast furnace requires a larger weight of air than the combined weight of ore, coke and limestone.

MANUFACTURE OF STEEL

Pig iron contains certain impurities which impart undesirable characteristics to steel. As will be seen later, the major difference between pig iron and steel is that the former contains as much as 5% of *uncombined* carbon while the latter contains 1% or less of *combined* carbon. In the manufacture of pig iron into steel most of the undesired materials are oxidized and carried off as slag or fumes: the remaining amounts can be tolerated.

The following table shows the approximate composition of pig iron compared to steel and gives an idea of the amount of refining accomplished in the steel making process.

	Pig Iron	Basic Open Hearth Steel
Carbon, %	4.10	0.36
Manganese, %	1.40	0.60
Phosphorus, %	0.30	0.02
Sulfur, %	0.06	0.02
Silicon, %	1.10	0.08

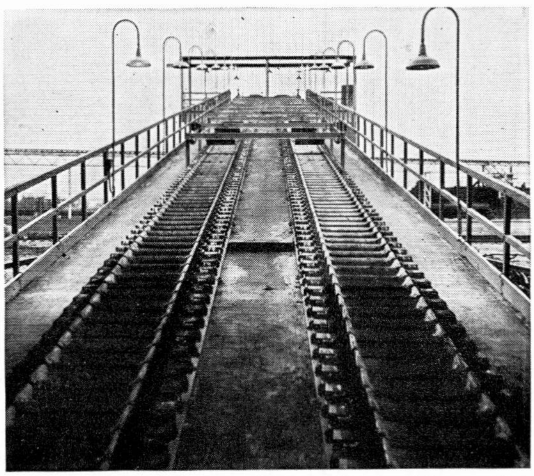
The following gives a brief description of four methods of steel making.

Bessemer Process

In this process a total of approximately 25 tons of molten pig iron (90%) and steel scrap (10%) are placed in the "converter," a brick lined steel cylinder closed at the bottom and illustrated in Figure 7. Air is blown through "tuyeres" in the bottom at 20 to 30 pounds pressure and oxidation of the impurities begins. Two types of the Bessemer process known as "Acid" and "Basic" are used.

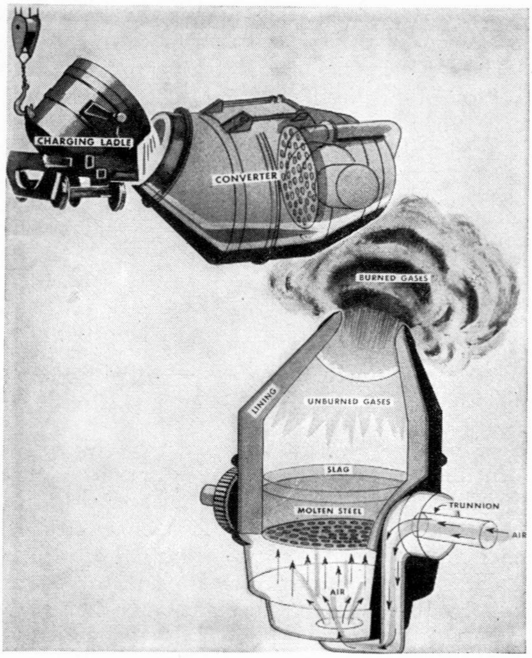
The *acid* process removes most of the silicon, manganese and carbon but does not remove phosphorus and sulfur. In this process the brick lining is of a highly siliceous nature. The nature of the lining has a definite effect on the degree of refinement of the steel.

The *basic* process removes all but a trace of *all* the impurities including phosphorus and some of the sulfur and is therefore suitable for moderately high phosphorus and sulfur ores. This process differs from the acid process in that the converter lining consists of calcined dolomite, and lime is added to the converter mixture and acts as a flux for absorbing impurities.



Courtesy of Heyl and Patterson Inc.

Figure 6 — Combined pig casting machines and conveyors.



Courtesy of American Iron and Steel Institute

Figure 7 — Charging and blowing cycles of Bessemer converter operation.

The Bessemer process requires about 20 minutes to complete. Steel is poured from the converter into a "teeming ladle" which is used either to fill ingot molds, or to charge the steel into open hearth furnaces for further refining.

Open Hearth Process

This process, the most widely used in the United States, employs a large bricklined dish-shaped "hearth" into which a total of approximately 200 to 400 tons of steel scrap (60%) and molten pig iron (40%) are placed. Figure 8 presents a battery of open-hearth furnaces with their charging equipment.

As shown in Figure 9 the hearth is heated by fuel oil or gas flame sweeping across the top of the metal. The undesirable materials (carbon, manganese, silicon, phosphorus and sulfur) are almost completely removed by oxidation or by combination with slag.

This process requires about 8 hours to complete. Molten steel is drawn off into "teeming ladles" from which the ingot molds are filled.

Like the Bessemer, there are two versions of the open hearth process; the "basic" and "acid". In the acid method silica sand is the flux material and in the basic method the lining consists of calcined dolomite and limestone is added as a flux. The latter method removes more phosphorus and sulfur than the former and is better adapted for high phosphorus and sulfur bearing ores.

The Electric Furnace Process

Figure 10 illustrates an electric furnace that is 24 feet in diameter and capable of handling 200 tons of steel in each melt.

Such a furnace can be charged entirely with scrap steel or with a mixture of scrap steel and hot iron. Lime or other flux material is also added.

Heat is derived from electric current applied by huge carbon electrodes extending down through the top of the furnace and barely touching the top of the slag. The impurities are removed by oxidation as in the previous methods, but additional oxygen is supplied by iron ore which is added from time to time. The process requires 5 or 6 hours for completion.

This method is used only for production of stainless steel, carbon tool steels, high alloy steels, aircraft, corrosion resistant and heat resistant steels. It has several advantages such as freedom from contamination of sulfur, positive temperature control and better production of high quality and high purity steels.

This process also utilizes the basic and acid versions in the same way and for the same reasons as in the Bessemer and Open Hearth processes.

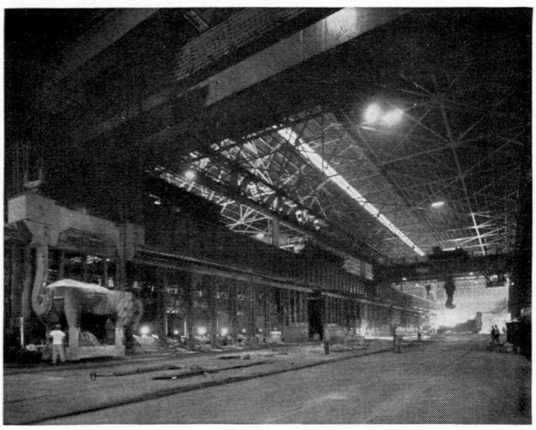
The electric furnace can be tilted slightly for drawing off the molten steel into ladles from which ingot molds are filled.

The Basic Oxygen Process

This newly developed process, diagrammed in Figure 11 has just recently been put into operation. The oxygen converter furnace has a cylindrical shape and is lined with basic-type refractory material. It can be tilted to remove slag and to pour steel into ladles.

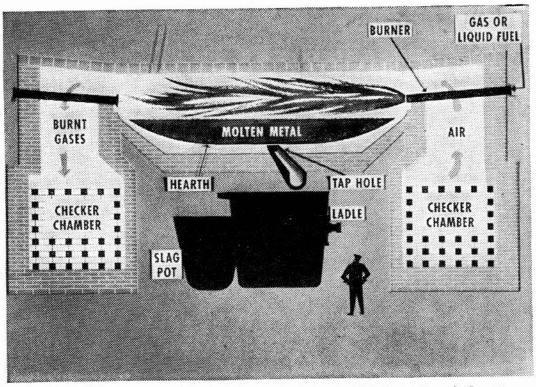
The charge usually consists of scrap and molten iron along with limestone or other slag forming materials.

The oxidation of the contaminating materials is



Courtesy of Koppers Company Inc.

Figure 8 — Battery of open hearth furnaces.



Courtesy of Bethlehem Steel Company

Figure 9 — Schematic cross-section of open hearth furnace.

started by a jet of pure oxygen impinging on the surface of the molten metal. Heat derived from the exothermic oxidation of carbon, silicon and manganese is sufficient to keep the charge molten and to support the refining action.

The furnace will produce approximately 50 tons of steel in 35 to 40 minutes.

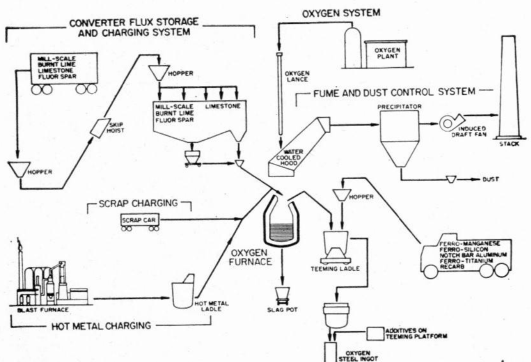
The steel produced by this method is low in sulfur and phosphorus content and is considered to have a high degree of purity.

The use of oxygen has been gaining acceptance gradually over the last 10 or 12 years in the normal production of steel in several ways:

1. For introduction into burners of open hearth furnaces.
2. For "jetting" into electric furnaces.
3. For enriching the air blast in the Bessemer converter.
4. For enriching the air blown through the blast furnace.

