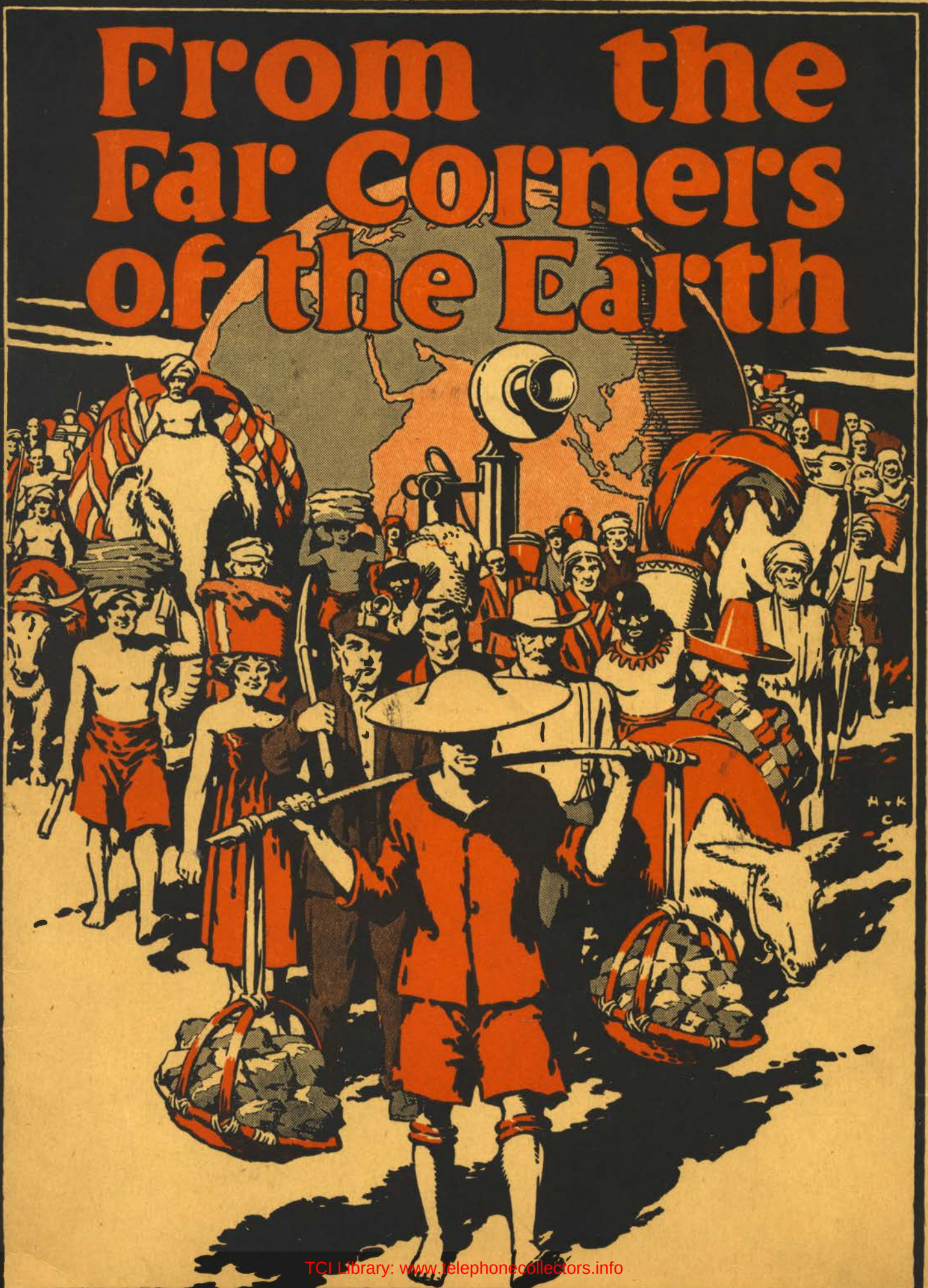
From the Far Corners of the Earth



THIS BOOK

has been published to tell you more about some of the world's raw materials,—where they come from, how they are obtained, and what qualities lead to their use for different purposes.

Since these materials come from the far corners of the earth, you will find yourself going into the hills of Pennsylvania, the treasure-laden Rocky Mountains, the Klondike, and far away India and Malaysia.

Naturally, as you read about these raw materials, you will want to know more about the workers who prepare the materials for use,—in what kind of houses they live, what they eat, and how they talk and act. You will want to know how these raw materials or their products are brought to the seaports or shipping points and transported from place to place.

If reading these pages helps you discover anew some of the many interesting places in your own country or in foreign lands, if it helps you learn more about strange people and their strange customs, you will be well repaid for the time spent in looking at the pictures and reading the message that this book brings to you.

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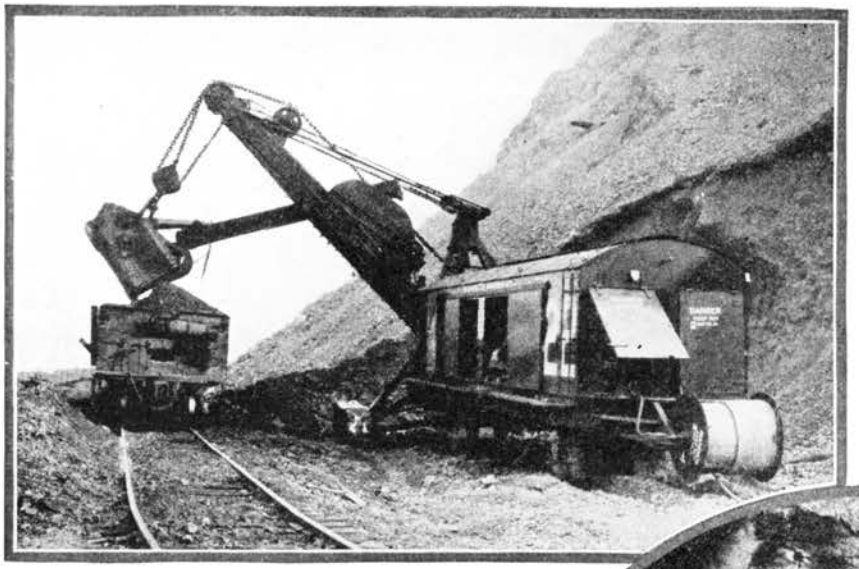
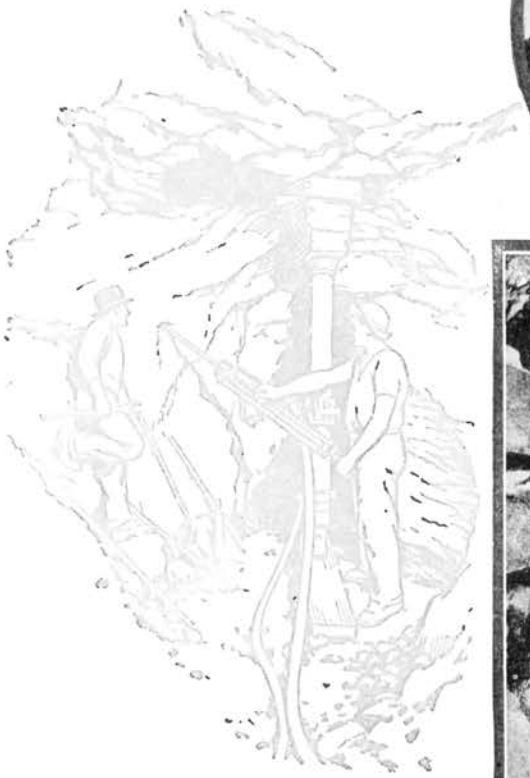
The Story of Copper

Copper in the form of wire is almost always used to carry electric currents. Copper and brass, an alloy of copper and tin, are essentials in automotive manufacture and for ships, buildings and the making of statues and other works of art.

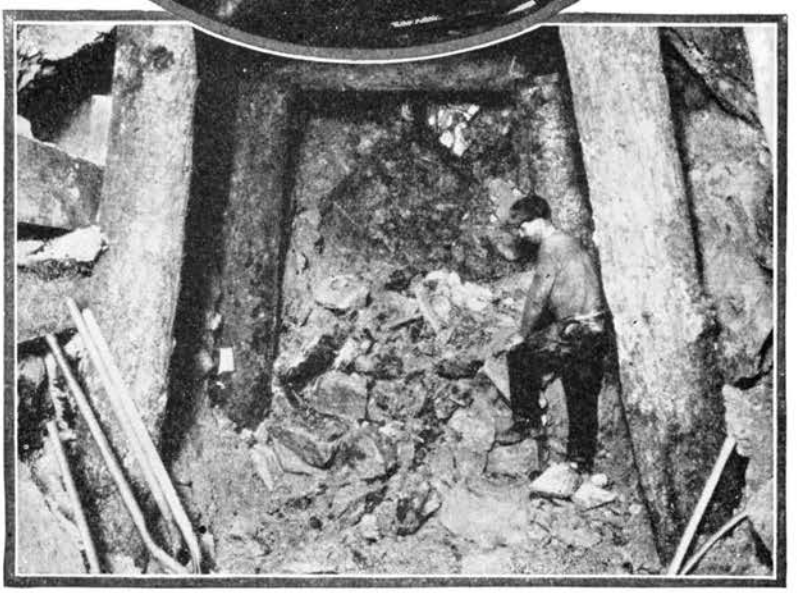


Copper ores in loose soil or from hillsides torn down by blasting are dug and loaded to send to the smelters by means of electric or steam shovels.

Below—To break up the rock, holes are drilled and packed with explosive. Then an electric current explodes the blast.



Running a drill deep down in a copper mine.

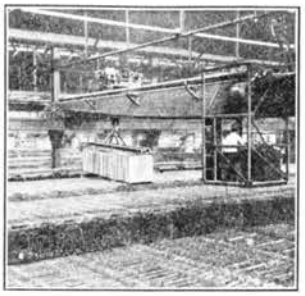


After the blast, the broken rock is taken away, broken into still smaller pieces and processed to obtain the various metals it may contain. The "timbering" is to keep the roof and walls from caving in.

In Your Telephone

Copper was used long before the beginning of the oldest written records, and today is second only to iron in its industrial value. For centuries it was used either alone or in bronze to make dishes and other vessels, and for ornaments, armor and weapons.

In those early days, too, copper coins came into use. Besides, a man's wealth was often measured by the weight of copper he owned. For instance, in the days of the early Roman republic, if a man was worth the equivalent of 150,000 pounds of copper, he had to provide himself with certain arms and armor suitable for fighting in the front ranks of the legion. If he were not quite so wealthy, the law made him serve as a certain class of soldier, and called for less complete equipment. And so it went down the scale of wealth until those who had property amounting to less than 1,500 pounds of copper went as orderlies to the lesser leaders and as "replacements." For those even less well off, military service was not required nor did they have to pay any taxes.



In the electrolytic process used to produce practically pure copper, the copper is made into anodes which are put into a solution and an electric current gradually deposits it on plates of pure copper. The copper plates or cathodes when built up by deposits are more than 99% pure copper.

Probably the most widely known product of copper dating back to those days was the famous Colossus of Rhodes, one of the Seven Wonders of the ancient world. It was a bronze statue to the sun god Helios, which the joyous people of Rhodes had made out of the spoils left by a besieging army which suddenly fled without waiting to gather up its belongings. It stood 70 cubits (105 feet) high and was thrown down by an earthquake about 224 B.C. One thousand years later it was sold by the conquering Arabs to a junk dealer, who had to use 900 camels to carry the metal away.

The copper deposits of northern Michigan, visited by the Jesuit Fathers at about the time of La Salle's discoveries, were first worked for commercial purposes by white men about 1844. These deposits around Lake Superior contain what is called native (practically pure) copper and are quite different from the mines at Butte, Montana, in which the copper is combined with sulphur or other elements. Still a third kind of deposits are worked. They are called porphyry and in them the copper minerals are scattered through large masses of rock.

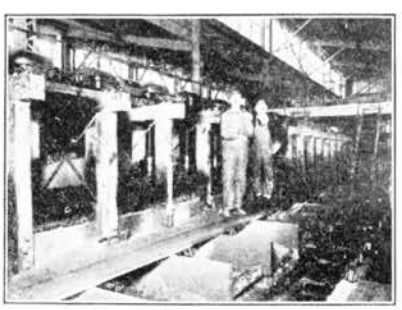
The deposits of *native* and of *sulphide* ores are worked by levels, drifts, crosscuts, stopes, and other underground workings. The ore is brought up through shafts, some of which are more than a mile deep.

Many of the porphyry deposits, on the other hand, are near the surface and mining is carried on in open cuts or pits, similar to those used to mine iron in the Lake Superior district. There are some porphyry deposits, however, worked by great underground systems. Most of the open cuts are terraced and by means of a railway on each terrace, the ore scooped up by steam shovels, is loaded on cars and hauled away. In this manner as many as 40,000 tons a day are mined and although the amount of copper in each ton of material is small a large amount of copper is secured because of the immense quantities of material mined.

While copper does occur as pure copper, most copper ores contain different amounts of lead, zinc, gold, silver and in some cases platinum, palladium and other rare metals.

To obtain the copper from its ores different methods are used depending on the character of the ore. Native copper, for instance, is generally separated from the dirt and rock—called gangue—dug up with it by a process in which oil or water carries the ore along and lets it gradually sink because the copper is heavier than the gangue which floats away. The copper thus secured is then smelted and refined.

Oxidized ores—those in which atoms of oxygen are combined with atoms of copper—are crushed and then poured into an acid solution which dissolves the particles and separates the copper from its gangue. Pure copper is obtained by the electrolysis method, described under the picture illustrating the process.



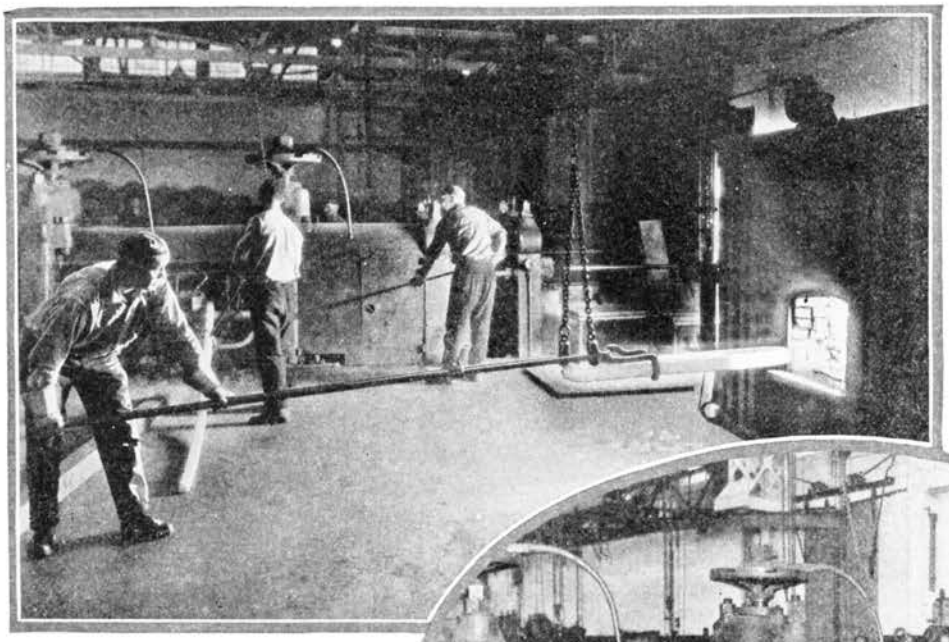
To get the grains of copper out of the ore by the flotation process the ore is crushed to a powder and then oil and water are mixed with it and air is forced through, forming a froth to which the copper grains adhere and from which they are skimmed off.

Some ores contain such small amounts of copper in each ton of material mined that a part of the waste material must be gotten rid of before the ore goes to the smelter. This is called enriching the ore.

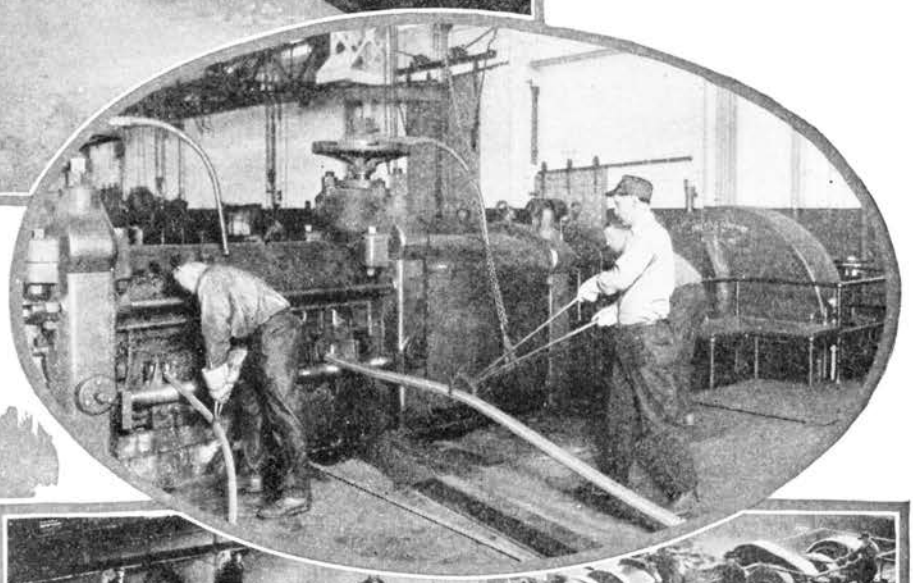
The United States produces from ore mined in the United States about 60 per cent of the total output of copper in the world, and through ownership of deposits in Mexico, Peru, Chile, and Canada supplies about 9 per cent more. The known

The Story of Copper

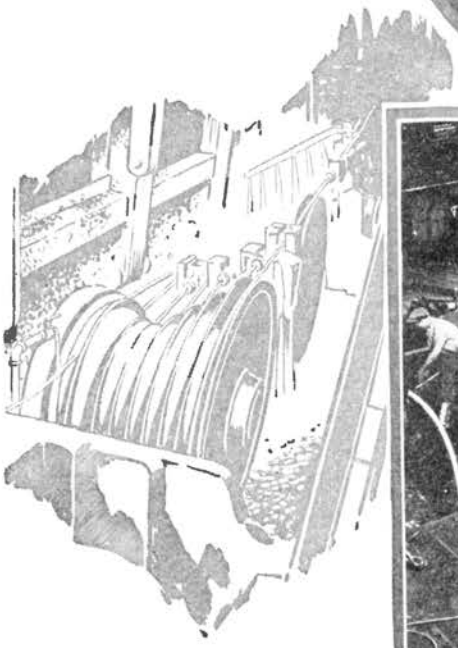
Copper lends itself admirably to change of shape when hot and even when cold, and one of its greatest services to present-day life is a result of these characteristics, for they make it possible to change short thick bars of copper into long thin wires for carrying electric currents.