Many advantages are claimed for the use of oxygen including:

a. Shorter heats and increased production.
b. Lower cost of fuel which helps compensate for the cost of oxygen.



Courtesy of Jones & Laughlin Steel Corporation and Air Products Incorporated

Figure 11 — Material flow diagram for basic oxygen.

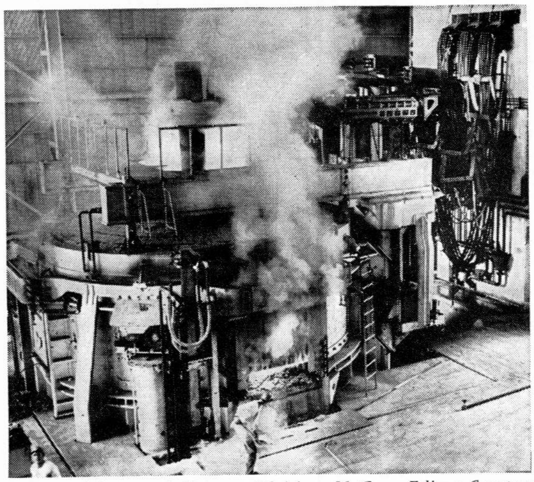
c. Reduction in nitrogen content of steel.

Several steel mills now manufacture oxygen for use in various processes and in many cases production amounts to well over one hundred tons daily.

In the Bessemer, open hearth, electric and basic oxygen methods of steel manufacture, various amounts of other metals are added to refined steel in the molten state to produce the types of alloys required for specific purposes.

ROLLING OF STEEL

Ingots are provided in various shapes and sizes of suitable dimensions for hot rolling. The molds in which they are formed are made of cast iron with thick melt-resistant walls, are frequently corrugated, and are slightly tapered from top to bottom to enable the mold to be lifted easily from the ingot.



Courtesy of Lectromelt Furnace Division, McGraw-Edison Company

Figure 10 — 24 foot diameter 200 ton capacity electric furnace.

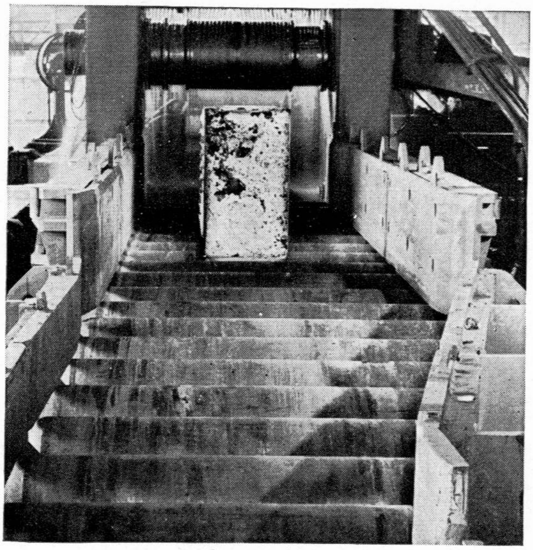
Soaking Pits

After removal, the ingots are transported on flat cars to gas-fired "soaking pits." At this point they are too cool on the outside and too hot on the inside for mechanical forming or rolling. They are therefore held or "soaked" in the pits until the temperature is equalized throughout the whole mass.

Blooming and Slabbing Mill

Ingots at the proper temperature (usually around 2100°F.) and weighing from 4 to 15 tons are lifted by cranes from the soaking pit one by one and put through a "blooming" or "slabbing" mill such as shown in Figure 12. This is usually a "2 or 4 high mill" with rolls which are suitable for rolling flat slabs, cylindrical, rectangular or various other shaped blooms.

The ingot is passed back and forth through the rolls and turned on its side occasionally until the resultant "bloom" has the desired size and shape,



Courtesy of The Morgan Engineering Co.

Figure 12 — White-hot ingot on back mill table of blooming mill.

the whole operation being controlled by an operator in the "pulpit."

The bloom, now thinner but several times longer than the original ingot, is carried on conveyor rollers to a "slab shear" or "bloom shear," shown in Figure 13, where it is cut into several "slabs" of suitable length for further rolling operations.

The flat slabs, or other shaped blooms, still hot, are charged into the rear end of a slab reheating furnace. They travel slowly through the furnace and are brought up to suitable temperature for further rolling. They are discharged when needed at the front end of the furnace onto a furnace table.

Hot Strip Rolling

Hot *slabs* from the reheating furnace are conveyed on tables to the following successive stands of a "hot strip mill," such as shown in Figure 14.

Roughing Stands

The slab passes through a scale breaker and a series of several roughing stands. Water under high pressure is sprayed over the surface to crack and wash off scale.

Finishing Stands

The elongated slab then passes to the finish-train which includes another scale breaker and several finishing stands which reduce the metal (still hot) to the desired thickness.

The elongated strip is then conveyed over a line of table rolls to a coiler which rolls up the strip which is then held for further processing. As the strip passes over the table rolls, water is usually applied to cool the metal before it is coiled. Quenching in this manner reduces the amount of iron oxide scale formation.

Pickling Operation

The coils from the hot strip mill are unrolled and passed through a hot acid bath to remove oxide from the surface, then through a water washing bath to remove the acid and finally dried with hot air, oiled and recoiled.

Cold Strip Rolling

The strip is then usually put through several stands of a four-high tandem cold reduction mill such as illustrated in Figure 15. Roll oils are used in this operation to provide lubrication and prevent scratching of the surface.

The coils are then *annealed* in an oven or a continuous annealing line to relieve internal stresses.

After annealing, the "temper pass" mill provides the final finish and hardness to the strip before it is shipped to the customer. Sometimes coils are shipped in coil form and at other times they are cut up into specified lengths and shipped in stacks. A rust proofing or slushing oil is usually applied before shipment to provide rust protection.

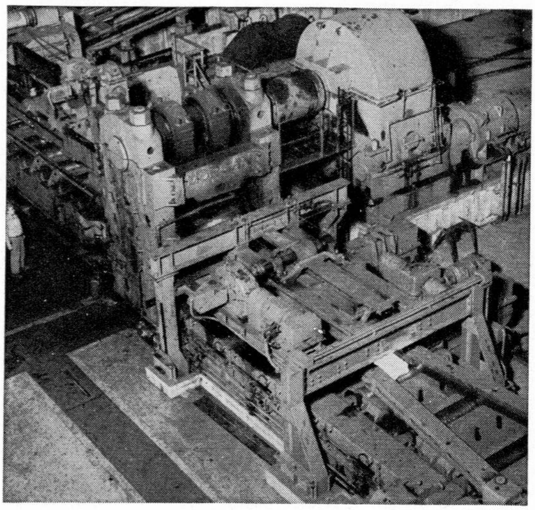
Plate Rolling

Sheets above ¼ inch thick are considered plates. Armor plate may be up to 10 inches in thickness.

Steel slabs are "scarfed" before heating by chipping hammer or torches to remove cracks or other surface imperfections.

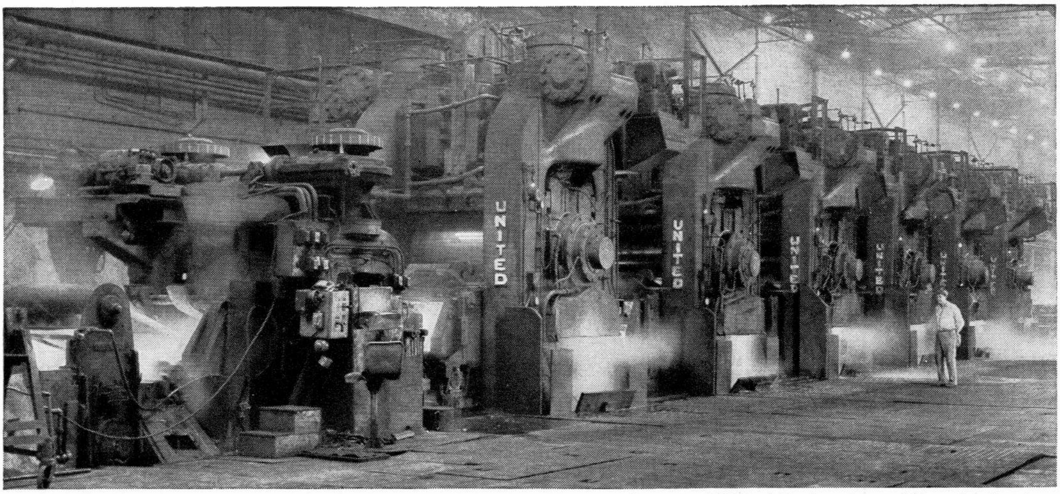
After being heated to a red heat in a furnace the slabs are run back and forth several times through a single stand rolling mill (2, 3 or 4 high) to get the proper width and thickness.

Plates are then put through a leveller or plate straightener, like that shown in Figure 16. Several passes may be necessary to get them perfectly flat. They are then sheared to the desired size.



Courtesy of The Morgan Engineering Co.

Figure 13 — Slab shear, 600 ton pressure.



Courtesy of United Engineering and Foundry Company

Figure 14 — 54 inch four-high six-stand tandem hot strip mill.

Plates are then carried by rollers to cooling beds to cool off, after which they are picked up by magnet cranes and piled up in stacks.