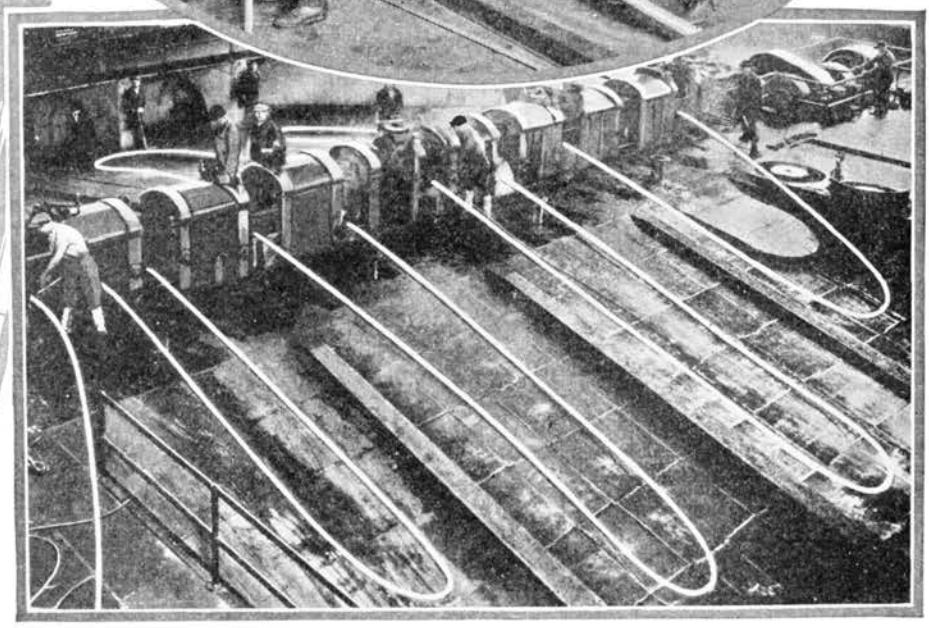
Taking a red hot bar of copper out of the furnace is the first step toward the rolls which turn the bar into a rod from which wire is drawn.



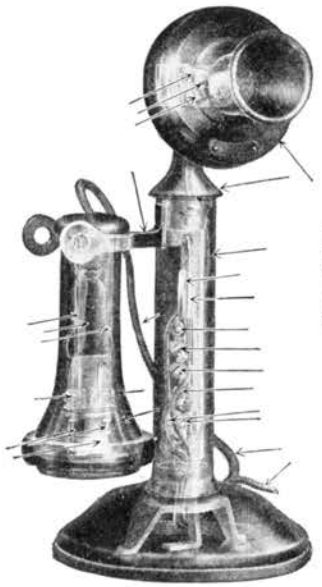
Below—A few more passes through the rolls and the copper bar has become a long thick, snake-like rod of copper.



A fast spinning capstan draws the rod through doughnut-like dies, each with a smaller hole than the preceding one, until the rod becomes wire of the diameter wanted.



Each pass through the rolls reduces the thickness of the copper and increases the length, so that now the bar, which was originally 54 inches long and 4 inches square, has become 1200 feet long and only ¼ inch thick.



Copper is used in your telephone as wire and as an alloy in brass for plates and screws.

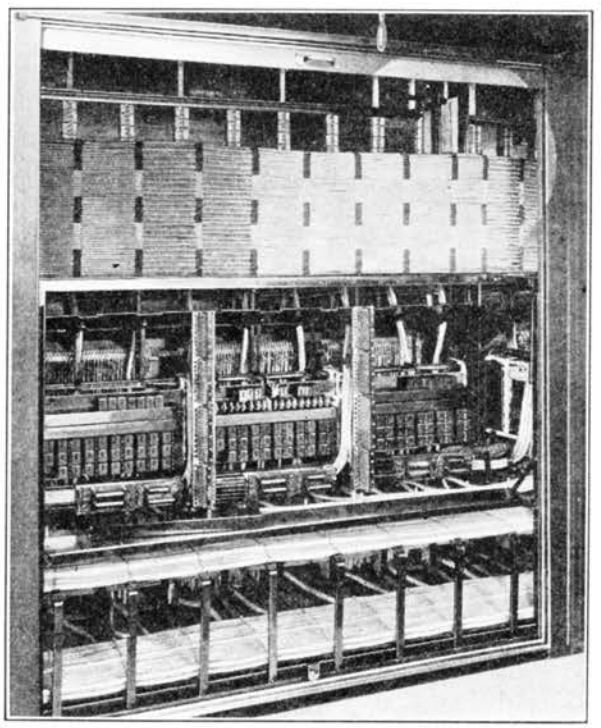
deposits not yet mined or reserves already developed in the United States exceed those of any other country. Chile continues to be the world's second reserve of copper, while the deposits in Spain which have been mined since the days of the Phoenicians are still rich.

While for a long time copper has been one of the most valuable metals, it has become indispensable only since the electrical industry was established. Most of the copper produced is used in that industry where it provides pathways for electric current. A large part of the remainder is used in the manufacture of brass, bronze, and other alloys used in automobiles, electric railways, electrified railroads and ships, and in building construction and equipment.

Because copper is a good conductor of electricity and because of its other qualities, it is extensively used in alloy with other metals and as wire in your telephone system.

The making of copper wire forms one of the most interesting departments of the great telephone factory. To see the large bar of copper taken red-hot from the furnace and started between a pair of revolving rolls like a huge wringer—to see it next like a red-hot snake glide between the next pair of rolls—and finally to see the small wire about the thickness of a human hair drawn out from a machine is a sight that few who have seen it ever forget.

Insulated thin copper wire is wound around iron rods in your telephone receiver to make a magnet.



Copper wire by the mile is used in switchboards. This copper wire brings voices to the operator, completes voice pathways between talking subscribers, permits current to pass around iron bars to form magnets and leads current to lamps which flash signals on and off.

Copper wire of this kind is used in the lead covered cable you have seen in manholes leading to telephone conduits under the street and in cables suspended on poles. The wire used in your telephone, too, is made that way. Here its chief use is in the wire windings or coils in the receiver, just behind the diaphragm.

Still more copper is used in your telephone in the form of brass screws and the terminals to which wires are attached. Coils for the bells which ring when you are called to the telephone, relay coils and many other types of coils for use in telephone circuits annually make use of millions of feet of copper wire in various sizes.

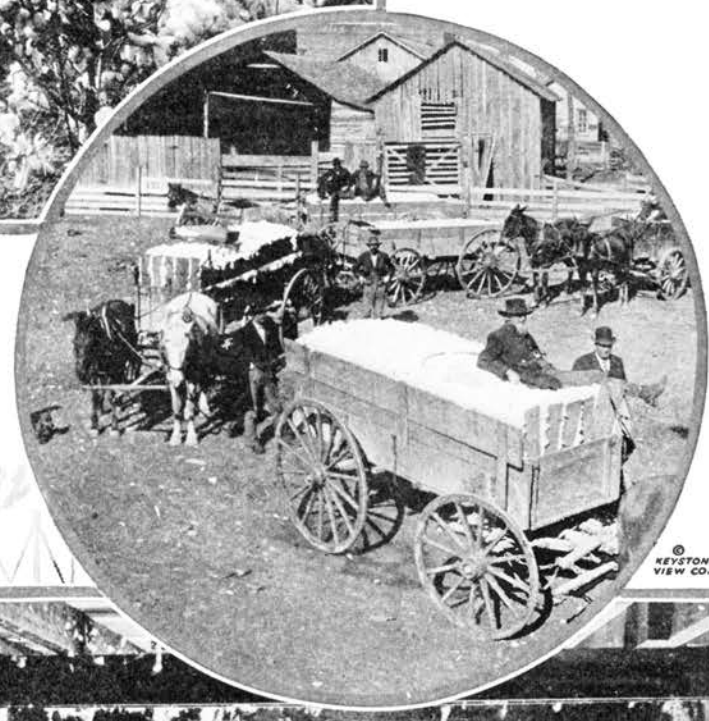
The Story of Cotton

There is scarcely a nation in the world which does not use cotton for clothing. The United States is the chief producer of cotton and uses millions of bales. Yet there is enough left so that we export more of it than of any other commodity.

© PHOTO by COOVERT.

"Way down South in the Land of Cotton."

Below — Waiting their turn at a cotton gin.



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On the levee at a cotton port beside the Father of Waters.

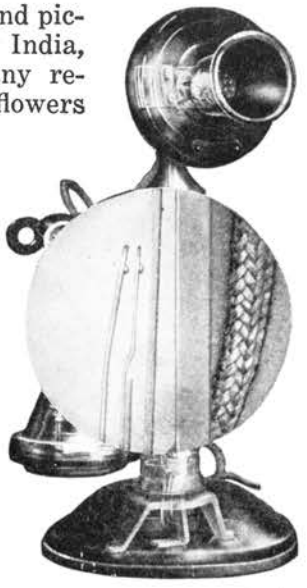
PHOTO by KEYSTONE VIEW CO.

Inside the ginning room where the cotton seeds and cotton fibres are separated.

In Your Telephone

Cotton! The very word brings to mind pictures of many centuries and countries: India, land of gorgeous potentates and many religions where the white and yellow flowers and snow-white bolls of the cotton plant have colored the landscape for fifty or sixty or seventy centuries—Egypt, home of the finest cotton in the world—ancient America, land of Aztecs and Incas and of tobacco, potatoes, sunflowers—and cotton.

Cotton scenes of today are no less scattered. The sunny land of Negroes, sunshine, and song calls Cotton — "King." Thousands of spindles and looms continually hum in New England, New York, Pennsylvania and in southern states, transforming the fluffy cotton into yarns and cotton goods. Ships ply our Atlantic coasts and cross the seas to England carrying cargoes of raw cotton. Ships set sail from Egyptian ports and from Calcutta and other British Indian coast towns for England and America laden with bales of cotton. And from England and our country other ships depart for all ports of the world with finished cotton cloths and goods.



The transmitter cord inside your telephone is covered with cotton to protect it as it comes in constant contact with metal parts.

Cotton has not always played so important a part in the world's commerce. The story of Eli Whitney and the invention of the cotton gin familiar to most of us, form the last chapter in a tale which starts with one John Kay in 1733. This Englishman invented a flying shuttle which enabled the weavers to turn out goods so fast the spinners could not easily keep up with them. For thirty-seven years the spinners struggled to supply the weavers. Then Hargreaves, another Englishman, invented the spinning jenny.

Cotton braid protects many types of telephone cords. As the insulated wires or cords come up through the center of this machine, spindles of cotton thread move in and out and round and round braiding on the protective layers.

This made the race even. The mills could furnish to the trade all the cotton goods it wanted. With this greater production the price of cotton goods dropped to a place where others than the very wealthy could buy. If the mills could get all the raw cotton they needed, cotton goods would be cheap enough for the common people to use. But there was the hitch—the cotton growers could not supply the mills with enough bales of raw cotton.

Eli Whitney solved this problem in 1793 by inventing the cotton gin which separates the lint from the seed. Under old methods one man would have to work two days to produce one bale of cotton. Now, a cotton gin produces fifteen bales in a day.

The cotton gin was a boon to our Southern states. New plantations sprang up, old plantations grew larger and the United States took the place which it has ever since held, as the largest producer of cotton.

The mill secrets of England soon seeped into New England. Wherever there was a good waterfall a textile mill was established. Instead, however, of buying its raw cotton directly from the South, New England at first secured American raw cotton more cheaply from Liverpool by way of the West Indies.

Cotton thus did a great deal to turn the South into a prosperous agricultural section and the North into a beehive of industry—and it is still one of the chief sources of prosperity for both sections.

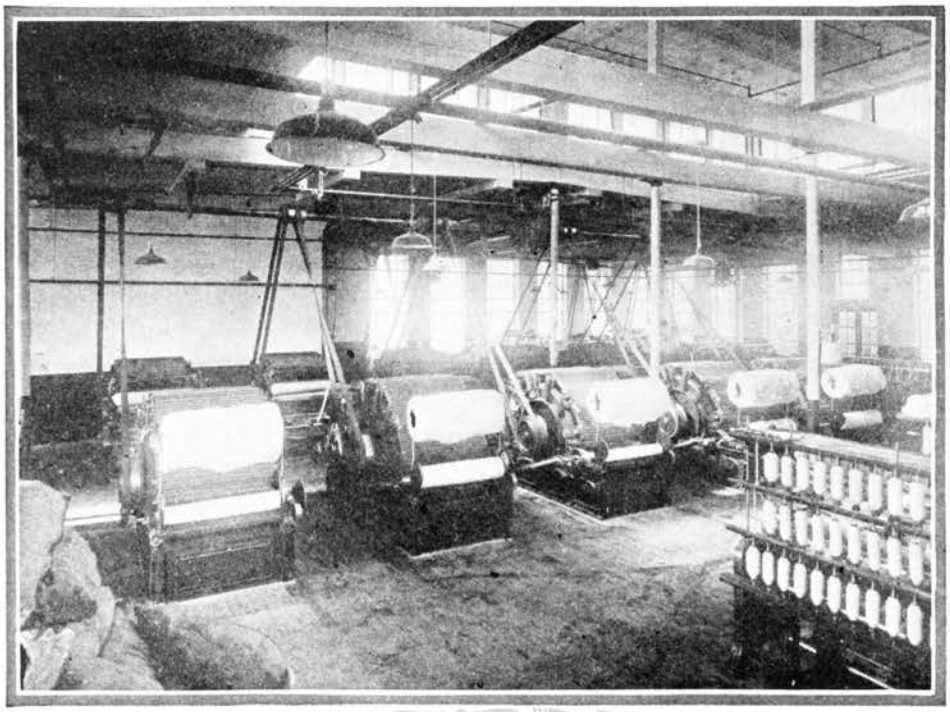
For anybody who has not seen cotton growing in the fields, a trip through the Southern states, when the cotton plant is in full bloom, is fascinating. Then acre after acre of spreading branches are beautiful with green leaves and white and rose-tinted blossoms. That is one picture.

Dyeing the paired telephone cords saves time because the different colored insulations identify the lines, making simpler the task of connecting up the proper wires.

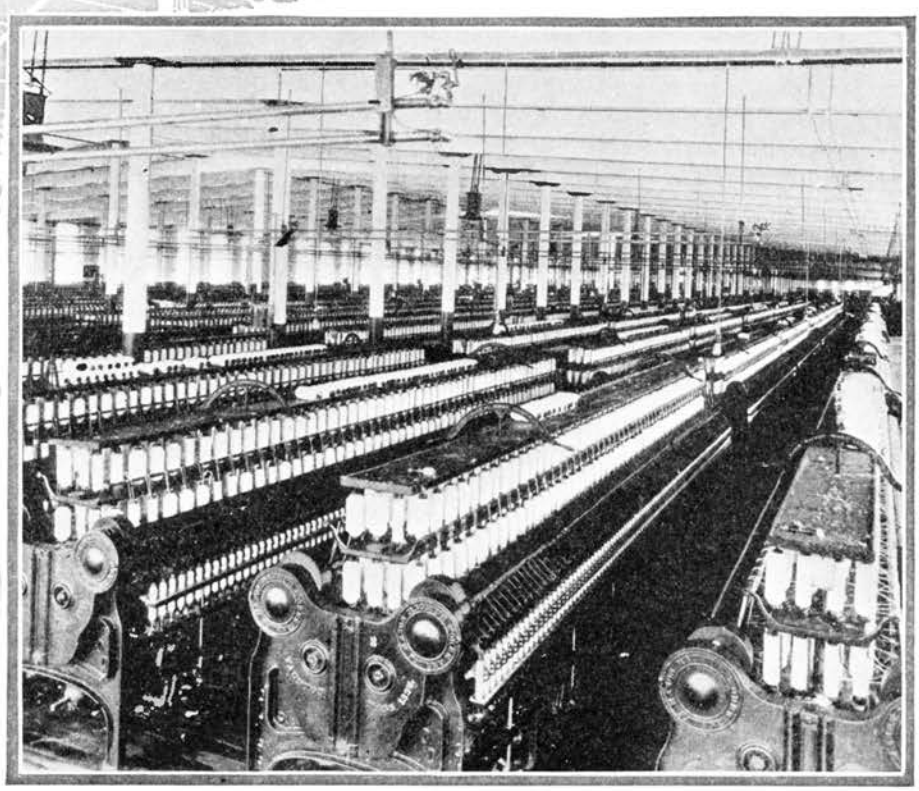
As the blossoms gradually drop off, the bolls begin to swell. Soon they burst and the white

The Story of Cotton

The plantations where cotton is picked and the towns where it is processed have prospered as the cotton cloth of commerce has gone from those towns further and further into the remote corners of the world.



Carding—Raw cotton, after being mixed, cleaned and "lapped" or "rolled", is carded and combed until the fibres lie parallel to each other.