Seamless Tube Rolling

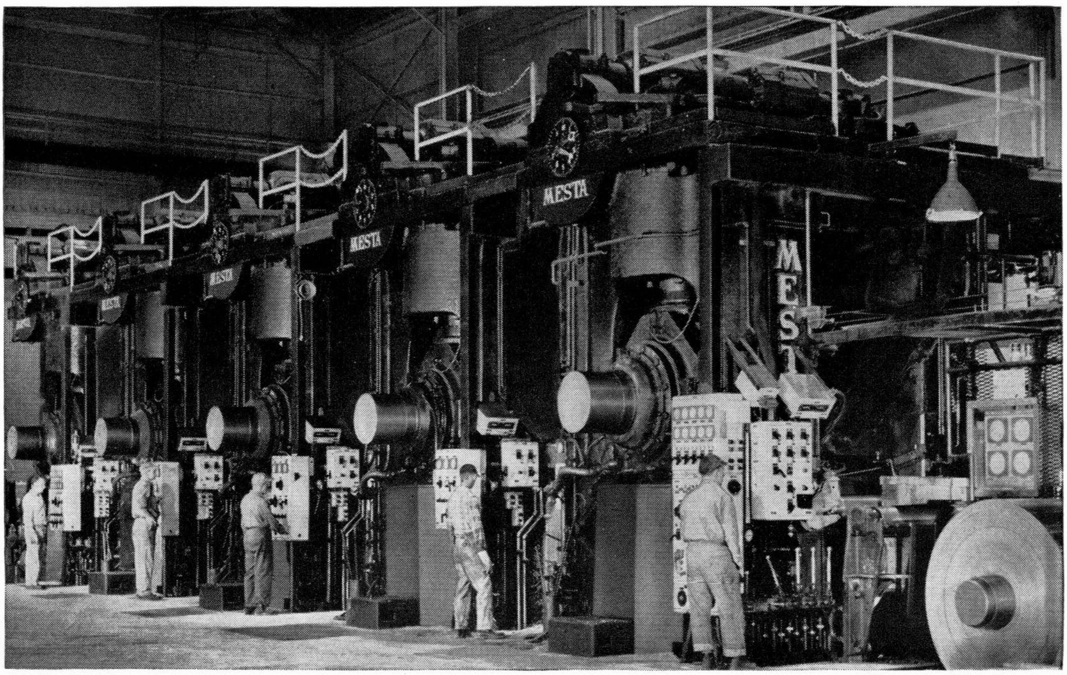
Cylindrical blooms are heated in a reheating furnace to a red heat and then run through piercing machines where a hole is pierced through the center of the billet making a tube with no side seams.

The tube is then run successively through a sizing mill to bring it to the right size, a straightener which also cracks off scale and then is sawed off to the desired length.

When seamless steel oil-field drill-pipe is being manufactured, the ends are heated and put through an "upsetter" which condenses the end providing extra thickness before the ends are threaded.

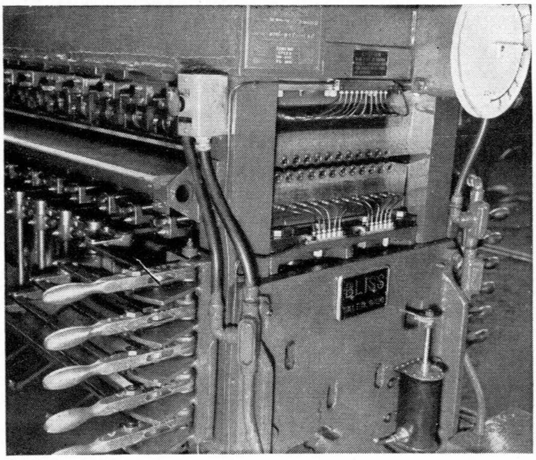
Skelp Rolling

Rectangular blooms are heated in a furnace and rolled out into "skelp" which is about 6 to 12 inches wide and ¼ to ⅜ inch thick. The process



Courtesy of Mesta Machine Company

Figure 15 — 48 inch four-high five-stand tandem cold reduction mill with coil winder.



Courtesy of E. W. Bliss Company

Figure 16 — Leveler or straightener.

is similar to plate rolling but the machines are smaller and there are usually a series of stands in tandem.

Skelp is usually made into welded-seam pipe by heating in a continuous furnace and passing through a series of roll stands where pipe is formed and the edges welded. The pipe is then sawed to desired length by a "flying hot saw." Then it is cooled, straightened and threaded.

Bar and Rod Rolling

Square billets 2x2 and 4x4 inches are heated and rolled in a series of roughing stands in tandem and then follow a looping course through intermediate stands, as portrayed in Figure 17.

The bars are run on to a cooling bed, then cut to desired length and straightened.

The rods usually proceed directly to "laying" or "pouring" reels where they are wound into coils for later processing into wire or other products.

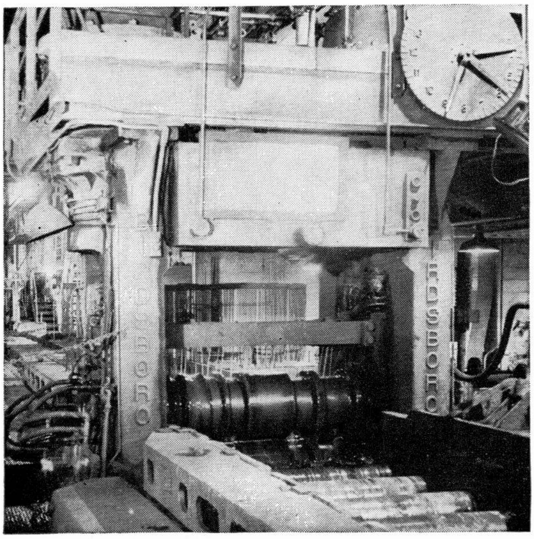
Structural and Rail Rolling

Shaped blooms are heated and rolled in a series of roll stands with specially grooved rolls designed for the desired finished product. The blooms are passed back and forth several times and then run through a series of intermediate and finishing stands until they arrive at the proper size and shape. Figure 18 shows the initial roughing stand for a structural or rail mill.

The structural steel or rails are cut to desired length with "flying hot saws" and passed on to the

Courtesy of United Engineering and Foundry Company

Figure 17 — Bar mill.



Courtesy of Birdsboro Steel Foundry and Machine Company and Allegheny-Ludlum Steel Corporation

Figure 18 — 22 inch reversing blooming mill for rolling structural shapes.

cooling beds. After cooling they are straightened and in the case of rails the ends are hardened.

Wire Drawing

The coil from the rod mill is pickled in acid to remove rust and scale then washed to remove the acid. It is then coated with lime slurry and baked in an oven to dry the lime.

Then it is passed through wire drawing machines which draw it through dies of successively smaller sizes to reduce it to the desired size and then annealed in a molten lead bath. After this it may be galvanized or coated with lacquer or paint.

TYPES OF LUBRICANTS AND THEIR APPLICATIONS

The steel industry today utilizes greater power and speed to satisfy the increasing demands for greater production. The motors, turbines and engines that produce this power require gears that have greater toughness and higher precision than ever before in order to transmit this power into desired channels. As an example of the tremendous power used in a modern steel mill, Figure 19 shows a rolling mill drive reduction gear which transmits 5500 horsepower.

It is common practice for operators to deliberately overload gears by double or triple their rated capacity in order to increase production. This overloading, of course, will eventually shorten the life of the gears. This can be counteracted partially but not completely by the use of heavy duty lubricants. The heavy cost of gear replacements is felt by some to be justified by the increased volume of material produced.

Types of Gear Lubricants

Due to the variations in steel mill operating conditions, several types of gear oils are required to provide adequate lubrication. The following types are generally used:

Heavy Residual Oil

The following variations of this type are available:

1. Straight Mineral

   These are heavy, very adhesive oils derived from the residuum remaining after distillation of the lighter fractions from certain petroleum oils. They are quite widely used on exposed spur, bevel and herringbone gears on machines in steel, cement, rubber and other mills where speeds are under 100 RPM.

2. Polar Type Additive

   Polar additives are sometimes used with the residual oil to provide better adhesion of the oil to gears operating under adverse water conditions.

3. Cutback Type

   Heavy residual type oils are often cut back with light petroleum thinner or chlorinated solvents. The purpose of this type is to provide ease of application. After application the solvent evaporates, leaving a coating of heavy residual oil.

   Care must be taken with the use of these products if used in an enclosed location. The petroleum thinner may present a fire hazard and chlorinated solvent vapors can be toxic to operators.

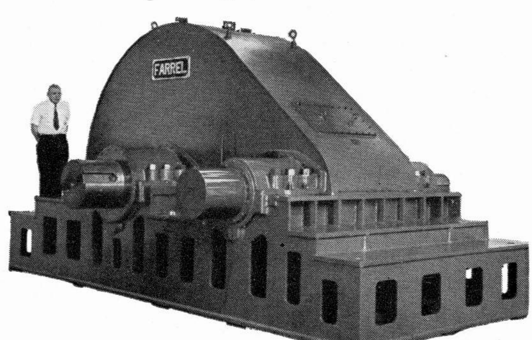
4. Extreme Pressure Additive

   Extreme pressure additives are sometimes incorporated into the heavy residual type to provide added protection for gears under conditions of very heavy load.