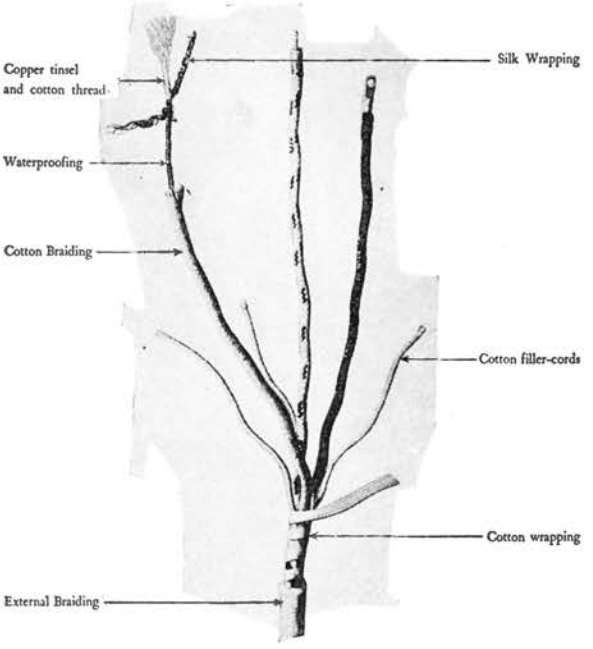


Spinning—After being carded, the fibres are stretched on drawing frames, twisted and finally wound on bobbins which spin them into thread for weaving.

Ginning cotton. A gin that looks like Eli Whitney's, except that it is larger.

fleece shows. This is usually in August or early September when the stalks are from two to four feet tall.

A cotton field is usually picked three times.



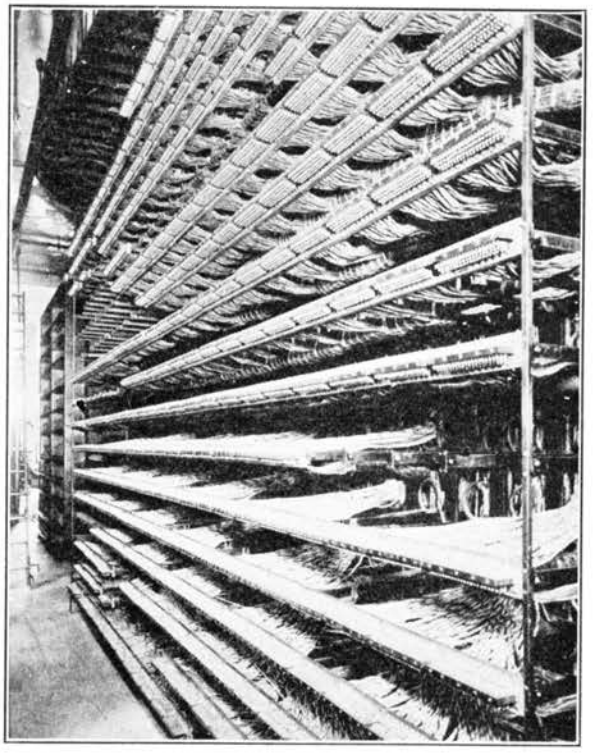
Each of the sets of copper ribbons carrying current is wound spirally around a cotton thread to make it spring-like and long lived. A cotton thread is used to help make round the group of conductors and over the grouped conductors is a braided cotton covering for insulation and protection on switchboard cords like this.

One-fourth of the crop is gathered in the first picking; one-half in the second, and the other one-fourth in the last. Dusky cotton pickers, working under a bright sun, dot the fields full of white bolls of cotton, making a picture in contrasts not soon forgotten.

After the Negroes pick the cotton, it is put into bags and taken to the gin. After the seeds are removed, the cotton is pressed into bales and shipped to wharves or to Southern mills. Galveston, New Orleans, and Savannah are among the chief cotton shipping ports.

The cotton seed and the waste from the gin were formerly thrown away. Now many valuable products are made from them. Cotton seed oil has become a common substitute for olive oil. Substitutes for lard, oil cake and oil meal are also manufactured. From the waste of the gin is made celluloid and a high explosive called gun cotton.

Copper wire wrapped with cotton and silk around iron cores makes the relay coils this girl inspects.



Each wire of the thousands wholly within the telephone exchange has a cotton insulation. These connect together the switchboards, and other auxiliary apparatus.

Cotton thread is used to cover almost all the wires used in your telephone and in the telephone system in general. Its toughness protects the wire and it insulates one wire from another, thus preventing the electric current that carries your voice from wandering off the wire pathway and being lost.

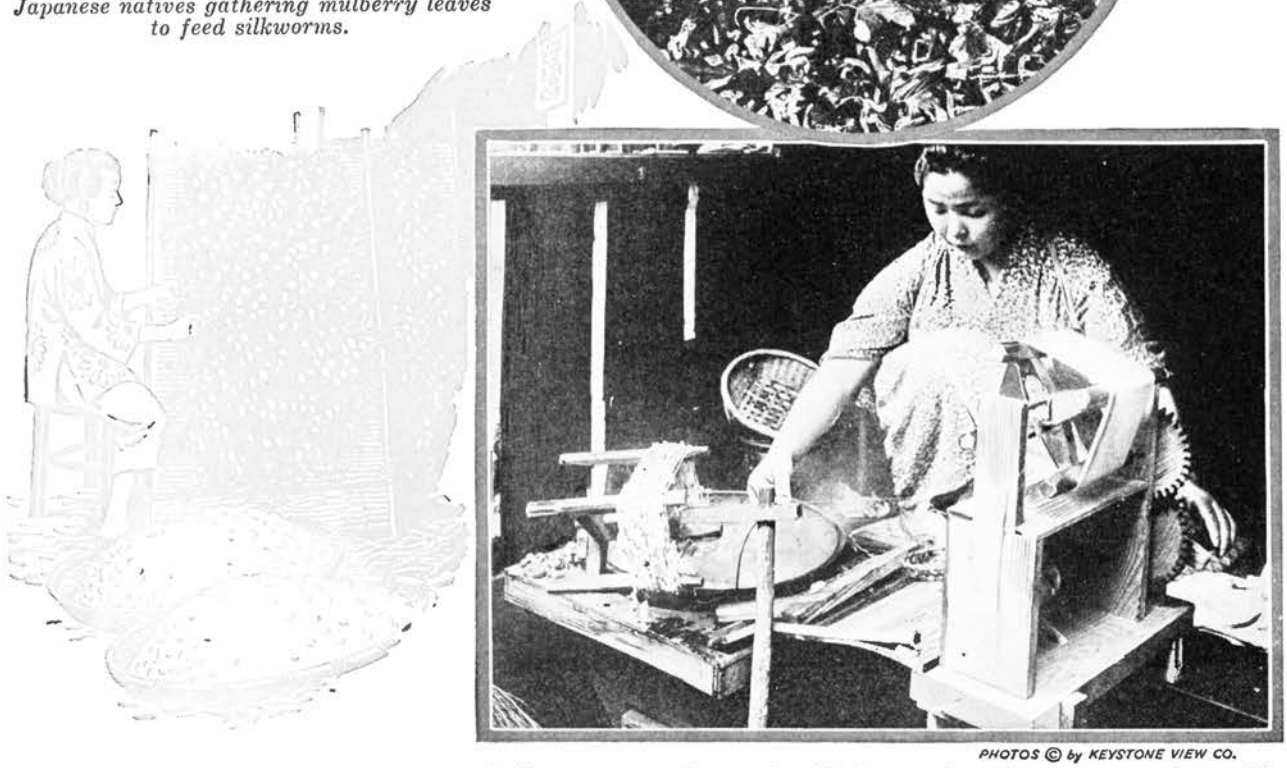
One particularly interesting use of cotton thread in telephone systems is in the cords you see outside your telephone. These cords are bent and twisted many times as you know, and since bending breaks a copper wire, flat ribbons of copper no thicker than your hair are wound spirally around a cotton thread. That produces a species of tinsel that, like a spring, can be bent many times without breaking. In this way cotton threads give strength to copper wires.

The Story of Silk

Six centuries ago the great trading cities of Venice and Genoa carried on trade in silk with the Far East, and today silk is a source of national wealth to Far Eastern countries.

Japanese natives gathering mulberry leaves to feed silkworms.

Below—Feeding mulberry leaves to silkworms.



PHOTOS © by KEYSTONE VIEW CO.

Picking cocoons.

Boiling cocoons to loosen the silk fibres and reeling the fibres of raw silk.

In Your Telephone

The story of silk is a story of olden times when merchant-adventurers journeyed to the Far East for valuable woods and spices and cloths—and of modern industry which sends men to those same strange countries of the Orient for the same precious products.

Pure silk covers the cords and wires of your telephone. Silk is strong, flexible and is a good insulator.

Often a single shipment of silk to this country is worth as much as $5,000,000 or $6,000,000. Telegraph cables and radio messages follow the fast ship laden with its costly cargo from the day it leaves the Oriental port until it reaches our Pacific Coast. The ship radios ahead when it has a silk cargo aboard. Outside the harbor, custom officials meet the vessel and inspect it. At the pier a special train which carries only silk is ready to steam away as soon as the cars are loaded. The cars are sealed so that no dirt, dust or water can enter and every precaution is taken against hot boxes, leaks, or anything that might hold up the train or slow it down. Once loaded the train starts immediately. It stops only to change engines and usually makes the trip to New York hours ahead of the fastest trans-continental passenger trains.

The silk itself is obtained from a worm which feeds on the leaves of mulberry trees. During its short life the worm spins a cocoon from one continuous thread 800 to 1200 yards long. This it wraps around itself in about three days' time, laying the tiny strand very evenly by turning its head to guide the thread, just as the silk braiding machines illustrated in this book guide the thread to make an even braid in the telephone cords.

After the worm has been in the cocoon for a short time, it moistens one end of the fibre shell, probes aside the fibres and flies away, a brilliant moth. The life cycle is completed when the moth mates and the eggs that result become silkworms which in turn again make cocoons and repeat the process just described.

This installer is connecting up the silk covered copper conductors in the telephone switchboard.

The cultivation of the silkworm and the mulberry tree upon which the worm lives is an ancient art in the Orient. It is said that about 2600 B.C. a Chinese Empress after encouraging the planting of mulberry trees created interest which led to the invention of looms to weave the fibres into fabrics. Later the Japanese and the Koreans entered into competition with the Chinese. As for India, a princess is supposed to have taken from China some eggs of the insect and some seeds of the mulberry tree concealed in the lining of her head dress.

As the knowledge of silk spread throughout Europe the demand for it grew until large caravans were needed to transport it across the deserts to the ports of the Mediterranean where the famous merchants of Venice and Genoa bought it and sold it to the nobility of Europe. When the trade was at its peak, the Turks invaded Eastern Europe, took Constantinople, closed the trade routes to the Far East; and the beginning of the end began for the glorious days of Venetian and Genoese commerce.

But Europeans still wanted the soft, lustrous cloths of the Orient. So Vasco da Gama sailed round the Cape of Good Hope to find a new eastern route, and Columbus and others sought a western route to the mysterious lands far away. In time, ships began making the long journey around Africa to the East and sailed back with the precious wares in their holds.

Today the silk which the worm spins is as greatly prized as in the days of the Crusaders. Thousands of people in China and Japan and in France and Italy take care of the little worms, bring them indoors if the weather is too cold for them outside and pick mulberry leaves for them to eat. Then they unwind the silk from the cocoons and spin it into silk thread.

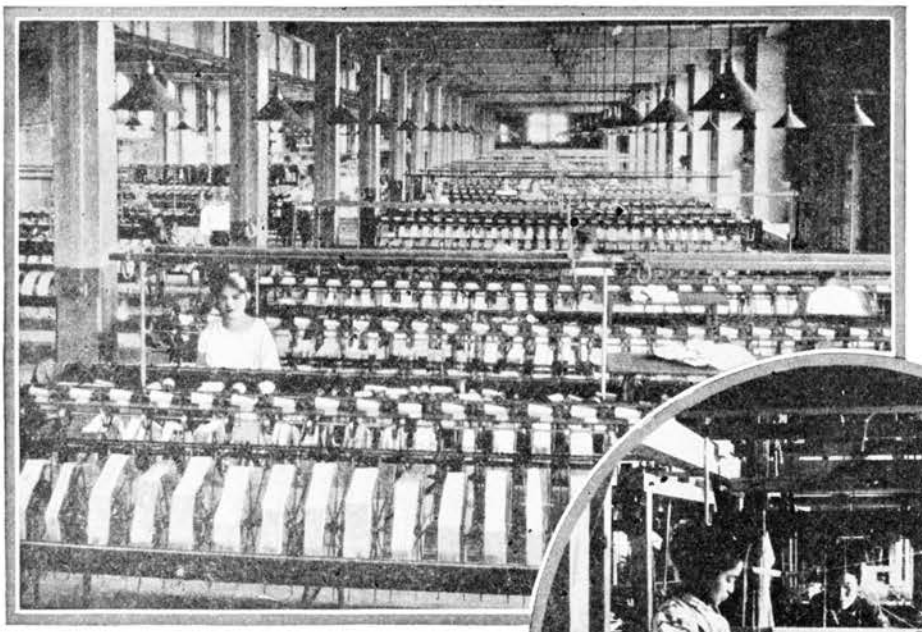
When the switchboard is completed, the operator uses the silk and cotton covered voice pathways to bring to her ears the number wanted and to make a continuous path from one telephone user to the other.

The uses of silk for clothing and drapings are familiar to most of us. Few people, however, know that silk is used in the telephone system in the form of silk threads wrapped around the current-carrying wires and braided over groups of wires to hold them together, to protect them, and to improve their appearance.

Another interesting chapter in the story of silk is the company its manufacture keeps in

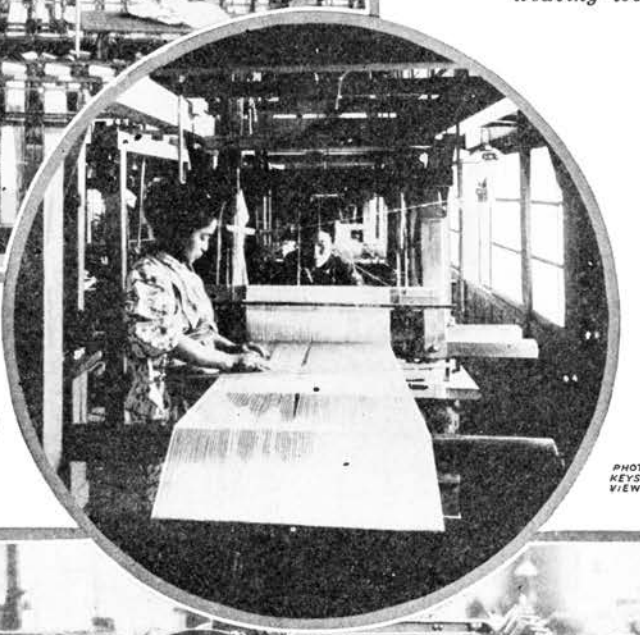
The Story of Silk

Silk, the luxury of the bygone centuries, is a worker today in the electrical industry because it keeps electrical currents on their pathways.



Winding silk fibre from skeins on to bobbins in an American silk mill.

Below—A native Japanese silk weaving loom.



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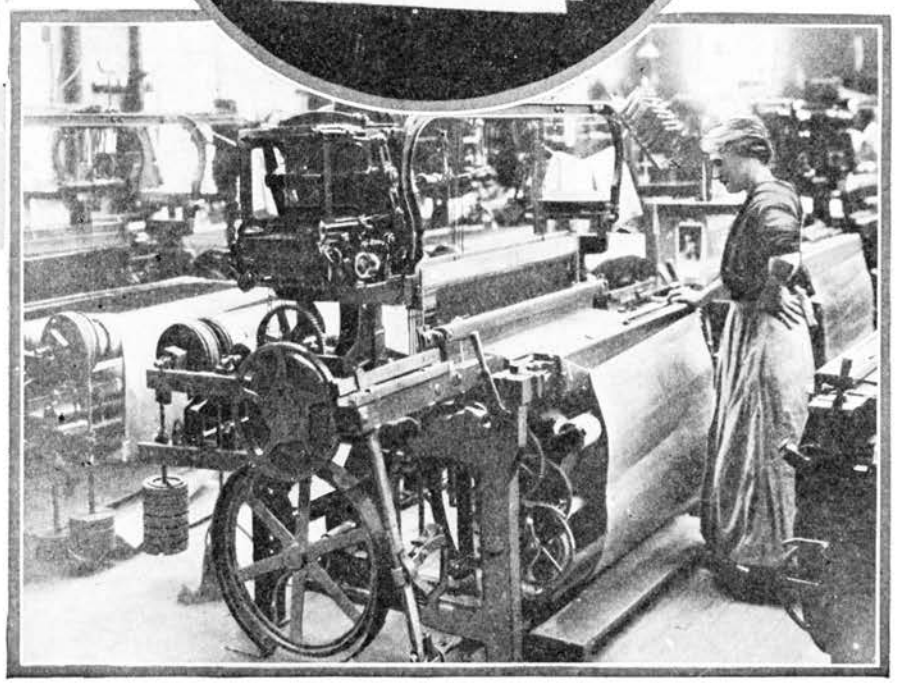
Winding silk from cocoons.



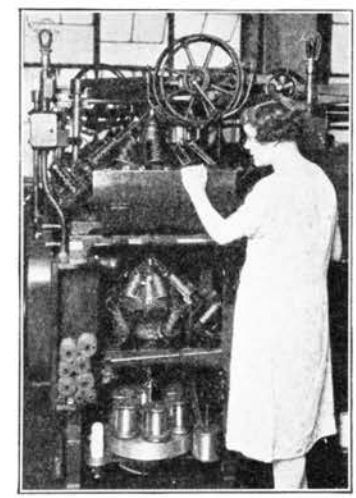
A power driven loom in an American silk weaving plant.

The arrows show where silk is braided on to the cords and wires of your telephone and on the cord which extends from your telephone to the box on the wall.