Intermediate Viscosity Oil

Several varieties of mineral oils are in use:

1. Straight Mineral Cylinder Oils are often used on spur, bevel and herringbone gears under normal operating conditions.



Courtesy of Farrel-Birmingham Company Incorporated

Figure 19 — 5500 horsepower rolling mill drive.

2. Compounded Cylinder Oils are recommended for bronze-on-steel worm gears and others (except hypoid) where thin-film lubrication conditions prevail. The fatty additive gives added adhesion and improved lubrication.
3. Turbine Grade Straight Mineral Oils of lower viscosity are often used for high speed helical and herringbone single reduction gears where speeds are comparatively high (several thousand RPM). They are very resistant to deterioration due to heat which may develop during operation.

Extreme Pressure Oils

Mild EP oils containing lead soap along with other EP additives such as sulfur, chlorine or phosphorous compounds are recommended for all gears especially where they operate under heavy duty conditions such as high speed-low torque, high torque-low speed, shock loading, high pressures or high speeds.

The EP additives in these oils become chemically active when local "high spots" develop high temperature due to friction. Chemical compounds of these additives with iron are formed on the spots, and they provide additional lubrication. This prevents tearing or scuffing and permits gears to operate without imminent failure.

Methods of Application To Gears

Due to the numerous varieties, sizes and locations of gear assemblies in a steel mill, several methods are employed for application of lubricant to the gears including the following:

1. By Paddle

Heavy residual oils are often applied to open gears by paddle. Too much is usually provided and the excess is thrown off into the surrounding area.

This, of course, is very wasteful, and presents a poor appearance.

2. By Hand

Residual-type lubricants are sometimes formed into a ball by hand and dropped into the gear mesh. This method was later improved, and the lubricant is now often marketed in small plastic bags. These are dropped through the lubricant opening, and the bags are eventually chewed to bits by the gears. This is a much cleaner operation than the former.

3. By Drip

In some gear sets, the softer types of lubricant including the cut back variety are dripped slowly on to the gears.

4. By Pouring

In some cases the lubricant is poured at intervals from a container on to the gears.

5. By Bath

The fluid type lubricants are often placed in a sump or bath in the bottom of the enclosed gear set. One of the gears dips into it and lubricant is transferred to the contacting gears. The excess is thrown against the housing and is guided by means of troughs into the bearings or back to the sump.

6. By Idler Gear

In many instances on slow moving gear assemblies, an idler gear dips into a sump and transfers its lubricant to the other contacting gears.

7. By Circulating System

In systems such as runout tables involving numerous gears, lubricant is pumped from underground tanks to the gear sets and then returns to the tank. Lubricants used in these systems occasionally are contaminated with water and mill scale and have to be reclaimed by settling, filtering and centrifuging.

8. By Spray

During the last decade automatic spray application on open gears has gained considerable prominence.

A controlled amount of lubricant can be sprayed over the gear surface at desired intervals, and the cycles can be controlled automatically or manually.

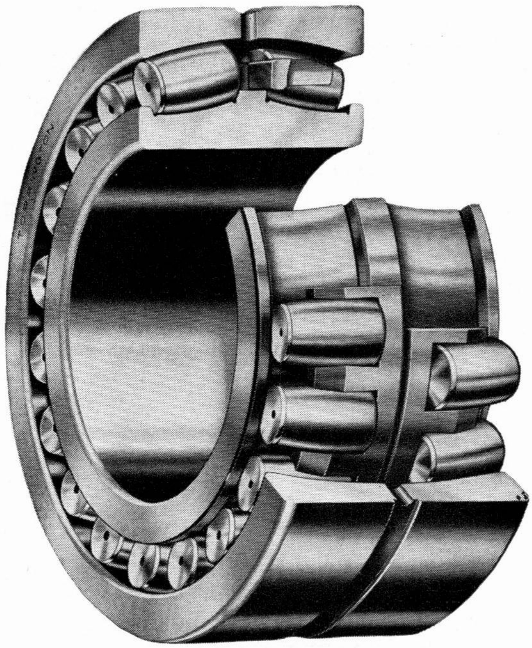
Size and shape of spray patterns can be controlled by use of various types of nozzles, distance from nozzle to target, pressure and temperature of lubricant.

The spray is usually applied on the pressure side of the gears prior to meshing. It has been found that application directly at the point of mesh is often faulty due to air turbulence at that location.

Heavy lubricants are usually used on open gearing, but experience has also shown that they can be applied by spray without difficulty. The limiting factor is the pumpability of the lubricant at the temperature of application. The use of solvent as a cutback for the very heavy residual type provides greater ease of application.

Spray application is being used on many types of steel mill equipment, some of which would normally be very difficult to lubricate. A few examples are listed below:

- Ring gear on blast furnace distributor.
- Mill table bevel gears.
- Table roll bearings, line shaft bearings and bevel gears on mill tilting tables.
- Plain rollneck bearings on blooming and slabbing mills.
- Chains, cams, eccentrics, slides, ways, dies and rollers.



Courtesy of The Torrington Company

Figure 20 — Self-aligning spherical roller bearing.

Large bevel-gear lineshaft drives of bar and rod mills and billet mills.

In comparison with manual methods of application, the spray method is claimed to have the following advantages:

a. Minimizes waste and contamination.
b. Saves man hours in application.
c. Eliminates accident hazards particularly on open gears.
d. Provides smooth, even coating.
e. Minimizes spoilage due to drippage on material being processed.
f. Provides ease of application to difficult locations.

9. Airborne

Oil mist or fog is being used to advantage in many mills for lubrication of both gears and bearings. Further details are given in another section of this article.

Lubrication of Roll Neck Bearings

The proper lubrication of roll neck bearings is a very important matter in heavy steel mill rolling equipment for several reasons. They represent a major investment, and great care must be taken to maintain them in condition to give precision performance. Any lubrication failure can be very costly by reason of lost production when it is necessary to close down the mill. There are four types of roll neck bearings and each has its own lubrication problems.

Antifriction Type (*Roller Bearings*)

These bearings are normally used on the work-rolls of all types of rolling mills including blooming, slabbing, plate, structural, hot strip, cold reduction, temper, structural, bar and rod mills. Figure 20 illustrates a self-aligning spherical roller type. Figure 21 shows a 4-row type roll neck bearing. Most work-roll antifriction bearings are lubricated by grease. However, back-up rolls are often equipped with roller bearings and are frequently lubricated with straight mineral oil or mild EP gear lubricants which are pumped through them. These "circulating oils" have the advantage of cooling the bearings.

Greases used for this purpose must have high quality and must operate under a variety of adverse conditions like the following:

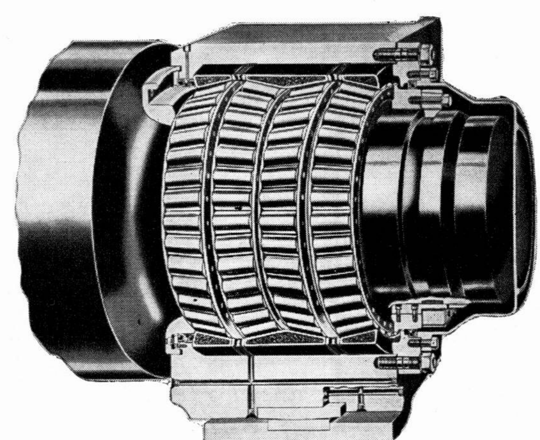
1. Exposure to extremes in temperature

Grease should be easily pumpable at low ambient temperatures which often prevail in cold weather. On the other hand, the grease must have sufficient body to lubricate properly when ambient temperatures are high such as when there is high heat radiation from hot steel being handled. Grease must also have sufficiently high dropping point so that it will not leak out of bearings. Such leakage will impair lubrication and will also contaminate the surface of steel being rolled and it may also contaminate the roll solution in cold reduction mills. Summer and winter grades with high dropping points are usually required to give all-year-around satisfactory performance.

2. High Pressure Operation

Roll necks are subjected to excessively high pressures and for this reason *extreme pressure* type greases are usually required. Bearing manufacturers specify extreme pressure type lubricants to give better protection and longer life to the bearings.

3. High Degree of "Working"



Courtesy of The Timken Roller Bearing Company

Figure 21 — 4-row type roll neck bearing.

Courtesy of Mesta Machine Company

Figure 22 — Oil lubricated plain type roll neck bearing.

Grease should have good shear stability to enable it to resist being worked down to a semi-fluid consistency. Greases with poor shear stability have a tendency to leak out of the bearings.

4. Water and Mill Scale Contamination

Water is used in large quantities in the manufacture of steel. When bearing seals are not kept in the best condition, a certain amount of water and mill scale contamination will gain entrance to the bearing. The better types of grease will absorb water to a certain degree without forming a fluid type emulsion that would run out of the bearings. The grease also should be very adhesive to metal under bad water conditions, should retain its original consistency, and should resist being washed away.

5. Roll Oil Contamination

In cold rolling operations, roll oils often gain entrance to the bearings and will have a softening effect on the grease. This is liable to thin it out to a point where lubrication is impaired.

Types of EP Roll Neck Greases

The ideal type of roll neck grease would be a single grade that would handle all adverse operating conditions during all seasons. The ultimate "all-purpose" product is still under development with these objects in mind.

There are seven types of EP steel mill greases in general use in roll neck bearings, and together they provide suitable coverage for handling all types of adverse operating conditions. The proper type is usually chosen after considering temperature, load, speed and contaminating influences.