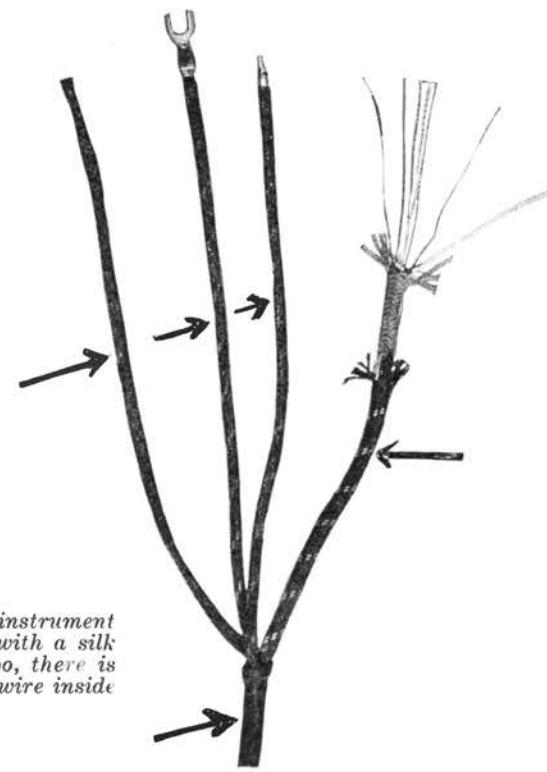
this country. Wherever tall black smokestacks of steel plants are to be seen sending their sooty fumes into the air, somewhere close by may be found a silk factory. Often coal is mined and beautiful sheer hose is manufactured in the same town in Pennsylvania. Many silk mills are located in New Jersey, Ohio, and in several southern states.

The reason for this is that big, brawny men are required to do the work in iron foundries and steel mills, while there is little or no work for women to do. In silk mills there is little work for men to perform, and so it is natural that the silk industry, which uses the deft hands of women, should have grown up by the side of steel mills.

The next time you take down the receiver of your telephone and hear a voice at the other end, try to picture the distance the silk wrapped around the whispering wires traveled before it arrived to serve you, and then, with a look backward, think of the ancient Venetians who had no telegraphs, no cable, no telephones to keep them informed of the progress of their silk caravans and ships, and who had not even a dream of a country to the west of them, which some day would transport the self-same silk by strange ships which speed over the waters without wind and by even faster caravans which, headed by a black monster spurting smoke, furiously pound their way over miles and miles of shining track to a great city called New York, where the silk is bought and sold for industry.



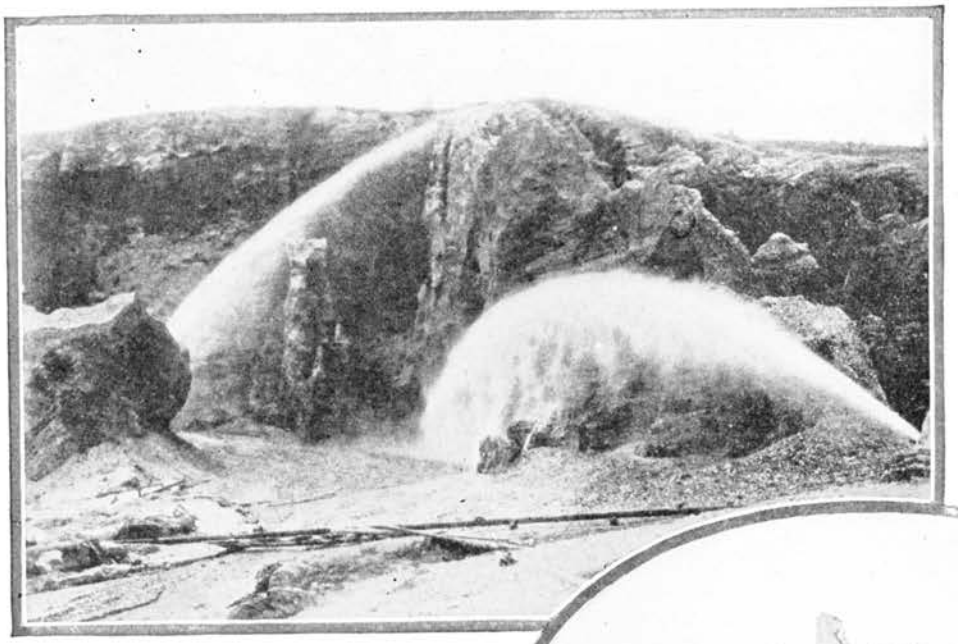
Silk and cotton are here being braided on telephone cords.



The cords which reach from your telephone instrument to the box on the wall or desk are covered with a silk braid to insulate and protect the wires. Too, there is a silk insulation wrapped around the copper wire inside the cord.

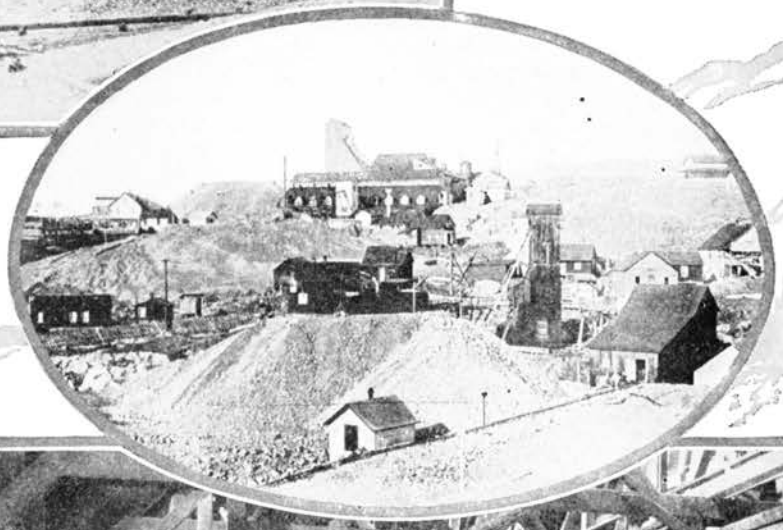
The Story of Precious Metals

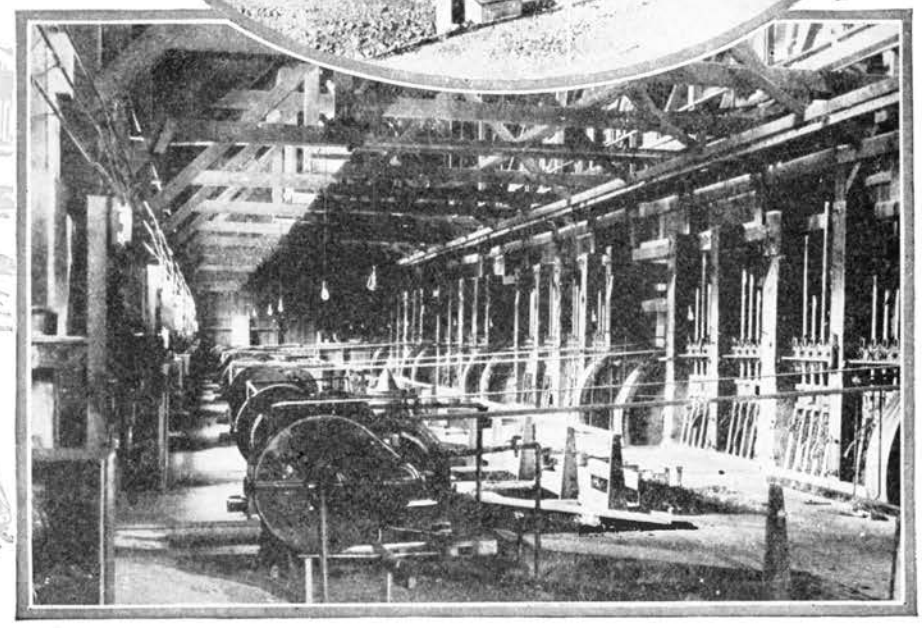
Gold, silver and platinum, for centuries the objective of the adventure seeker and the explorer, have lost a large part of their romance today, for their mining and separation from other metals have become a business in which the engineer, the chemist and the banker rule.



In some places powerful jets of water are turned against a hill to wash down the soil bearing the golden grains.

Below—In this silver mine the ore is found in veins of quartz and must be mined by digging deep shafts and blasting out tunnels.





Dredging gold-bearing sands from the Yukon.

Stamps like this crush to powder the gold ores so the golden grains and other valuable metals can be separated from the worthless materials.

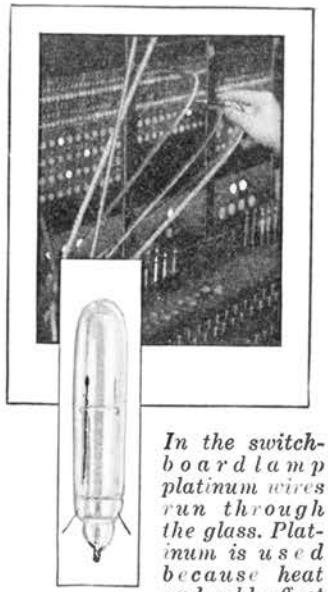
In Your Telephone

Gold and silver have been precious metals since the time when the women of ancient Egypt and Assyria wore gold and silver jewelry and the leaders of warriors used these metals to decorate their arms and armor. Platinum, on the other hand, has been known to us only since the eighteenth century, although today it is the most costly metal in commercial use, its market value ranging from ninety to about one hundred and twenty-five dollars a troy ounce.

About seven centuries before Christ, a coin was made from an alloy of gold and silver. This, the oldest coin known, is called the Babylonic Stater. Not more than 200 years later in the days of the Persian king, Cyrus the Great, the King of Lydia stamped his royal insignia on lumps of gold and thus made the first gold coin that had a definite value and was used in trade.

Down through the centuries that followed, the traders who carried the names of Tyre, Carthage, Alexandria, Florence, Genoa, Venice, Flanders, and England far and wide, used gold and silver in their trading. Later with the expansion of international trade which followed the Crusades, men became possessed with such a desire for gold that the scientists of that day and age working in secret spent their lives trying to turn silver and other comparatively cheap metals into precious gold. Of course, they failed but their researches with metals and acids resulted in the so-called science of alchemy, which might be called the father of today's wonderful science of chemistry.

Then came the days when the Turks captured Constantinople. Columbus sailed west and Vasco da Gama went around Africa in search of India and the East Indies. Out of these explorations came the discovery of many new lands which have produced great wealth, but not in the form of gold or silver. Peru and Mexico turned out to be the only real El Dorados or Lands of Gold for the gold-seeking Spaniards.



In the switchboard lamp platinum wires run through the glass. Platinum is used because heat and cold affect it to about the same degree as glass and therefore the wires do not shrink away from the glass and let air into the lamps.

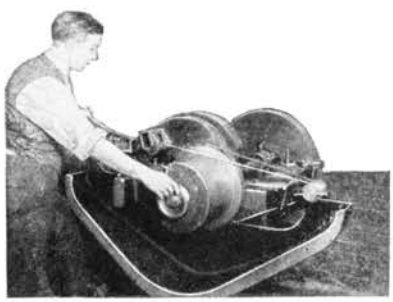
Today the world's gold and silver come principally from Alaska and the Klondike, our Rocky Mountain states, the Transvaal in South Africa, and Australia. Huge sums are invested in machinery to bring the ore to the surface and to separate the gold from the other metals with which it is frequently combined and the useless material dug up with it. Most platinum comes from the Ural Mountains between old Russia and Siberia, but Colombia, Borneo in the East Indies, and British Columbia are also producers in quantity. A few of our states produce small quantities of platinum.

Gold is frequently found uncombined with other metals, although it usually occurs in ores also containing silver and small quantities of copper or iron. Besides being mixed with gold, silver is often found combined with lead and zinc and copper.

Mining gold and silver with a pick and shovel as you see it in the "movies" is no longer a commercial practice in the more advanced mining districts. Although platinum from the Urals is still frequently obtained that way, the more advanced methods for getting gold and platinum are to dredge up river sands to secure the material for refining; to wash down hillsides or to blast out ore from mines in native rock. Silver is usually brought out of the earth as part of an ore containing some other metal.

Once the material carrying gold, silver or platinum is taken from its native river or hill it goes to the refineries where some of the processes, shown in the illustrations, are used to purify it for the uses of art, commerce and industry. These industrial uses are quite recent and make the precious metals more precious than ever before.

One of the well-known uses of silver (as a nitrate) is in photography, while platinum finds a hundred uses in



For telephone work platinum frequently must be drawn into wire, some of which is later rolled into thin ribbons and some is used as wire in the switchboard lamps and vacuum tubes

The combination of gold, silver and platinum resists corrosion and wear, From thin ribbon such as this man is making, discs are punched and welded onto springs to provide contacts.

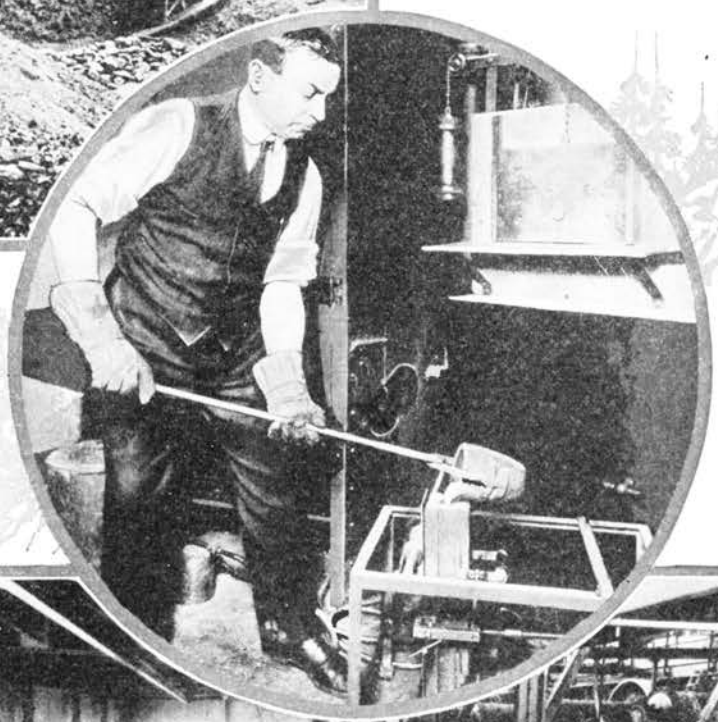
The Story of Precious Metals

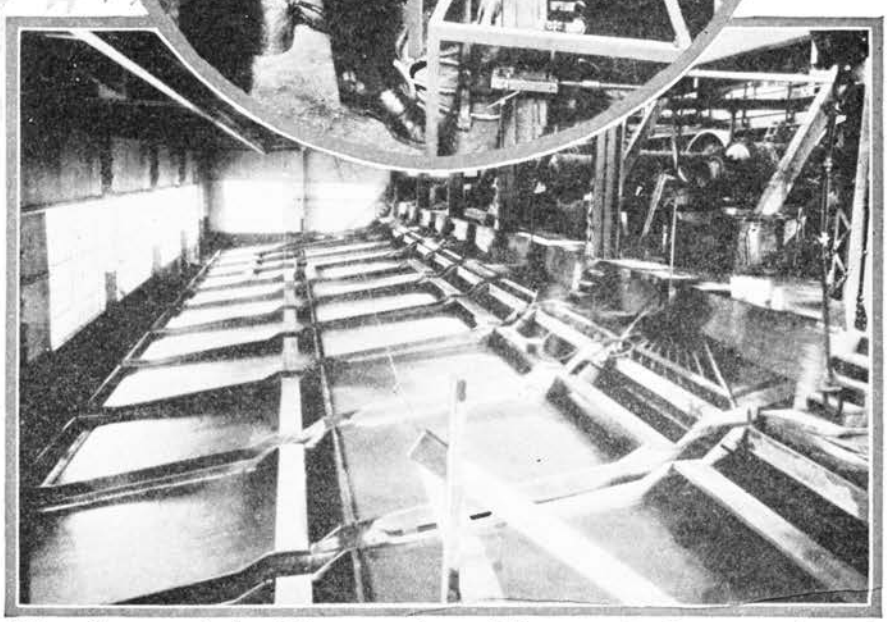
Gold, silver and platinum, the precious metals for centuries because of their purity, and use for ornaments, decorations and coins, are now more precious than before because Industry finds them more suitable than any others for certain uses.

PHOTO © by UNDERWOOD & UNDERWOOD

A gold mine in the Klondike.

Below—Pouring the mixture of gold, silver and platinum which plays a part in your telephone conversations.





Mining gold in the days of the Forty-Niners.

When the amount of gold in an ore is small the concentration process is used to eliminate materials that contain no gold. Sometimes this is done by passing the finely crushed ore over plates covered with quicksilver which the gold or silver join and from which they are afterward separated by heat.

In Your Telephone

The two points on these upright springs are made from a gold, silver and platinum alloy. When you take the receiver off the hook, these springs come together until the points make contact—a path over which the voice currents travel.

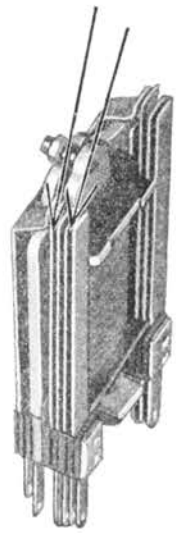
scientific instrument manufacture where wires often thinner than the finest strand of hair are used—in the manufacture of chemicals—in surgery—and in laboratories where its ability to withstand intense heat and metal-dissolving acids makes it valuable.

One of the interesting uses of these metals in industry is in the manufacture of electrical equipment. For instance, gold, silver and platinum are in your telephone instrument on the contacts which make and break electrical circuits and on the relays which open and close other pathways for electrical currents—so that you may call your operator; so that she can make connections to other exchanges and to the party you are calling.

When you call a number which is in the same exchange as your own the lifting of your receiver off the hook sets in operation 21 relays, many of which operate several times during the call and each of which has one or more of these precious metal contacts. If you dial your number there are 146 relays, each with one or more contacts which work one, two, three or more times during the operation of getting your number.

All the tiny lights which flash up in front of the operator to call her attention that numbers are wanted, that parties called have or have not answered, or that both parties have hung up—have platinum in the wires which support the light giving filament, similar to that in the electric lights in your home, but with this difference, that the filament in the lamp in front of the operator is made of carbonized paper.

Probably you are wondering why precious metals are used in a telephone system. The reason is that these metals are least expensive over a long period of time for they resist the corrosive effect of the atmosphere which otherwise would in time put your telephone out of order. Used as contacts, their surfaces always stay bright and clean and thus provide a good pathway for the electric currents used in telephones. Although these contact points are very small and light, the combination of metals in them offers good resistance to the wear caused by rubbing as they touch each other.



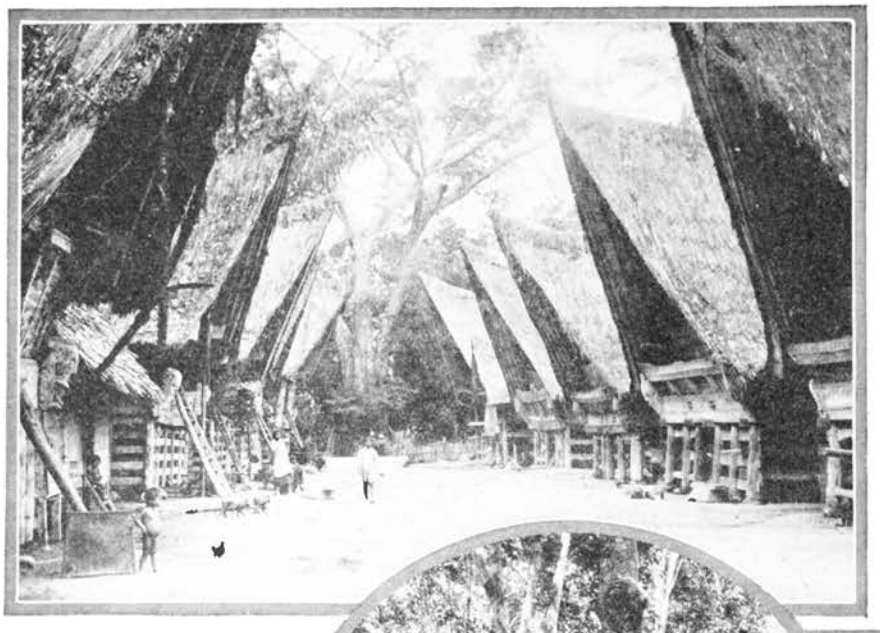
There are contact points of gold, silver and platinum between the leaves of this relay and when a current passes through and operates it, making some of the leaves go together, the contact points establish new pathways for currents and thus the relay performs its part in a telephone conversation.

This girl is electrically welding contacts of gold, silver and platinum alloy on springs which will go into telephones.

The story of platinum in the lamp is a little different. The wires which carry current from the outside of the glass to the inside of the lamp have to pass through the glass. As the lamp burns it heats the glass. Platinum is the only metal we now know which changes its size with heat and cold at the same rate that glass does. Therefore, platinum is used, as it does not tear away from the glass and let in the air which would spoil the lamps.

The Story of Rubber

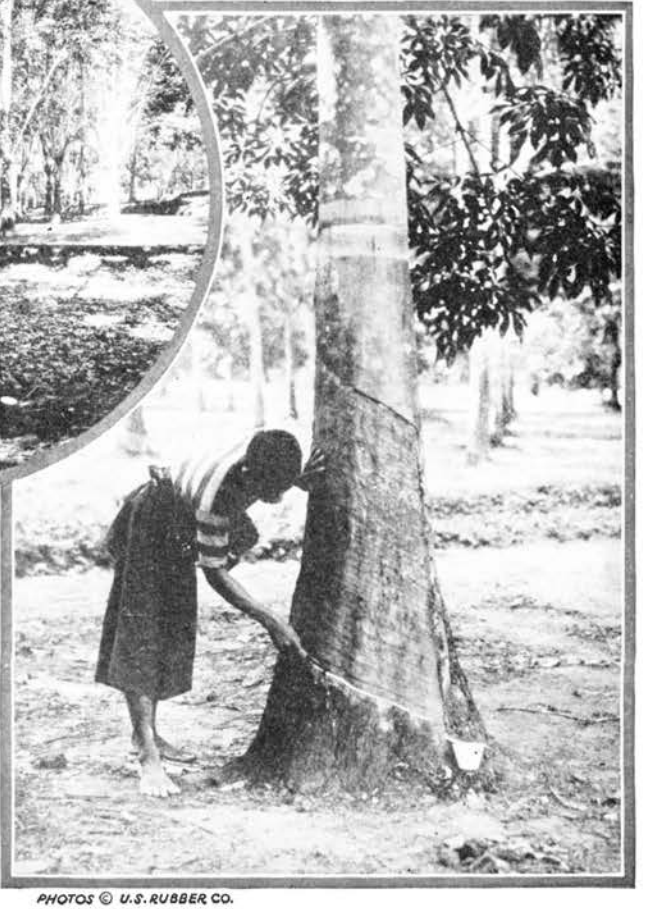
Rubber came to the knowledge of Man with Columbus' second voyage but this humble product, which could have made the Caribbean Islands a profitable field to cultivate, was overlooked in the more romantic search for gold.



Left—A native village in the Island of Sumatra.

Rubber trees on an East Indian plantation.

A Brazilian native smoking latex in an Amazonian forest.



PHOTOS © U.S. RUBBER CO.

Gathering rubber on an East Indian Plantation.

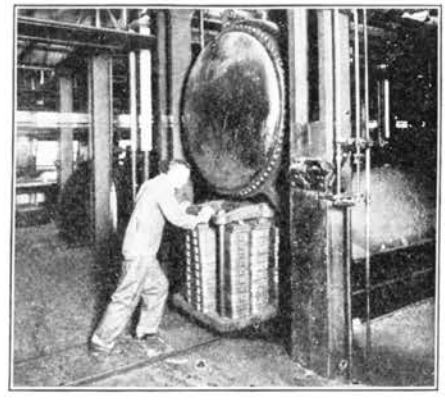
In Your Telephone

Four nationalities have played an important part in the history of rubber—an Italian discovered it, an Englishman gave it its name, a Scotchman put it to commercial use, while an American discovered how to vulcanize it.

On his second voyage, Columbus found the natives of Hispaniola (Haiti) playing with balls of an elastic substance. It was one of the many strange sights experienced by the discoverer of the New World and made him also the discoverer of rubber.

The Spaniards soon learned to waterproof their canvas cloaks with the fluid from the rubber trees and also made shoes of it.

Some of the crude rubber in time found its way to England where it was considered a curiosity and plaything with no commercial value. But about the time of our Revolutionary War a famous scientist in England by the name of Priestly, who also discovered oxygen, found that this curious material would rub out lead pencil marks. From that time on English speaking people called the queer substance "rubber." Other nations have imitated the word used by the natives for the tree, the French spelling of which is caoutchouc (koo-chook).



To bake and vulcanize the rubber for your telephone receiver, truckloads of moulds containing the rubber strips, shaped like half of a receiver, are pushed into an oven.

From long narrow strips of soft rubber, machines punch out pieces, shaped like half of the receiver rolled out flat.

Little more was learned about rubber for more than fifty years but about that time a Scotchman named Mackintosh, found a way to use rubber for waterproofing cloth and started to manufacture rubber-treated clothing. The word "Mackintosh" is still sometimes used in speaking of raincoats.

But the rubber overalls and coats made by the firm of Mackintosh did not make ideal wearing apparel. Even the best qualities of rubber get soft and sticky in hot weather and stiff in cold weather. Indeed, little rubber would be used today if some one had not discovered a way to treat it so that ordinary changes in temperature would not affect it.

The very year Charles Goodyear was born the first rubber was brought into this country. Thirty-nine years later, Goodyear, almost despairing of finding the secret he had worked on for so many years, accidentally discovered the process which made possible the huge rubber industry of today.

A piece of rubber containing sulphur slipped out of Goodyear's hand and fell into the stove. The heat completely changed its qualities—it was no longer sticky, it stretched and bent without breaking and retained those qualities in high or low temperatures.

The process, which he afterwards developed, and which he called vulcanizing, after the Roman god of fire, is a necessary step in turning rubber into tires, conveyor belts, rubber belts and practically everything made from rubber or having rubber in it.

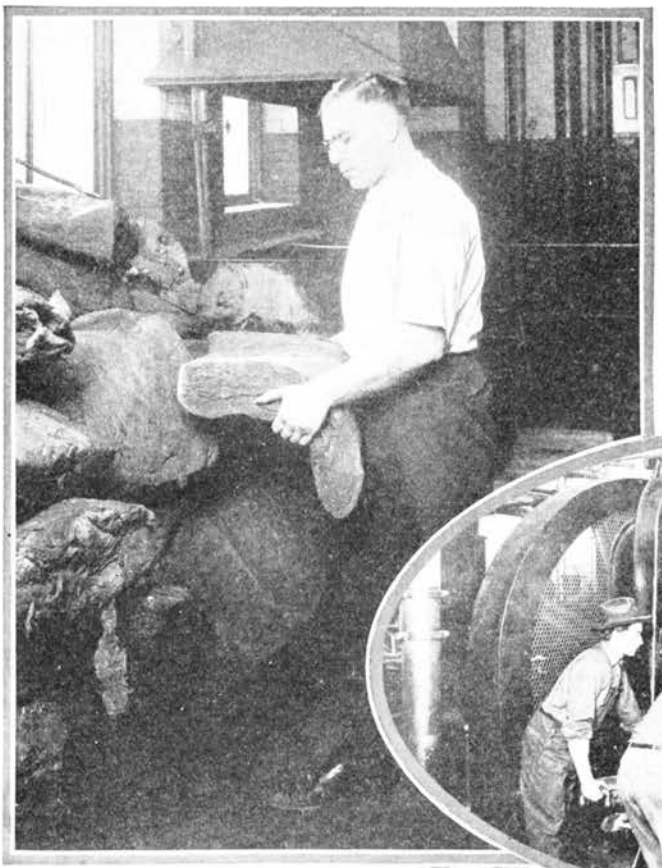
The best known of the rubber trees in South America is the Hevea (Heé-ve-uh) tree. This tree growing from 60 to 100 feet high with its branches starting about 45 feet from the ground is found in the warm, damp jungles of Bolivia and Brazil and also in Mexico and Africa.

The juice from which rubber is made flows from the tree and is soon used before it hardens and turns black. This latex, as the juice is called, is a milk-like fluid circulating just beneath the outer bark. It is distinct from the sap. To collect it from the trees, gashes

To make a telephone receiver, a sheet of rubber, shaped to form half a receiver, is laid in a mould then a metal core is laid upon it and another sheet of rubber is laid over the core. Thereupon the operator puts the top on the mould and it is ready to be loaded on the truck and sent away to be baked.

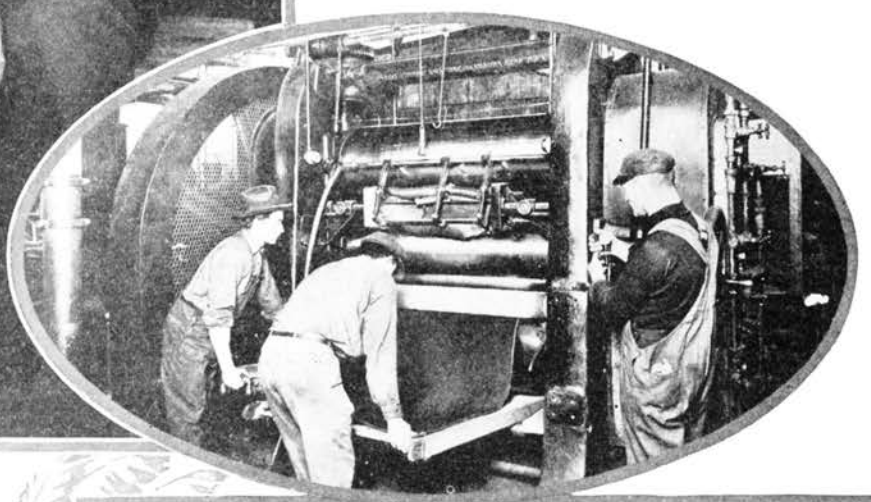
The Story of Rubber

Today, rubber touches our daily lives in telephone communication, transportation, production of the garments we wear the foods we eat, the games we play and in a hundred other ways.

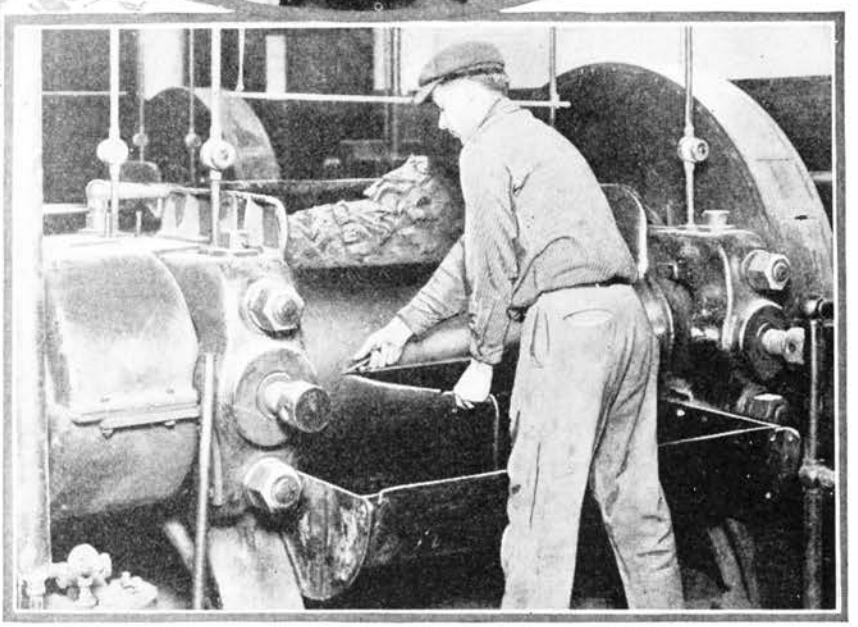


Left—Crude rubber as it comes to the telephone factory to be made into telephone receivers and other hard rubber parts for the telephone system.

Below—Rolling and rerolling rubber sheets to obtain even surfaces and uniform thickness.



Where the rubber is loaded at an East Indian port.



Partially rolled sheets are slit and put through the rollers again and again to knead in the sulphur and other ingredients for vulcanizing the rubber.

are cut in the bark through which the liquid drips into dishes.

In the Amazon region the latex is smoked in a smudge made from palm nuts. The smoke of

Sheet rubber baked and vulcanized is used for the receiver of your telephone and moulded rubber dust is used to form the cap of the receiver.

the palm nuts is a chemical agent which transforms the latex into the crude rubber of commerce.

On rubber plantations the rubber part of the latex,—which is composed of rubber and resin,—is made to curdle by chemicals. The curds are washed, sheeted and after being dried are smoked in hardwood fumes to prevent possible spoiling.

Rubber dust is poured into moulds like that the operator has before him and dies are inserted. When heat and pressure have vulcanized the rubber contents of the mould, receiver caps result, ready to be smoothed to the glass-like surface you have so often felt against your ear.

To make this crude rubber of use to industries it must be mixed with sulphur and other substances and heated to a certain temperature for a definite length of time. Ebonite or hard rubber is made by adding about 30 to 35% sulphur to the ordinary mixture.

It would be difficult to name all the things met with in our daily lives and made wholly or partly of rubber. It is worth while to know, however, that new uses for rubber are being discovered every year. As a result we use things every day that we scarcely realize are rubber because the article made of it looks so little like rubber.

For instance, the shell of your telephone receiver, the part you grasp to place at your ear is of sheet rubber, while the cap at the end which actually touches your ear is moulded of rubber dust. There are hundreds of telephone parts used in different places in the vast equipment that makes up a telephone system produced from sheet rubber. Then, too, rubber is used as insulation on some wire which provides pathways for electric currents.

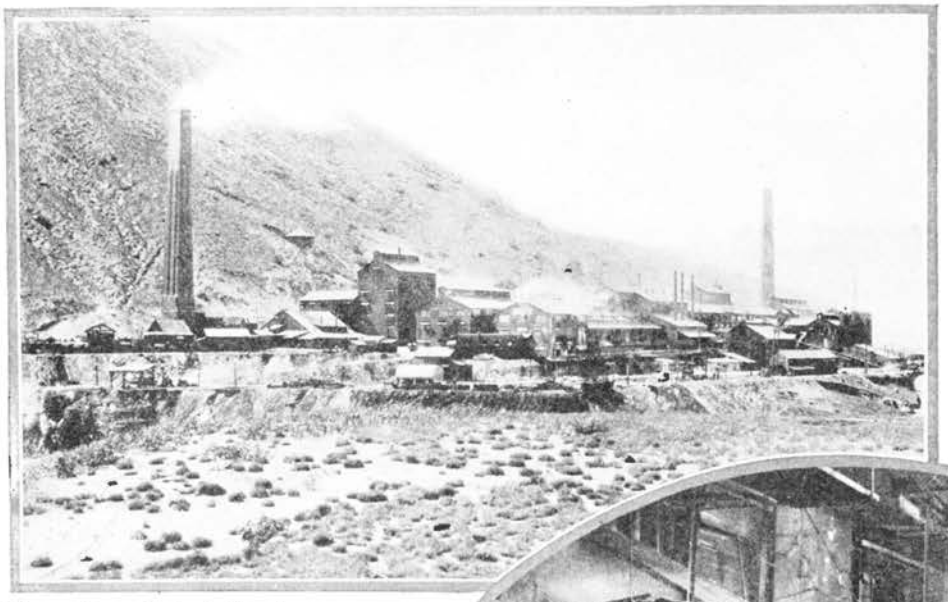
The hard rubber receiver of your telephone owes its smooth surface to the fact that it is trimmed smoothly by diamonds. The diamonds indicated by the arrows are here shown trimming away the rough edges.

Rubber is also used in many places throughout the equipment that goes to make up the telephone system—insulators, bushings, the tops of switchboard keys, key shelves, and number plates used on switchboards.