These products contain EP additives and usually have EP test ratings in the intermediate or higher range. They contain medium-high viscosity mineral oil (around 70-75 seconds SU at 210°F.), and they are normally available in three penetration grades that enable easy handling under various ambient temperature conditions. Prominent characteristics of the various types are shown below:

A. Calcium Soap Base Grease
   Low dropping point (200°F.).
   Fair resistance to water washing.
   Medium shear stability.

B. Lithium Soap Base Grease
   High dropping point (360°F.).
   Medium resistance to water washing.

C. Anhydrous Calcium Soap Base Grease
   Medium high dropping point (275°F.).
   Excellent shear stability.
   Good resistance to water washing.

D. Calcium Acetate Stabilized Grease
   High dropping point (500°F.).
   Good resistance to water and roll oil washing.
   Very good shear stability.

E. Silica-Thickened Greases
   High dropping point (500°F.).
   Good resistance to water and roll oil washing.
   Very good shear stability.

F. Urea-Thickened Greases
   High dropping point (475°F.).
   Good resistance to water washing.
   Good shear stability.

G. Rheopectic Lithium Soap Base Grease
   High dropping point (340°F.).
   Hardens in service by 1 or 2 NLGI Grades.
   Good "slumpability" in drums.
   Low pressure pumping in long lines.

Plain Babbitt and Bronze-Grid Type Roll Neck Bearings

Plain babbitt bearings with bronze inserts are still being used on roll necks of Blooming, Slabbing, Bar and Rod Mills, Structural and Plate Mills. The inserts are usually 4 to 6 inches wide and are located one on the bottom (or top) and two on the sides of the bearing. The function of the bronze inserts is to strengthen the bearing and to resist squeezing out of the babbitt material under high loads.

Three methods are used in various mills for lubricating these plain bearings.

1. Hand Packing

The older method of hand packing, with a hard lime-tallow soap grease containing powdered graphite, is still in use in some mills. The grease must be pressed frequently against the necks and fillet in order to maintain sufficient film of grease on the radial and thrust areas of the roll neck.

2. Centralized Greasing

Application of a soft grease by means of a centralized grease system is used in many mills. Grease is usually supplied through grease grooves in the bronze inerts and in the thrust collar. This type of lubrication has increased bearing life considerably.

3. Spray Application

Recently a new method has been devised for application of an adhesive EP gear oil to the plain bearings. Lubricant is supplied at desired intervals to several spray nozzles mounted near the roll neck. Compressed air at the nozzle atomizes the oil and sprays it on the roll neck and fillet. The advantages of this method are elimination of grease grooves in the bearing, direct application to the roll neck, low lubricant consumption and greatly extended roll neck bearing life. This method of application is in the development stage.

In the above rolling operations a considerable volume of water is sprayed on the roll necks to dissipate heat conveyed from the barrel of the roll. The lubricants used must therefore be very adhesive to metal and must resist water washing.

Composition Roll Neck Bearings

Sleeve type composition bearings, consisting of fabric impregnated with plastic materials, have been used successfully for a number of years on roll necks on skelp, bar and rod, and structural mills.

Cool water applied under low pressure and in copious amounts usually provides sufficient lubrication for these bearings. However, it is necessary for the water to be cool, clean and free from dirt and chemicals. If any of the above adverse conditions exist, grease should be applied along with the water.

Grease is usually applied through a chamfered hole in the bearing or through grease grooves. Soluble or non-soluble greases are equally satisfactory. Lithium, calcium and sodium base greases have been used with considerable success. Grease application should be kept at a minimum so as not to interfere with the proper flooding of the bearing with water. The fabric bearing incidentally requires only about ⅓ the amount of grease normally required for other type plain roll neck bearings.

Plain Oil Film Type
Back-Up Roll Neck Bearings

Plain back-up roll neck bearings, such as illustrated in Figures 22 and 23, operate under very adverse conditions of heat, water, and shock loading. The circulating oil used for lubrication of these bearings must be of highest quality to enable the rolling mills to operate with the required precision. Heavy loads require the use of high viscosity straight mineral oils ranging in S.U. viscosity* from below 600 to above 2500 seconds. Viscosity requirement is usually determined by the bearing manufacturer and is calculated on the basis of temperature, speed and load conditions involved. Back-up rolls carry most of the load on 4-high mills. Operating conditions are very severe, and the lubricants become contaminated with roll oil, water, mill scale and dirt. This contamination, in addition to normal oxidation of the oil, forms an accumulation of sludge in the oil. Most of the contamination will settle out in the tank and can be drawn off the bottom. The rest can be removed by centrifuging in equipment like that shown in Figures 24 and 25.

Most circulating oil systems are equipped with two tanks, each with a capacity up to 10,000 gallons or more. These tanks are used alternately and after several weeks use the oil in one tank is reclaimed, while oil in the other tank is put in service. Reclaiming is accomplished by heating, settling, filtering, and centrifuging. In Figure 26 the two tanks are actually separate although they have a common interior wall. At times, especially after extra long rugged service or after contamination, tight emulsions with water may be formed and it may be necessary to use an emulsion breaker to eliminate the water.

This type of circulating oil should have the following properties:

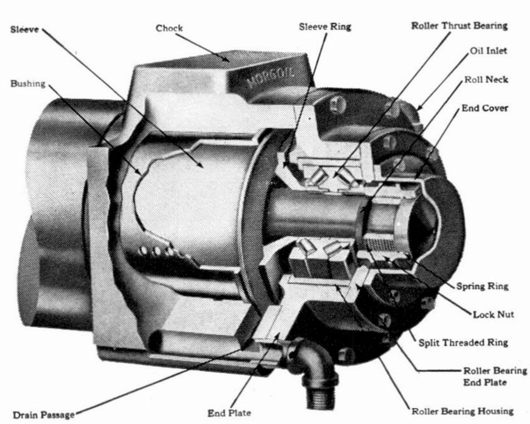
1. Should separate easily from water, should resist formation of emulsions, and should retain these characteristics after a long period of use.

2. Should possess inherent resistance to oxidation to provide long oil life.

3. Should have the proper viscosity and viscosity index for use at the operating tempreature involved.

Roll Oils

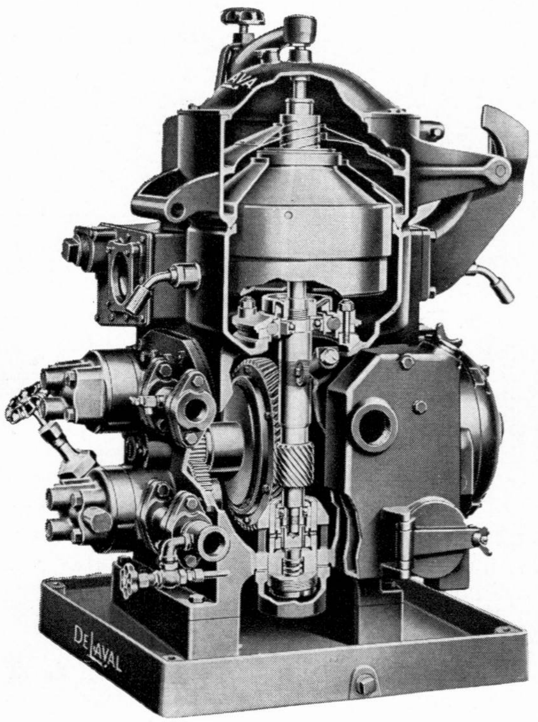
Roll oils are usually used only in cold processing of flat stock such as sheets, plates, strip steel or tinplate. They are applied to the steel just before it passes through the rolls in cold rolling operations, usually by dripping from nozzles or by spraying on the upper and under side of the sheets. Roll oils are not used in hot rolling operations.



Courtesy of Morgan Construction Co.

Figure 23 — Cutaway view of precision sleeve type backup roll neck bearing with roller end-thrust unit.

*at 100°F.



Courtesy of The DeLaval Separator Company

Figure 24 — Centrifuge.

Function of roll oils

During the cold rolling process the steel is subjected to very heavy pressures which reduce it to the thickness required for the intended use. Considerable heat is developed chiefly from internal friction due to metal deformation.

Roll oil has the following general functions:

1. To lubricate steel as it passes through the rolls. This prevents scratching of the metal.
2. To protect the highly polished rolls from surface damage.
3. To provide sheets with a bright and smooth finish.