While Brazil is the original source of our rubber supply and for years furnished the world from its wild rubber trees, of recent years plantations in the East have been supplying most of the world's raw rubber. Curiously enough, the East has lost first place in coffee raising in exchange for leading the world in crude rubber.

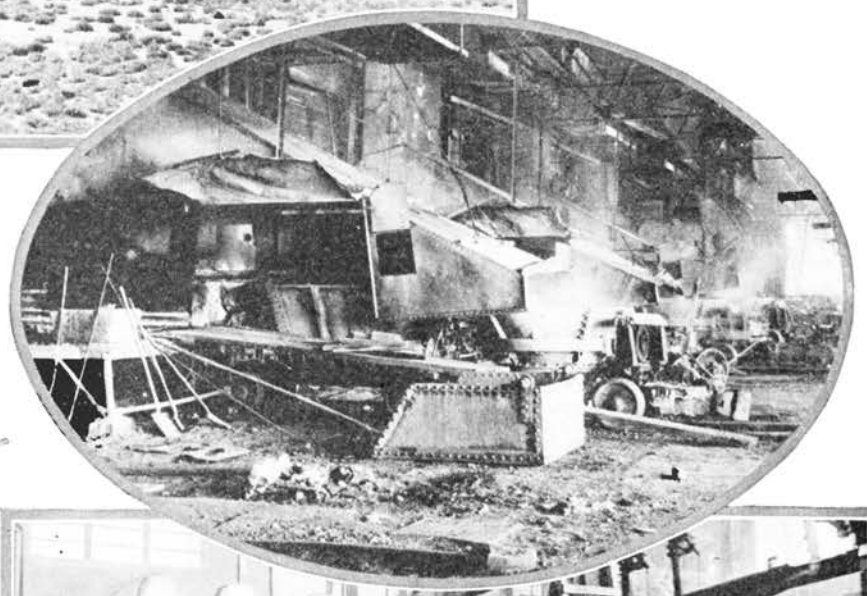
The Story of Lead

Lead is often used instead of more expensive metals because of its lower cost. Its softness and flexibility make it suitable for many uses.

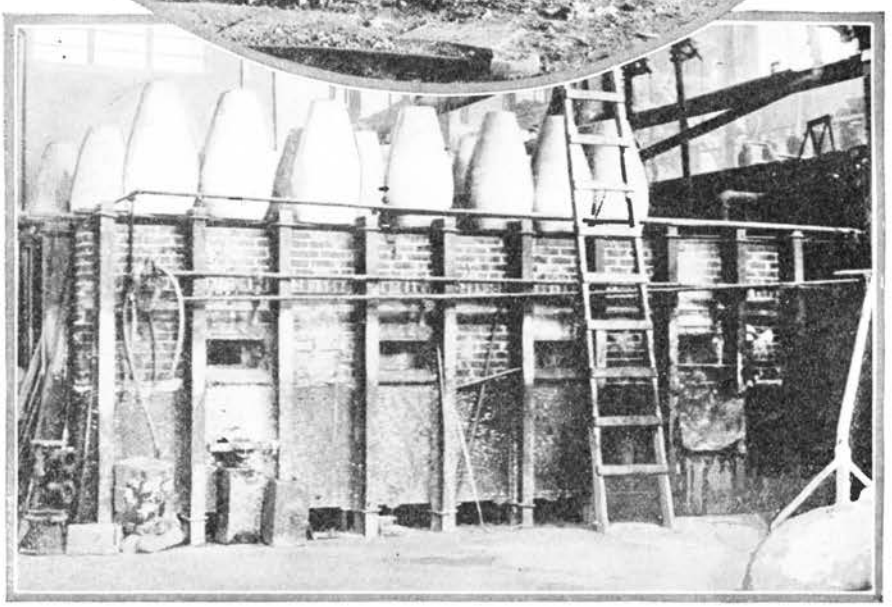


View of a typical big lead smelting plant.

Below—Lead and copper frequently are found together and part of the process of separating them is to smelt them in a blast furnace like this.



Molten lead flows from furnace nozzle to casting troughs to form "pigs".



Refining furnaces separate the silver or zinc often found in the ore with lead.

In Your Telephone

It is a clear crisp day and you are out skating. As you cut fancy eights and double eights on the ice you feel as warm as toast while George or Jim or Susie or Anne, dressed as warmly as you and skating just as fast, is cold with chattering teeth and numb fingers. Back indoors, however, you immediately begin to feel drowsy while the person whose teeth were chattering is wide awake.

There is lead in the telephone fuse wires which protect the telephone circuits.

In much the same way the more than fifty metals in the world differ from each other. Iron, for instance, is tough and can be made into everything from soft iron magnets, cast iron radiators, malleable iron for railway cars to steel axles, steel girders, steel wire and steel tools. Of all the metals it can play the most parts in industry.

Yet there is one thing about iron that makes it unsuitable for certain uses. It quickly rusts and if not protected will, in time, completely change into iron rust, or as it is technically called, iron oxide.

Lead scarcely possesses one of the good qualities of iron. It cannot be made into rails or girders. It is so soft it can be cut with a pocket knife or dented with a finger nail, *but it will not rust.* A thin film or tarnish quickly forms and this extremely fine coating acts as a protection against further oxidization.

Lead pipes have come down to us from the days of Rome, Pompeii and Herculaneum, while iron pipes and other iron objects of that same period have long ago rusted and turned to dust.

By giving iron a coat of lead in the form of paint today we help to keep it from turning into dust and thus give to it one of the good qualities which belongs naturally to lead.

On telephone switchboards in the large central offices (exchanges) there are nearly 4,000,000 soldered joints containing lead.

But this is only one good point about lead which we have come to think of as almost a precious metal because it has become so necessary to us. Besides its uses in paint it is used for roofing, to make queer looking gargoyles, and water pipes—in crankshaft, driving shaft, and connecting rod bearings—in solder—in type metal—in ammunition—in musical instruments—in petroleum refining—in glass, rubber, pottery enamels—and in electrical systems.

Many of these uses are almost as old as civilization. The Romans made waterpipes of lead and soldered them with lead. The slingers of Hannibal's army that invaded Italy used little lead balls for sniping at the Romans.

In those early days the mining of lead was sometimes done by prisoners of war of the Roman government; and in the remains of some of the old mines in Sardinia there are shafts so narrow that it is believed the men who cut them must have been lowered head downward and worked in that position. But today the miners in Missouri, or in Idaho, in Australia or in Spain would certainly laugh at you if you asked them whether they had to work with their heads down.

Lead miners have to deal principally with an ore called galena in which the lead is found joined together with sulphur.

Lead ores found near the earth's surface are usually easily smelted and sometimes contain considerable silver, but the ores for which miners go down into the bowels of the earth are more complex and generally contain zinc, copper and iron sulphides. To smelt the lead out of these ores and not lose the tricky, valuable zinc which would love nothing better than to go floating off into the air, was for a long time impossible. Now through a flotation process enormous amounts of lead-zinc ores, formerly thrown away, make up an important part of the world's yearly supply of these two metals.

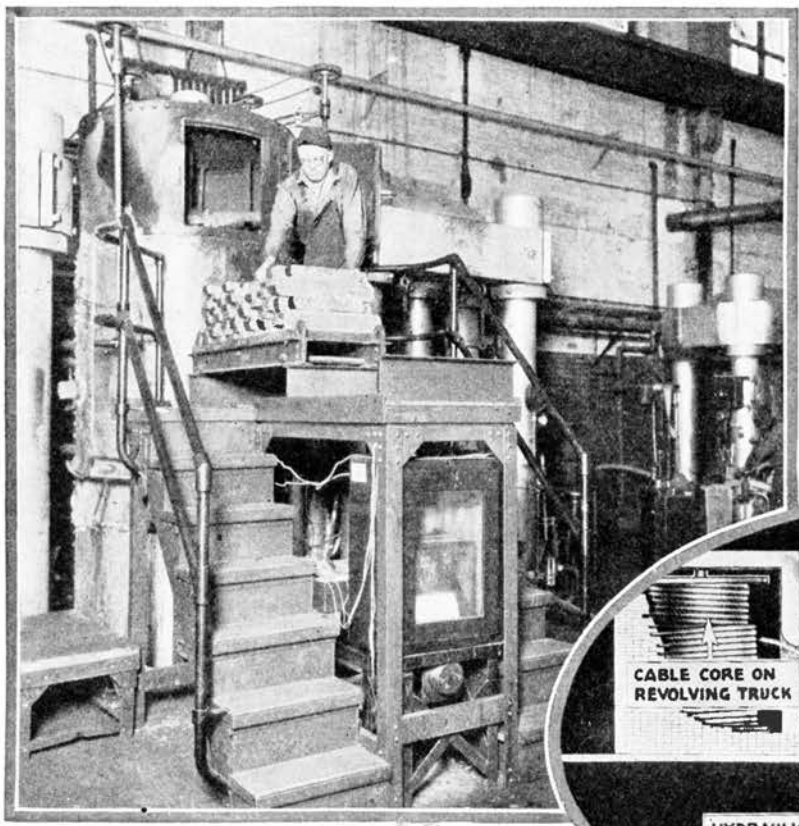
Zinc and lead, by the way, are almost always found together, the lead mines of Spain being the only ones with large outputs that do not also produce a large amount of zinc.

Among the largest users of lead are the telephone companies. The cables which you have seen strung on poles along streets, or at which you have peeked through manholes are covered with a lead and antimony jacket or sheath. Enough of this cable

In this familiar scene the telephone wires are being put underground enclosed in their protective sheath of lead and antimony.

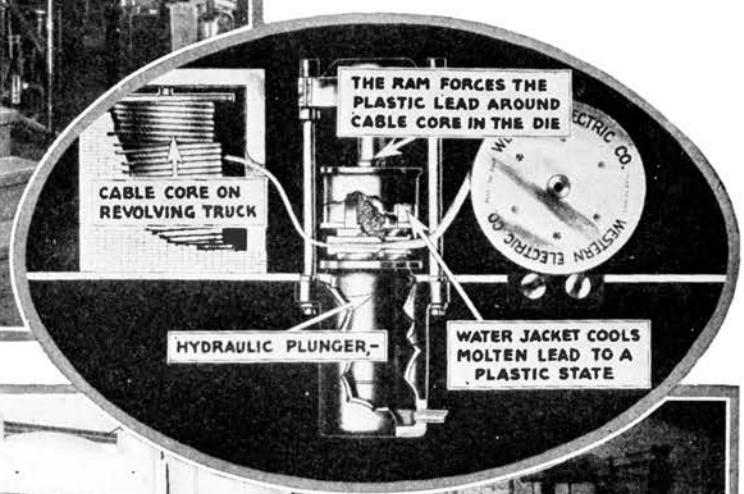
The Story of Lead

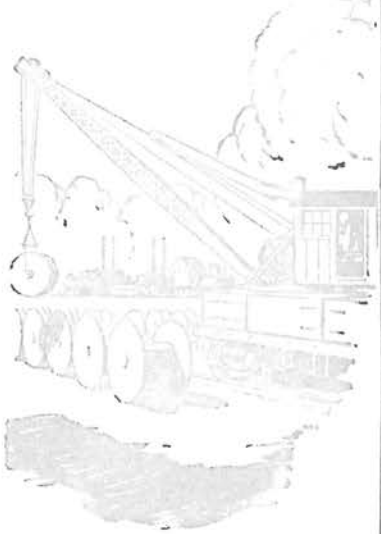
Lead easily combines with many other metals. This makes it useful in electrical goods, making type and paints, and in the widely used combination of lead and tin we know as solder. Another valuable characteristic of lead is that acids do not easily eat it up nor change its chemical nature.



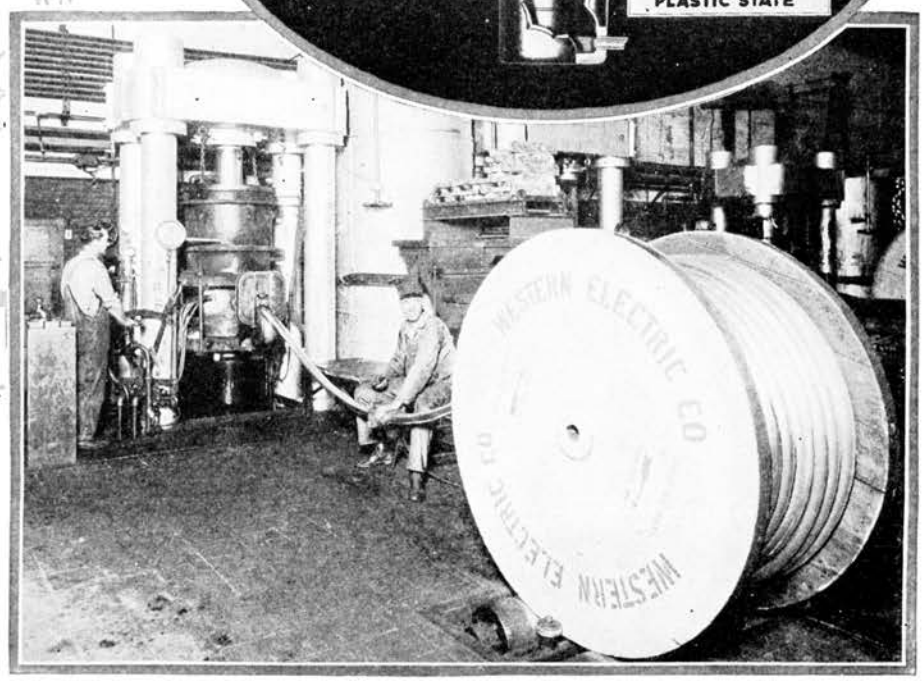
Left—Making lead sheathing to protect telephone wire starts with melting the pigs of lead for the lead press.

Below—In the lead press molten lead and antimony are poured into a compartment surrounded by a water jacket that cools them to a softness like putty, so not to burn the paper insulation on the wires. As the ram and the hydraulic plunger press toward each other, this plastic alloy is forced out through the same hole that the core of the cable occupies thus forming a covering around the cable core.



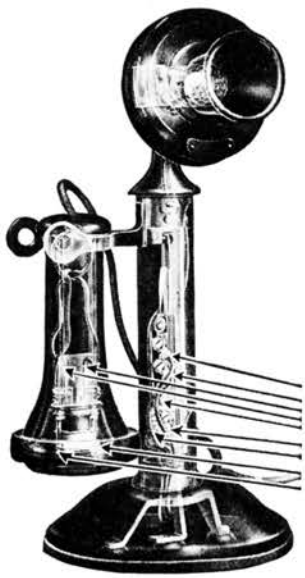


This electric storage battery crane locomotive handles cable reels and does the work of many men.



As the sheathed cable comes from the lead press it is wound on a reel which is turned slowly by the rollers under it.

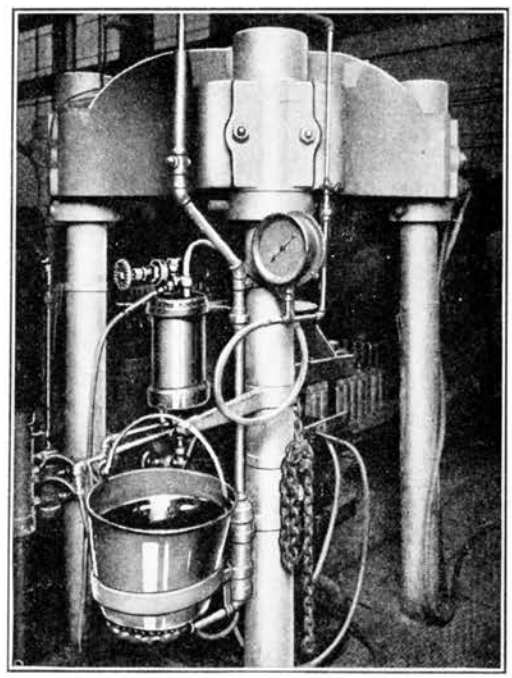
is turned out each year by the largest manufacturers of telephone cable to reach from New York to Shanghai (China) by way of the Suez



Solder, a lead and tin alloy, joins connectors to the telephone cord wires and receiver coil terminals.

Canal. Some of these cables contain as many as 2400 separate wires, but the average is 406 wires. The Western Electric Company uses about seven million miles of copper wire in a year's output of cable.

The use of the cable is to protect the wires and to permit many wires to be carried in a very small space. A hundred pairs of wires mean only a hundred private telephones. To string these on a pole would require twenty cross-arms with ten wires on each. The pole would have to be very high and in addition to this inconvenience there would be danger of the wires breaking under the strain of heavy gales or from the weight of sleet and ice. By using a cable, as many as 1200 pairs of wires can be brought together in a small space and protected by the lead covering. One of the reasons why lead is used for cables is because it will bend and can be handled easily. Besides, it is not greatly affected by changes in temperature.



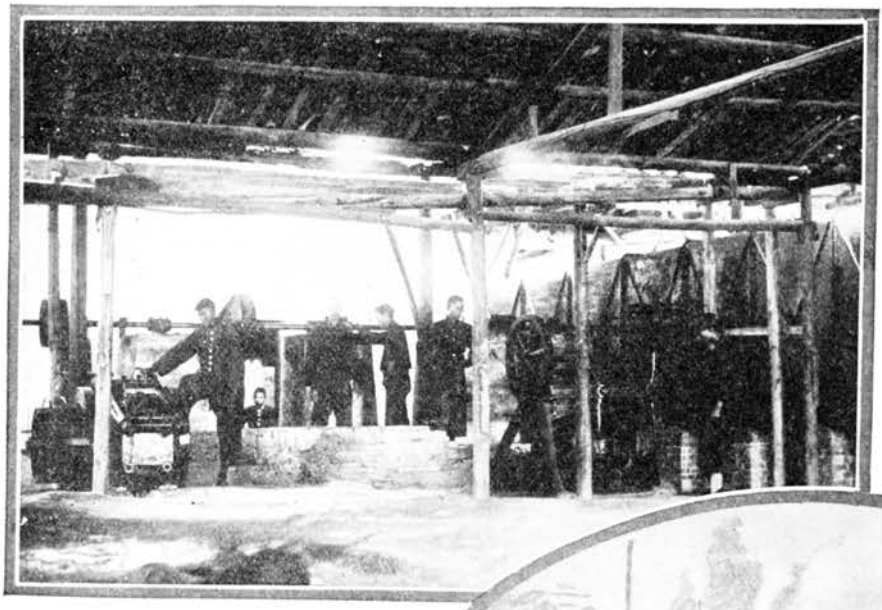
In this press, thin hollow lead piping is filled with rosin to make easy-to-use rosin core solder.

Lead is also used in your telephone instrument in solder, and on the switchboards in the central offices to solder together thousands and tens of thousands of wires.

In the yard of the world's largest telephone factory this overhead traveling crane picks up heavy reels of lead covered cable and carries them the length of the yard or across it in a very few minutes.

The Story of Antimony in

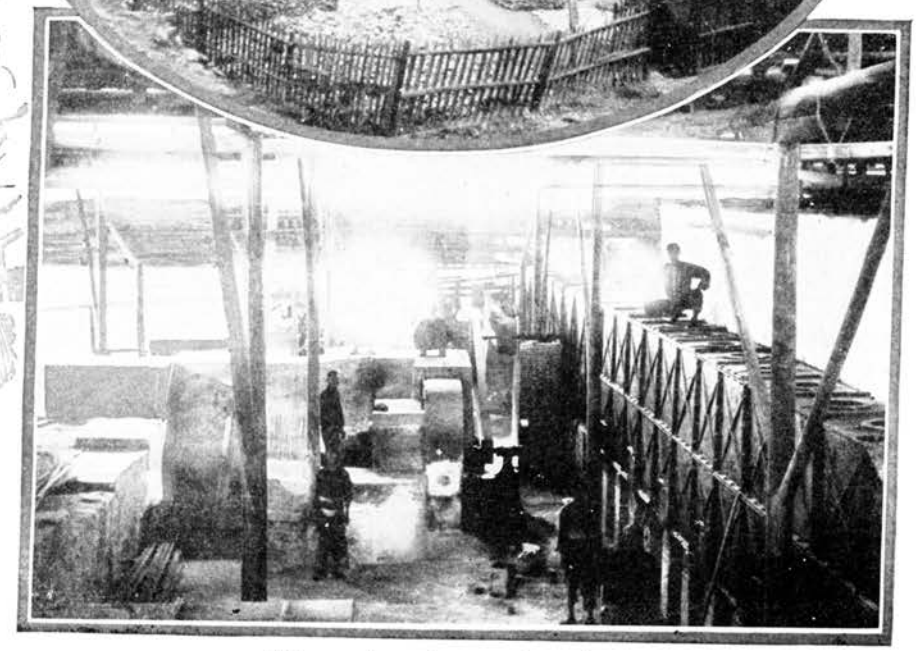
Antimony is widely used with lead for storage battery grids, type casting for linotype machines, and for telephone cable sheath. Its value for these purposes is in increasing hardness and strength of the alloy.



Left—Inside an antimony plant in the metal's home among the mountains of China where native laborers produce the antimony of commerce.

Right—Chinese antimony smelter where the first processes of separating antimony from the ore take place.

Native antimony smelter back among the hills in China.



Chinese at work near the mines.

Antimony is one of the metals that has few uses in industry. Yet no American daily newspaper is printed without the help of antimony, which with lead and tin forms the liquid metal out of which type is made.

The use of antimony dates back a great many centuries. It was employed by the ancients to color the hair and the eyebrows and to make the eye seem larger; all of which were thought to be marks of beauty.

A story by the great French writer, Flaubert, tells how Hamilcar, the father of the great Hannibal, upon returning to Carthage from a campaign in Sicily, made a tour of inspection through his slave-operated factories. In time he came to the departments of his factory which were making and preparing expensive perfumes and dyes for shipment. Hamilcar was displeased especially with the weight of the spikenard, an expensive perfume which was then worth about fifty dollars a pound. He found it took too much valuable spikenard to make a pound for commercial uses so he ordered the overseer to add antimony to increase its weight. Today we find honest uses for the silver colored metal.

Pigs of antimony are melted with pigs of lead to form the alloy composing the sheaths of lead covered cables.

In the middle ages antimony was used as a medicine and as early as 1500 A.D. it was used in type metal and for mirrors and bells. A few of these uses continue to the present day.

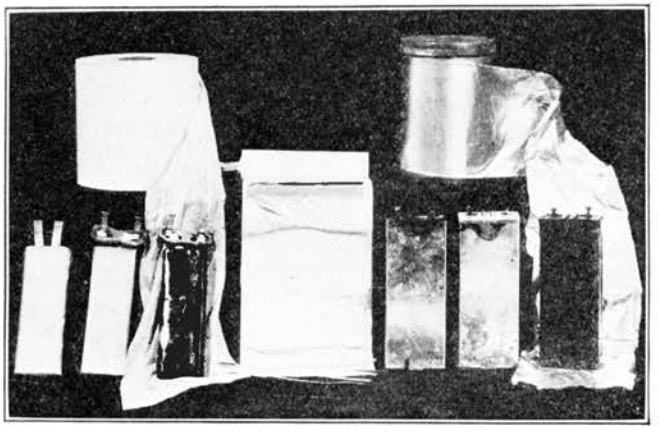
While we as a nation produce many of the raw materials that we use, there are a number of commodities which we have to go half way around the globe to obtain. Antimony is one of these. The world's demand for antimony is not large, although we use more than any other country and require more each year.

Most of the antimony ordinarily comes from Hunan, China, a province especially noted for its mineral deposits. During the Great War when large quantities of antimony were mixed with lead to make bullets and when the sulphide went into the primers to fire the shells and was used as a powder in smoke shells, some of our Western States mined antimony. The price of antimony, however, is not high enough to induce American mines to produce it in peace times.

Antimony ores, like those of mercury, occur in rocks of all geologic ages. Veins bearing antimony are as a rule rich only near the surface or to a moderate depth below. The Chinese having located a fairly rich vein, work out the ore as they find it without using any particular system and leave irregular-shaped chambers behind them which are often of considerable size and without proper protection, as the Chinese do not use timber supports in their mines.

In Bolivia, where the deposits of antimony are scattered over the high Andean plateau the ore is dumped into sacks which are loaded on llamas, burros or mules. The llama is the principal beast of burden in these high altitudes mainly because it will forage for its own food, no matter how barren the country may be. These animals will carry a load of 100 pounds of ore—but should the pack be made much heavier, they will refuse to proceed. Once ready for the journey only an Indian can drive the llamas, although one Indian can drive several hundred.

One of the largest uses of the silver-white, hard, brittle antimony in this country is to harden the lead sheaths which carry telephone wires under the streets and on lines of poles. By making the sheaths ninety-nine parts lead and one part antimony they are well protected against breaks and from wear by friction. While the percentage of antimony is small, it serves the purpose.



Antimony is used in the manufacture of condensers. At the top are rolls of insulating paper and the foil containing antimony, in the center a condenser unit slightly unrolled, while in the lower view are (left to right) a condenser unit after baking and impregnating; unit with outside terminals in place; unit after dipping; a condenser before cleaning and painting, and at the extreme right the finished product.

Other uses for antimony are in cheap tableware, toys, battery plates and acid-resisting valves, while antimony oxides are used in glass, enamels, paints, and in antique silver finish.

The Story of Paper

Old rope from riggings that have sailed the seven seas and rags of linen, cotton and other cloths find their way eventually into the paper that has been used for centuries to send written messages and to record commercial transactions.

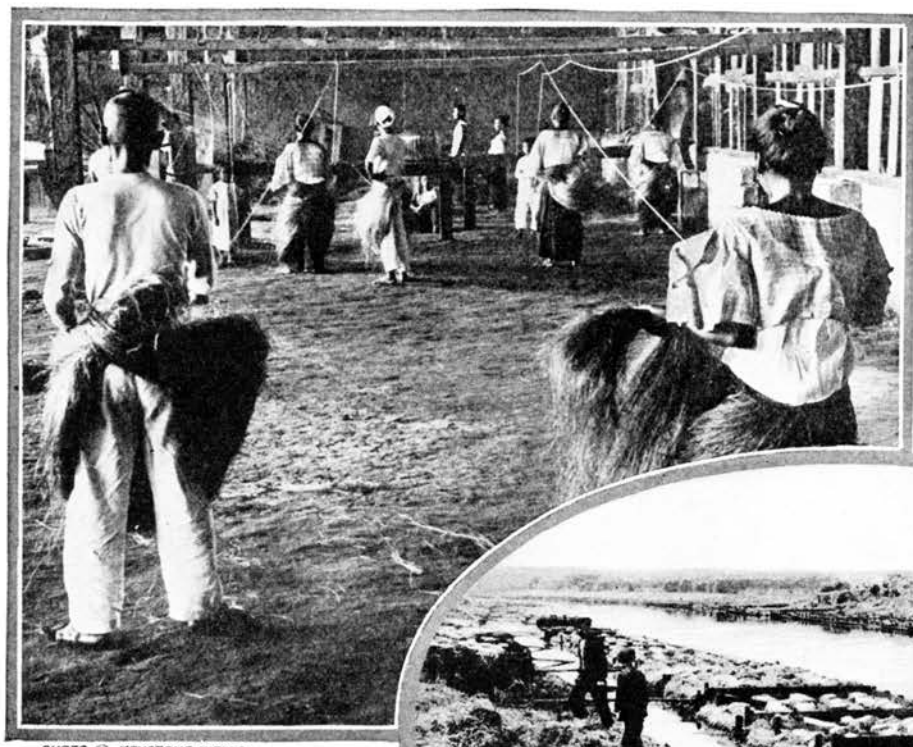


PHOTO © KEYSTONE VIEW CO

Left—Interior of a native rope factory in the Philippines.

Below—Loosening the flax fibres from the stalks by wetting them in a river where they are in crates weighted down with stones.

Photo by Keystone View Co.

A native of the Philippines cutting and trimming hemp trees.

© Barbour Flax Spinning Co.

Spreading flax fibres on toothed belts to convert the separate fibres into continuous even sized yarns.

In Your Telephone

Priscilla like other Puritan maidens had no fashion books or fashion films to guide her in her dressmaking but she may have treasured her frock more than the modern maid who, as often as not, buys her clothes ready made from a store. For the Puritan maiden made her own dresses from start to finish, often beginning her work before the cloth or even the thread was made.

And small wonder when fields of waving green flax were all around her and the spindle and distaff were in her home.

Most of us, however, think of flax and the making of fine linen as belonging to the old world. And this is as it should be. Irish linen has long been famous while Italy and Russia and Belgium have likewise been noted for the quantity and quality of the flax they grew. The old world has always raised flax and its history goes back beyond the days of Egyptian Pharaohs. No doubt you remember reading in the newspapers about the linen curtains found in Tutankhamen's tomb.

Paper made of linen rags is inserted as an insulator in the transmitter button of the telephone instrument.

One reason why flax still belongs to the old world is the personal care and attention the plant demands. In our country we rely on machines to help us do our work and so far no machine has been perfected to take the place of the men and women who patiently stoop over the slender pastel green stems to weed them and who just as laboriously harvest the crop.

Thus in Ireland the seed is sown by hand, the fields are weeded by hand and in the latter part of August the plants are pulled by hand, gently so as not to injure the fibre. The next step is to soak the bunches of flax in water to get rid of the gum in the straw and to make it possible to free the fibre from the useless stem. Sometimes this is done by spreading the flax over fields and allowing the dew to settle on it or by putting it under water, as is done in Belgium.

The fibre is actually separated from the stem in scutching mills by wooden blades which strike the straw as it is pushed across a shelf, thus beating off the broken straw and leaving only the flax fibres.

The flax then goes to a spinning mill to be made into thread. Here the short and tangled ends are removed while the long, finely split fibres are combed out into the tow used for the yarns and twines from which linen is made.

We now have the linen cloth from which many fine things are made. But in making fine tablecloths, dress goods and other linen pieces, odd scraps are left over. And after a time the pillow cases, embroidered table pieces, the tablecloths and linen dresses wear out and are thrown away as rags.

These scraps from linen factories, and rags from everywhere find their way to mills where they are changed into high grade linen paper.

First the rags are sorted, dusted, cut into small pieces and boiled in water containing lime. When they come out of the boiler the rags are of a brownish color. Then after being washed again they are beaten down to a pulp. When this is poured out onto a moving wire mesh, the linen fibres in the liquid crisscross and bind together. The product is then passed through heated roll after roll, which dries and presses it until it comes out at the end in large rolls as finished paper.

Linen paper is used in your telephone system in what is called the condenser. Now a condenser is a very simple piece of apparatus made in its simplest form of two metallic plates insulated from each other so that the current is unable to flow directly from one to the other. Yet it is very important.

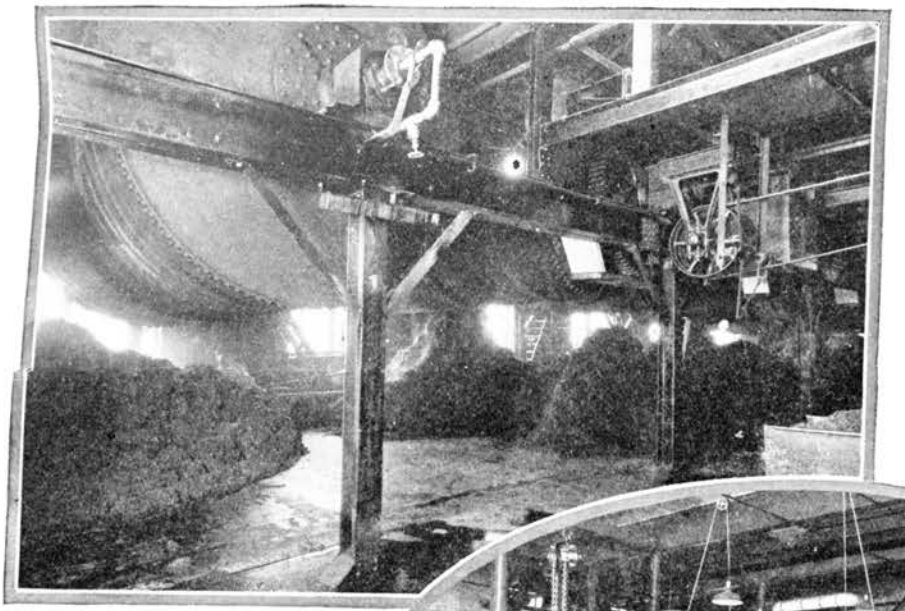
A strip of insulating paper is wrapped around each copper wire for lead covered cable. Different colors identify the wires. In the closeup the wire is seen coming up through the center of the flat roll of paper while the bobbin spins around it, wrapping the paper on in a long spiral.

And for this reason. A direct current is unable to flow through it while an alternating current can pass through freely—and telephone ringing currents are alternating currents, while the energy for talking over telephone wires is direct current from storage batteries.

Now there are many places where this direct current ought to go and many others where it should not go, and condensers act as policemen to keep it out of all the "should-not" places. One, for example, keeps the heavy direct battery current from flowing through the telephone receiver. This same condenser allows the alternating current to

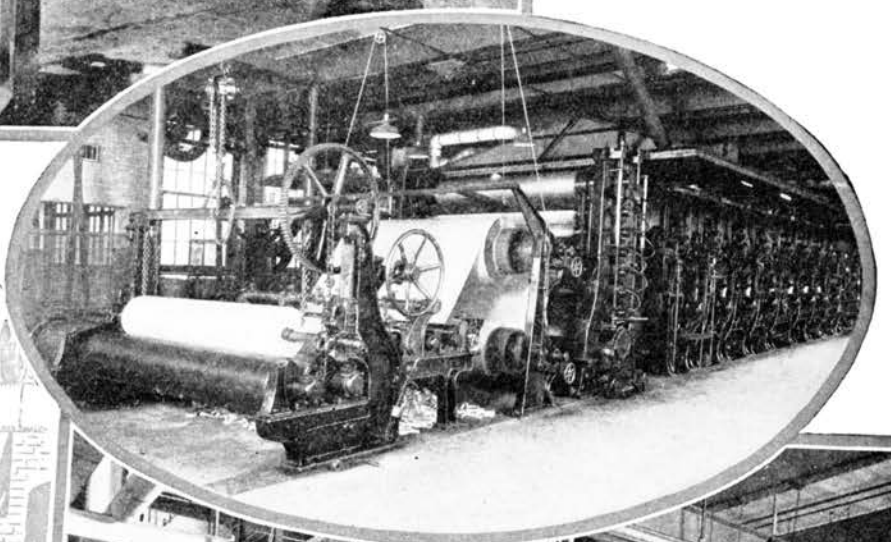
The Story of Paper

Today paper plays another part in the transmission of thought. It provides insulation for the hundreds of wires sheathed in the lead covered cables along the rural highways and under the streets in our large cities.

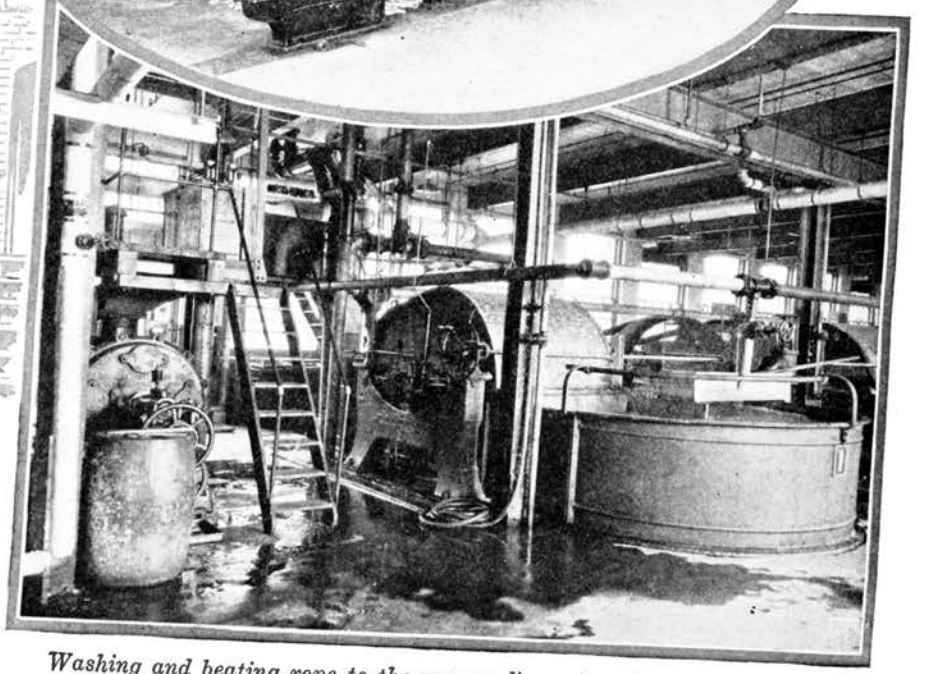


Below—The dry end of a paper making machine where paper is dried, calendered and rolled.