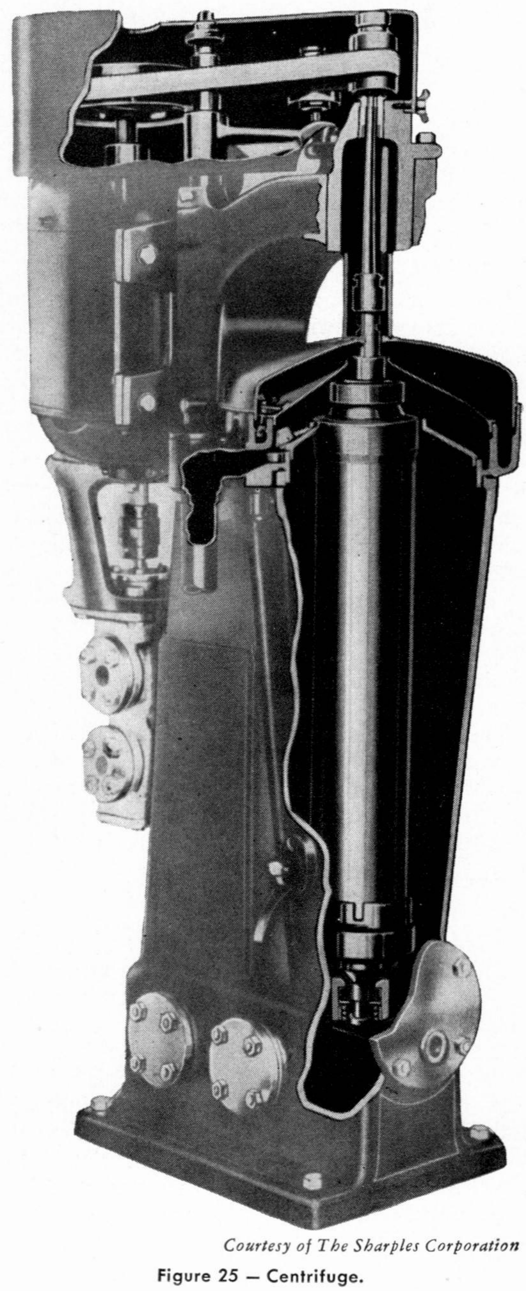
Desired characteristics

There are several properties that are required in a good roll oil, such as:

1. It must be heavy enough to provide proper lubrication but not so heavy that it will cause slippage as the steel passes through the rolls.
2. It should have the proper balance between "lubricity" and "bite". (In some roll oil blends these characteristics are controlled by the use of fatty oils for the former and water for the latter.)
3. It should not cause a heavy stain to form during subsequent annealing. (Use of proper type oil is necessary.)
4. It should have good wetting or spreading properties, especially in tin plate rolling (palm oil and other polar type materials have this characteristic).

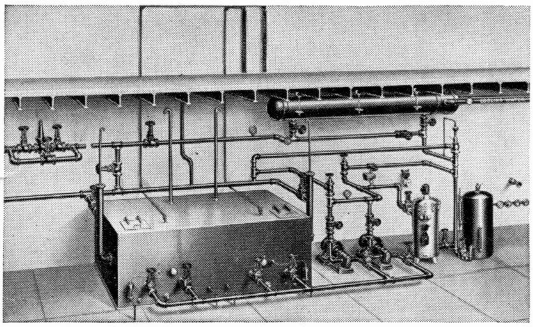
Types of roll oils

No two rolling operations are exactly alike in respect to speed, pressure, type of steel or amount of reduction. Mill operators feel that each set of conditions requires a different roll oil formulation to give desired results. For that reason, a great



Courtesy of The Sharples Corporation

Figure 25 — Centrifuge.



Courtesy of Bowser Incorporated

Figure 26 — Circulating oil settling and filtration system.

variety of rolling solutions are used including the following:

1. Palm oil, straight.
2. Palm oil mixed with 8 to 10 parts of water.
3. Palm oil mixed with soluble oil and water emulsions.
4. Palm oil blended with straight mineral oil.
5. Straight mineral oils (Viscosity 100 to 200 seconds SU at 100°F.).
6. Straight mineral oil (Viscosity 100 to 200 seconds SU at 100°F.) blended with fats or other polar materials.
7. Palm oil substitute (usually consisting of hydrogenated fat) mixed mechanically with water and emulsifiers.
8. Straight soluble oil.
9. Soluble oil emulsified with water.
10. Special soluble oils emulsified with water.
11. Sendzimir Mill roll oils.

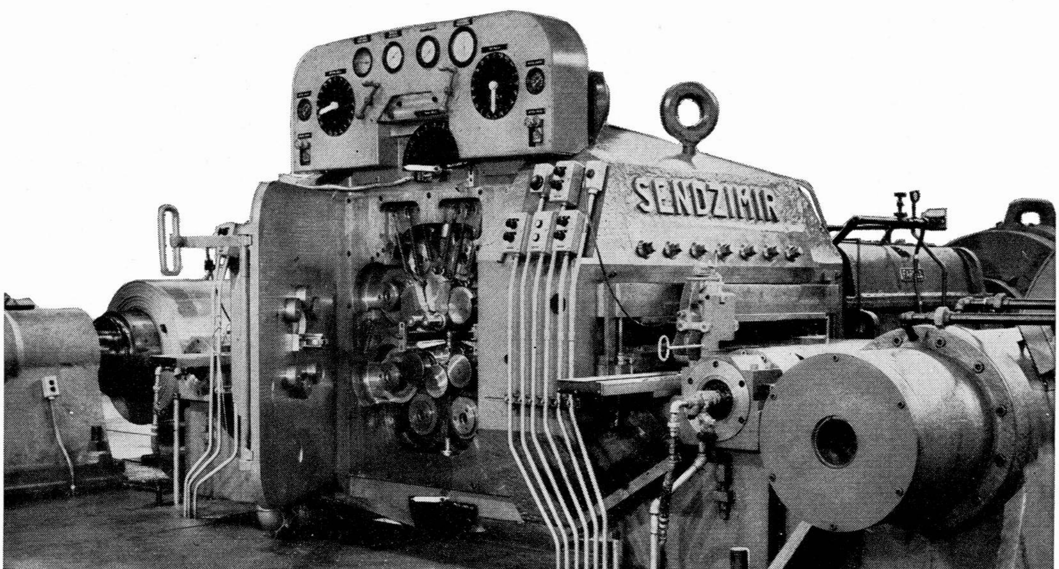
Palm oils and *palm oil blends* are generally used for rolling tin plate. It is necessary to remove all traces of oil by electrolytic or other methods before tin or other metallic coatings can be applied. (Palm oils and blends are also used for rolling sheet and plate steel.)

Straight mineral oils are used in rolling heavier gauge steel where speeds are comparatively slow and reduction in gauge is not heavy.

Straight mineral oil blended with fat is used where more "lubricity" is needed and where better finish is desired.

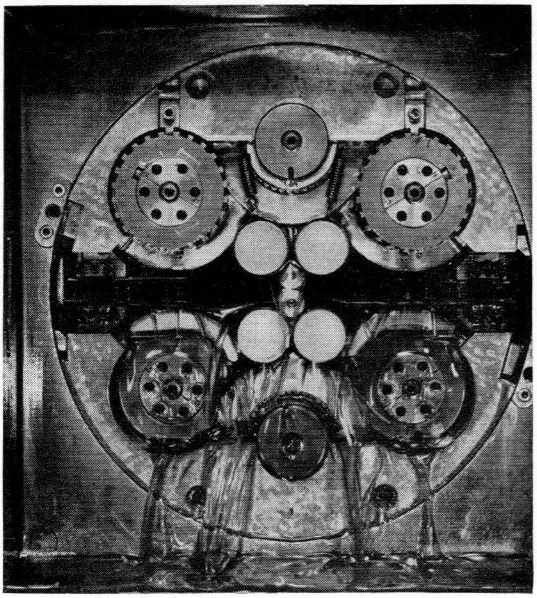
Palm oil substitutes (which usually contain fatty or other polar material) are gaining prominence for rolling sheet, plate, and in some cases tin plate. Palm oil substitutes were developed to replace palm oil, which is expensive and difficult to obtain at times.

Soluble Oils are used in certain rolling blends because they help to form an emulsion with palm oil or mineral oil which may be used with them.



Courtesy of The Waterbury-Farrel Foundry & Machine Co.

Figure 27 — 49 inch strip Sendzimir reversing mill with 2⅛" work rolls.



Courtesy of The Waterbury-Farrel Foundry & Machine Co.
Figure 28 — 8½ inch strip Sendzimir reversing mill showing ⅞ inch work rolls and flooded lubrication.

For some rolling operations ordinary soluble oils (straight) or soluble oil emulsions can be used to advantage.

Special soluble oils containing emulsifiers and sizeable quantities of saturated fats are blended with various percentages of water to provide a balance between "lubricity" and "bite".

Sendzimir Mill Roll Oils are used in the mill illustrated in Figure 27, a relatively recent and quite unique design that is particularly adapted to cold-rolling both ferrous and non-ferrous metals in very thin section (such as foil) where uniformity of thickness across the strip and fine surface finish are of paramount importance. This is accomplished by using finely finished work rolls (those in direct contact with the work) of relatively small diameter, each of which is supported throughout its length by an ingenious arrangement of two series of back-up rolls. Again, unlike conventional mills, the Sendzimir's two work rolls are driven purely and indirectly through frictional contact with their back-up rolls. Work rolls less than 2⅛ inches in diameter are the rule, and rolls ⅞ inch in diameter are regularly used.

Roll oil for a Sendzimir is a specialized product because, in addition to its normal function as a roll oil, it must also act as a lubricant for the mill's many roller bearings and as a coolant. Figure 28 shows how the work and working parts of the mill are literally flooded with roll oil. The mill illustrated in Figure 27 is provided with a 9000 gallon oil reservoir and oil is circulated at a rate of 600 gallons per minute.

The following types of Sendzimir Roll Oils are in use:

A. Straight Mineral Oil

Straight mineral oil with viscosity of about 100 seconds (SU) at 100°F. is satisfactory for mild rolling operations.

B. Mild EP Type

A straight mineral oil blended with mild EP and possibly other additives has a decided advantage in eliminating "heat streaking" on ferrous sheet in units where speed and pressures are critical. It may also contain an oxidation inhibitor to provide long oil service life and a rust inhibitor to protect the mill itself.

C. Soluble Oil Type

Specialized types of soluble oil emulsions (20% oil-80% water) are being tested in a limited number of Sendzimir mills for rolling high, medium and low carbon steel. Apparently, rolling of stainless steel with soluble oil has not been too successful because the desired luster can not be obtained.

The advantages of soluble oil emulsion are:

1. The strip runs about 100°F. cooler than with mineral oil and mills can roll much faster because of better heat removal.
2. The distortion of strip is minimized.
3. The mill and the atmosphere around it are cleaner due to absence of oil vapor.

The use of soluble oil emulsion has two disadvantages:

1. Mill roller bearings wear out faster due to deficiency of lubrication.
2. The emulsion must be discarded after about a month's service due to contamination with fine metal and sludge which can not be removed satisfactorily.

Rust proofing or "Slushing" Oils

Rust prevention is very important whenever finished steel sheets, coils, bars or other shapes are transported from one place to another or are stored for any period of time. Rust cannot be tolerated on many types of steel products because subsequent processing demands absolutely clean metal surfaces.

Rust is the result of oxidation of steel or iron in the presence of moisture. The latter must be present, for there is very little reaction between oxygen and the metal at normal temperatures if the metal is absolutely dry. The presence of moisture on metal surfaces may be due to incomplete drying during processing, or it may be the result of condensation of moisture from the air, especially in a humid atmosphere when temperature changes take place.

Finished steel is usually covered with a coating of rust proofing or "slushing" oil before it is crated or wrapped in waterproof paper for shipment or storage.

The slushing oil has three functions:

1. To prevent rust formation on surfaces during storage or shipment.
2. To furnish lubrication between the metal pieces to prevent surface scratching during shipment.
3. To provide, in some cases, a lubricant for subsequent drawing operations in plants where the steel is fabricated.

Three types of slushing oils are used in large volumes:

Straight Mineral Oils. Straight mineral oils with viscosities ranging from 85 to 250 seconds at 100°F are satisfactory where storage or shipping conditions are ideal and where great care is taken to prevent accumulation of moisture on the steel.

Special Rust proofing Oils. Such oils with viscosities of 35 to 250 seconds at 100°F. may contain polar compounds such as lanolin, or emulsifying agents such as water soluble soaps which are good inhibitors against rust formation. Some also contain a thinner, which evaporates after application, leaving a comparatively thin layer of rust resistant material. These special products give effective protection where storage or shipping conditions are bad, however, they are not intended for protection in outdoor storage.

Heavy Petrolatum Type Compounds. Materials of this type are sometimes used on steel where protection against the effects of outdoor storage is desired. In addition to their heavy consistency and high adhesiveness they usually contain rust inhibitors and will give protection from a few months up to several years, depending on the severity of conditions.

Hydraulic Oils

Due to flexibility and simplicity of operation, hydraulic systems are used quite extensively in steel mills to transmit power from one location to another, especially in equipment where other forms of power would be difficult to apply. A few of these locations are shown below:

Furnaces — to open and close doors
Hydraulic Roll Balance Systems on rolling mills
Die Casting Machines
Welding Machines — to open and close jaws holding work
Electric Furnaces — to tilt furnace for pouring and to raise and swing back the roof
Handling coils on strip mills
Combustion controls on soaking pits and reheating furnaces
Door operating mechanisms on coke ovens.

The hydraulic system is really a precision machine and considerable care must be taken in selecting the proper type of hydraulic fluid and in keeping the system clean and free from dirt, scale or sludge of any kind. It is estimated that 70% of the operating troubles with a hydraulic system are caused by improper condition, i.e., contamination of the hydraulic oil.

For the proper operation of a hydraulic system the fluid should have the following desirable characteristics:

1. It should flow freely at the operating temperatures.
2. It must be practically incompressible.
3. It should show a minimum of change in physical and chemical characteristics during its normal service life.
4. It should have sufficient body to provide a good seal between the moving parts.
5. It should protect internal parts from rust formation.
6. It must have enough lubricity to minimize wear on moving parts.
7. It should allow rapid settling of insoluble materials that may contaminate the system.

There are two general types of hydraulic fluids in use today:

Mineral Oil Type which is used in a majority of systems where flammability is not a factor.

Fire Resistant Types of which several kinds are available for use in locations where flammability of the fluid would be a hazard.

Mineral Oil Type

In selecting a mineral oil type hydraulic oil, the following factors should be taken into consideration in respect to its physical characteristics:

a. The *viscosity* must be suitable for the system in which it is used.

Viscosity is perhaps the most important property of a hydraulic oil. Pump manufacturers usually have definite specifications which are developed after considerable field experience. If the viscosity of the oil is too high, internal friction will develop with a corresponding increase in oil temperature. Operation will become sluggish and power consumption will increase. If the viscosity of the oil is too low, leakage will increase and pump efficiency will decrease accompanied by increase in oil temperature. Rate of wear may increase, the system will lose pressure and there will be a loss of precision control.

It is generally agreed that at its operating temperature, an oil in service should never have a viscosity SU above 4000 seconds or below 45 seconds.

b. *Viscosity Index* may also be a very important consideration. In each hydraulic system there is a certain viscosity range which will give the best performance. Any hydraulic oil will change in viscosity with changes in temperature, but an oil with a high viscosity index will show a minimum viscosity change with changes in temperature.

If the hydraulic system is in a location where it is exposed to large changes in ambient temperature, a high viscosity index oil is desirable, but if there is no appreciable temperature change, viscosity index is of little importance.

Highly refined paraffin base oils will have viscosity index values between 80 and 110. If higher viscosity index is required for the particular application, it can be obtained by the use of VI improvers. They usually represent long chain hydrocarbons or polymers, and they are quite expensive.

c. *Pour Point* is important if the hydraulic system is exposed to low temperatures. To insure good flow, the pour point should be about 20°F. below the lowest temperature to which the oil will be exposed.

d. *Other important qualities* are necessary in a good hydraulic oil to enable it to withstand the onslaughts of temperature, time and contamination.

Today's best hydraulic oils are made from crudes which experience has shown will provide long service life even under very adverse operating conditions. The latest refining procedures such as solvent refining, solvent dewaxing, deasphalting, acid treating, clay contacting and clay percolation are used to remove undesirable constituents from the oil. The resulting oil will have improved oxidation resistance and color, low pour point and improved water separating qualities.

Premium type hydraulic oils are usually blended with certain additives that will further enhance the good qualities they already have. Oxidation inhibitors will prolong service life and minimize formation of gummy deposits, sludge and emulsions which interfere with the efficiency of the hydraulic system.

A small amount of water due to moisture condensation in the system will cause the formation of rust which can be very troublesome in a hydraulic system. However, a small amount of an effective rust inhibitor in the oil will give a thin protective film which plates out on the metal and prevents rust formation.

Air usually gets into hydraulic systems through leakage into the oil suction line or leakage around gaskets and, of course, by direct exposure in the main reservoir. Air in the dynamic parts of a hydraulic system can cause a heavy foam layer in the reservoir, and it can also cause oil oxidation not only from intimate contact with the oil but also from heat developed when air is compressed in the system. Being compressible, air also interferes with precise control. A small amount of a foam-depressant type of additive will cause foam bubbles to break quickly so that air can be separated easily from the system.

Water in the hydraulic oil can also emulsify with the oil under the violent agitation that exists in a system. Oxidation products and rust in the oil can also increase any tendency to emulsify. Thick, gummy emulsions often form, which may collect dirt and rust and will affect proper functioning of valves, increased friction, wear and oxidation. Rapid separation of water from the oil will minimize these harmful effects. A high degree of refinement and inherent water separating qualities of the oil will permit quick water separation.

Fire Resistant Type

Steel and other industries have need for a fire resistant type of hydraulic oil for use in systems closely adjacent to flame or hot metal. There have been some accidents where hydraulic system lines have broken and burning oil has been sprayed around the vicinity. In order to eliminate this hazard, the following types of fire resistant hydraulic oil are under development:

Water in Oil Emulsion
Water-Glycol
Phosphate Ester
Phosphate Ester Base
Halogenated Hydrocarbons

As a rule, the fire resistant types do not have as good all around efficiency as the mineral oil type, and they represent a compromise in order to obtain non-flammability.

AIRBORNE LUBRICATION

Experimental work with mist lubrication units has been going on for several years in many steel mills. At first only the light duty machines were lubricated in this way, but later it was found that many pieces of heavy duty equipment could also be successfully lubricated by mist application.

The mist lubrication system employs an oil reservoir with capacity up to 3 gallons. The oil is atomized to a mist or fog by the use of compressed air. After passing a baffle, only the microscopic particles are blown into the delivery tubes which carry the mist to bearings, gears or other moving parts.

The theory of this type of lubrication is that the mist will flow through straight pipes and around bends without any appreciable condensation, but oil droplets will condense only on moving parts at locations where the lubricant is needed. The low pressure flow of air (usually below 5 PSI) on the bearings also provides some cooling effect.

The mist can be applied through various types of fittings suitable to the mechanisms being lubricated; such as:

Oil Mist Fittings

These are used with enclosed gears, enclosed chains and antifriction bearings where speeds are sufficiently high for the oil to condense out.

Oil Spray Fittings

These are recommended for all roll neck bearings, open gears, eccentrics, cams, rollers and chains where speeds are not high and where a distribution of oil is required. These fittings condense the mist to a fine wet spray.

Oil Condensing Fittings

These are used with plain bearings, ways and slides where drops of oil are required. These fittings convert the mist to liquid droplets.

Mist lubricators can utilize oils with viscosities at 100°F. SU ranging between 150 and 1000 seconds. Both straight mineral oils and EP oils are used, the latter being preferred where heavy duty conditions exist.

Advantages

Many claims are made for superiority of oil mist or airborne lubrication over the conventional methods, including the following:

1. Mist application is useful on tinning lines where drippage of conventional lubricants from bearings will contaminate tinning solutions.
2. Points which are hard-to-get-at or in dangerous locations can be lubricated from one convenient point.
3. Positive air pressure in the system tends to minimize the entrance of contaminating materials such as roll oils, water, dirt and abrasives.
4. Application by this method provides positive and continuous lubrication in contrast to intermittent lubrication by other methods.
5. Greatly reduces internal friction in bearings often caused by overlubricating with grease.
6. Reduces lubricant consumption as high as 90% or more, thereby reducing costs.
7. Improves general housekeeping by eliminating waste.

Disadvantages

Some steel mill operators feel that mist lubrication will not be able to handle all phases of steel mill lubrication for the following reasons:

1. On some equipment the service is too rugged for the low viscosity mist oils to handle. Heavier oils or greases are required to give proper lubrication.
2. In many bearings a heavy flow of circulating oil is required to remove heat. The flow of air in the mist system does not have sufficient cooling effect.
3. Oil mist escaping from bearings especially in confined locations may present a health hazard to operating personnel.
4. Air supply sometimes fails, thereby increasing the chance of bearing failure.

Steel Mill Applications

Mist lubrication is being used in a great variety of steel mill equipment including the following:

1. Antifriction roll neck bearings (back up and work roll) on hot strip and cold strip mills.
2. Bearings of conductor rolls on electrolytic tinning lines where slight drippage of oil would damage the tin plating.
3. Hot-saw bearings.
4. Spindle bearings on buffing and polishing machines.
5. Shake-out bearings.
6. Antifriction bearings on cold rolling mills.
7. Slides, gears, cams, ways, rollers and chains.
8. Roller bearings on flying shears.
9. Plain bearings and gears of rod mill cooling beds. (In one installation over 750 points are mist lubricated with a mild EP gear lubricant with viscosity of 300 SU seconds at 100°F.).

Mist lubrication is gaining increasing acceptance in steel mills, and it has advantages in many types of equipment. However, the conventional oils and greases and conventional methods of application are still required for a majority of the very heavy duty machines.

ADDITIVES IN STEEL MILL LUBRICANTS

The day is fast approaching when practically all lubricants used in steel mills will contain additives of one kind or another. An additive may be defined as a chemical compound which gives new properties to a lubricant or which improves the properties it already has.

During the last two decades the use of additives in steel mill lubricants has been increasing gradually. This is probably caused by the modern tendency to speed up machines to the point where additives are necessary to provide proper lubrication under extremely adverse operating conditions.

Table I shows the types and functions of various types of additives often used in steel mill lubricants:

The application of additives to lubricants should be a very carefully controlled procedure. Many factors must be considered, since some oils are more difficult to inhibit than others and too much additive may actually degrade the desired characteristics. The use of additive concentrates with used or reclaimed oils should always be under careful laboratory supervision. Considerable "know-how" is required to obtain maximum results.

It is strongly recommended that the use of additives in lubricants be handled by the lubricant manufacturers since they are equipped to determine the type and amount to give optimum results.

TABLE I — TYPES OF ADDITIVES IN STEEL MILL LUBRICANTS

Steel Mill Lubricants	Types of Additives They May Contain	Purpose of Additives
EP Greases	Sodium, calcium, lithium soaps Lead, sulfur, chlorine or phosphorus compounds Polar compound Oxidation inhibitor	Thickening agents Withstand extreme pressure Improve lubrication especially in presence of water Resist oxidation
High Temperature Greases	Clay, silica or bentonite Oxidation inhibitor	Thickening agent and to provide high dropping point Resist oxidation
Roll Neck Greases (Hand Packed)	Calcium soap Graphite	Thickening agent Assist in rough lubrication
Cup Greases	Calcium soap	Thickening agent
Ball and Roller Bearing Greases	Rust inhibitor Sodium, lithium or mixed calcium and sodium soaps Oxidation inhibitor	Prevent rusting in presence of water Thickening agent Resist oxidation
Gear Oils — EP Heavy Duty	Lead, sulfur, chlorine, phosphorus compounds Polar material Rust inhibitor Anti-foam compound	Withstand extreme pressure Improve lubrication Prevent rusting in presence of water Minimize foaming
Gear Oils (Cutback)	Petroleum thinner, chlorinated solvent or coal tar solvent	Provide ease of application
Heavy Duty Motor Oils and Diesel Lubricating Oils	Pour depressant Viscosity index improver Anti-foam compound Detergent Oxidation inhibitor Corrosion inhibitor	Permit easy cold weather starting Minimize foaming Keep engines clean Resist oxidation Prevent bearing corrosion
Turbine Oils	Oxidation inhibitor Extreme pressure agents Rust inhibitor Anti-foam compound	Provide long oil life Withstand extreme pressure Prevent rusting in turbines Minimize foaming
Steam Cylinder Oils (Compounded)	Fatty materials such as tallow, lard or degras Pour depressant	Provide better lubrication of cylinders under wet steam conditions Permit easier handling at low temperatures
Rustproofing or Slushing Oils	Polar materials or emulsifiers	Protect steel from rusting
Rustproof Compounds (Heavy)	Polar materials, emulsifiers or certain salts	Protect steel from rusting
Thread Compounds	Powdered lead, copper, zinc and graphite	Prevent galling of threads Provide good seal under pressure
Roll Oils	Palm oil, tallow or other polar additives Soluble oil or other emulsifiers	Prevent scratching and provide good surface finish Provide ease of emulsion formation
Soluble Oils	Water soluble soaps and sulfonates and other emulsifiers Bactericide Extreme pressure agents Rust inhibitor	Provide stable emulsions Eliminate bacterial action in emulsions Withstand extreme pressure Prevent rusting of parts being processed
Cutting Oils	Sulfur, phosphorus, chlorine compounds Polar material	Withstand extreme pressure Give adhesion to metal
Quenching Oils	Polar materials and other wetting agents	Provide quick wetting of hot metal

SUMMARY

Steel mill operations are so severe that it has often been necessary to make especially rugged products to handle these adverse conditions.

Steel mill lubrication presents a constant challenge to lubricant manufacturers to develop products of greatest usefulness and stability.

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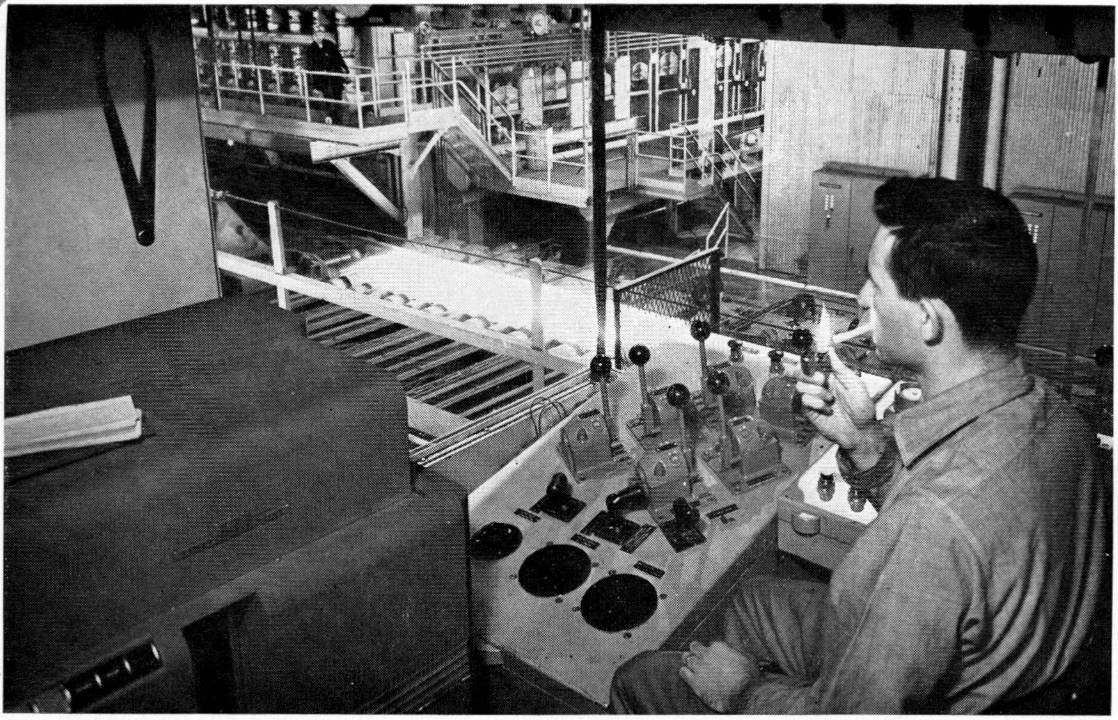

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