Cooking rope under pressure to remove oil, dirt, etc.

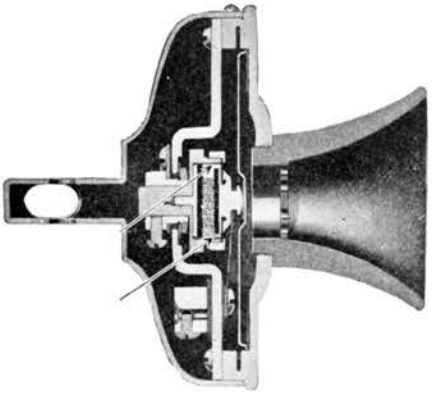


Cutting rope and separating fibre yarns.



Washing and beating rope to the proper dimensions for paper making.

pass through the telephone bell ringer, while at the same time preventing the direct current from the central office batteries from flowing



Linen paper used as insulation lines the walls of the little metallic cylinder which contains the granulated coal.

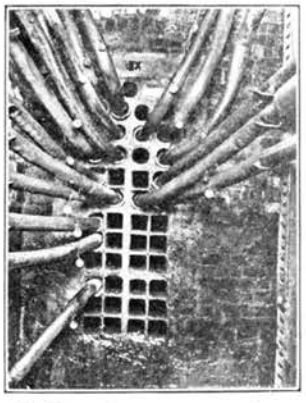
continuously through the ringer coils when the receiver is on the hook.

The Western Electric telephone factory in Chicago makes about three million telephone condensers a year. Most of these are made by taking two strips of tinfoil and four strips of paper and winding them together so that each foil strip is separated from the other by two paper strips. This is followed by various processes such as treating them with wax, dipping them in an asphalt mixture and sealing them in small containers. In making some kinds of condensers, mica is used in place of paper since it is also a good electrical insulator.

With a telephone that will talk when you want it to talk, you must be sure that your voice will not get off the track on its way.

Here again paper works for you—although in this case the paper used is not made from linen but from Manila hemp. This paper insulates the wires in the lead covered cable.

Six thousand miles from San Francisco and half as far again from New York, a group of islands some 3,000 in number rise out of the placid waters of the Pacific. On these Philippine Islands, which fly our flag, is raised a hemp which is really not a hemp at all but a species of banana which bears no fruit.



Under the streets from manhole to manhole the lead covered cable carrying hundreds of pairs of wires lies in clay conduit, either square or round.

This Manila hemp is only grown on these Islands. The Filipinos cultivate the plants, weeding them when they are young. Just before the time for flowering, they cut the plant down near the roots and split it open so that the sun can dry the fibre. After this the fibre coats are scraped. Two natives can cut and scrape about twenty-five pounds of the fibre in a day.

The outer fibre which is hard and strong is used to make stout cord and rope. The layers next to these are made into web cloths and gauzes while the inner fibres are woven into delicate fabrics like the "grass cloth" the French manufacture.

To make Manila hemp paper only old rope can be used. For these old pieces of rope which have served their day on ships and farms make the strongest of papers. The rope is reduced to a pulp which is treated in much the same way as the rag pulp already described.

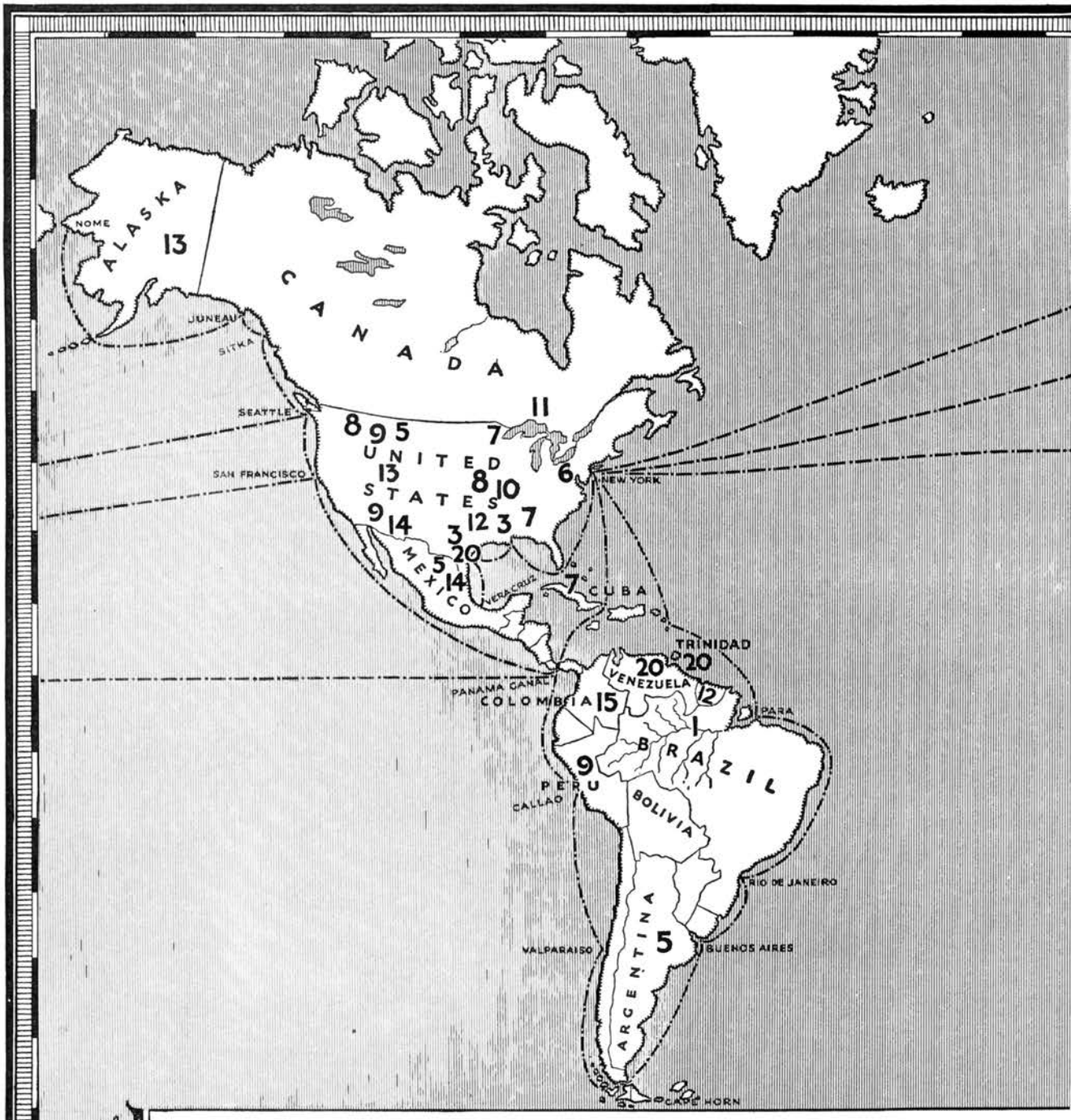
The pair of wires for your telephone if they form a part of a lead covered cable are separately wrapped with this hemp paper to keep them from touching each other. Then this pair of wires is twisted together as are all the other pairs in the cable. And around the whole bundle of pairs is wrapped a layer of hemp paper over which the lead sheathing is placed.

This shows the paper wrapped wires in a cable and the paper wrapping around the entire rope-like group of wires, just as the cable core looks before it receives its sheath of lead and becomes real lead covered cable.

Still a third kind of paper is used in the telephone circuit. Since this page which you are now reading contains carbon (a diamond is carbon as well as the graphite in your pencils and coal has a great deal of carbon in it) it is possible by an interesting chemical process to change the carbon in paper into filaments which glow in switchboard lamps when a current passes through.

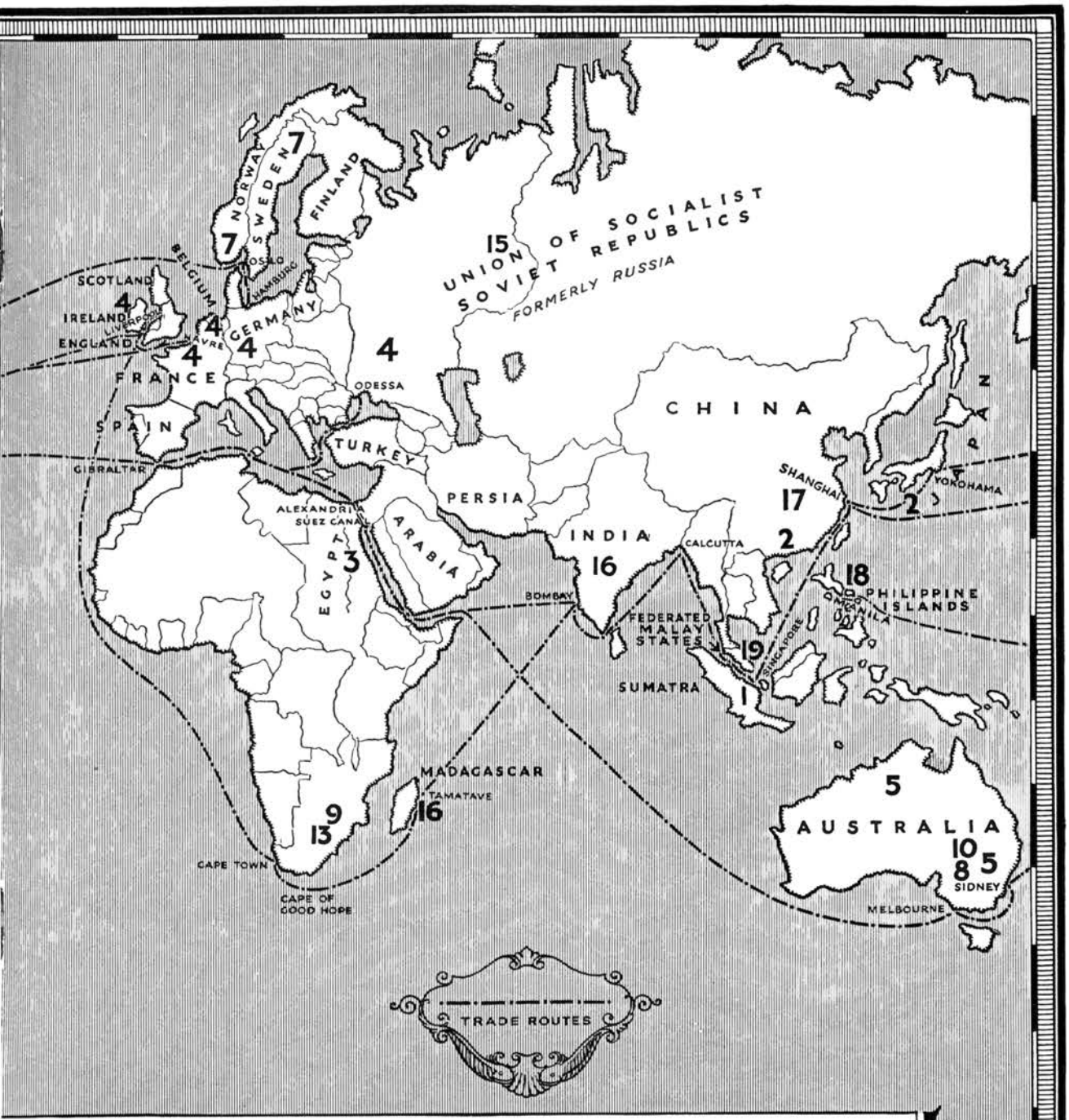
Thus the switchboard lamps which signal your telephone operator that you want a number or that you have finished talking are lighted up by filaments which were originally paper.

The Materials which make up your T



1	*Rubber*	5	*Wool*	9	*Cop*
2	*Silk*	6	*Coal*	10	*Zinc*
3	*Cotton*	7	*Iron*	11	*Nic*
4	*Flax*	8	*Lead*	12	*Alu*

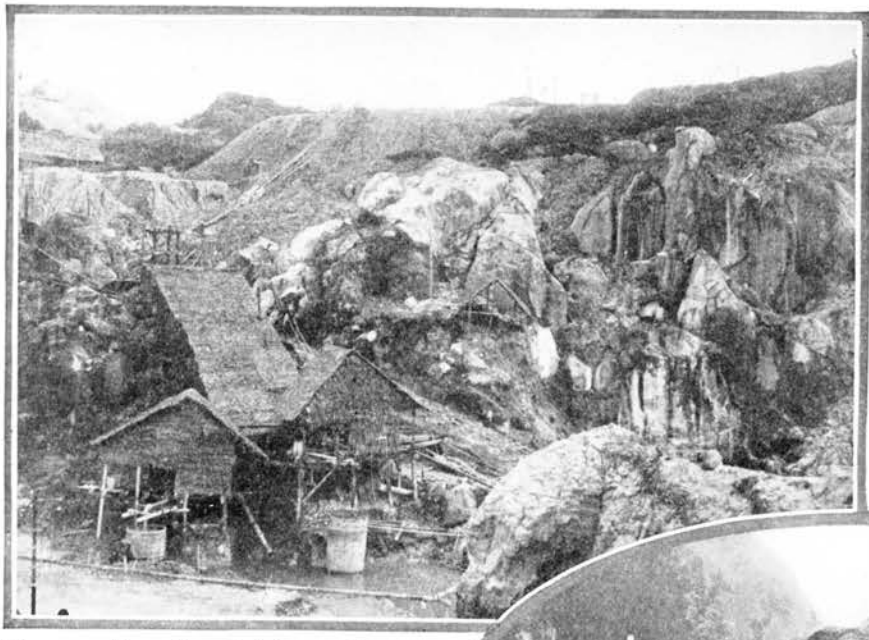
Telephone and where they come from



r	*13*	*Gold*	*17* *Antimony*
	14	*Silver*	*18* *Hemp*
!	*15*	*Platinum*	*19* *Tin*
num	*16*	*Mica*	*20* *Asphaltum*

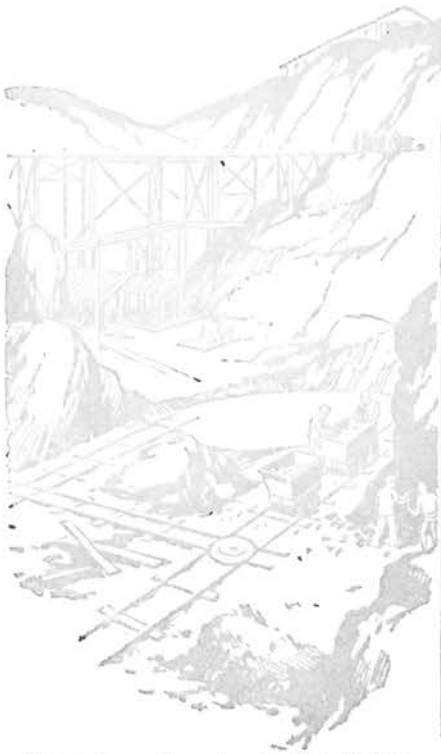
The Story of Tin

Tin has two chief uses in Industry. It is a part of the solder used to join metals and, as a covering on sheet iron and steel, it forms the so-called tin used for roofing, making tin cans and pails for paints and food, and lends itself to a thousand and one other articles.



To carry the soil containing grains of tin up from the mine it is dumped into the water that gathers in the low parts of the mine. Then pumping the water to the surface brings the tin up, too.

Below—These riffles for gathering tin from the gravel are long chutes with cleats across the bottom. As the water carrying the gravel and grains of tin flows along, the heavier tin sinks, is caught against the cleats and is recovered later, while the other material and water flow away.



Down in a tin mine on the Malay Peninsula.

After the tin has been separated from the gravel it is put in bags to go to the smelters from which it comes out as the tin of commerce.

In Your Telephone

Napoleon is remembered today as a great general who led victorious armies through Europe until he met the combined British and Prussian troops at Waterloo and went down in defeat.

Tin is a part of the solder which makes firm good current carrying connections between many of the small parts in your telephone.

But Napoleon did other things besides lead an army. At one time he offered a prize to any man who could discover some means of keeping foods fresh for an indefinite length of time.

About 1809 or 1810 one Nicholas Appert won the prize of 12,000 francs for discovering a way to can foods and the canning business he started is still run in Paris by the Appert family. Appert, however, was just one year ahead of Peter Durand, an Englishman, who was the first to preserve food in tin "canisters," Appert having used glass for his first containers.

In the United States today where 5,000,000,000 cans of food are eaten every year, nearly 40% of all the tin used goes into tin plate for making tin cans.

Tin has been used almost as long as any other metal. Copper was probably the first to be used and was followed by bronze, an alloy of copper and tin, the first use of which was for arms and armor. Later it was made into cannon—and bronze cannon were common up to a few decades ago.

Besides the use of tin for cans, which, by the way, are made from sheets of steel coated on both sides with tin, the metal is used in making solder, tin foil, collapsible tubes for tooth paste, vaseline, shaving cream and similar articles,—and to give weight to silk and make it rustle.

Solder joins the wires in lead covered cables and also joins the lead sheaths where two cables come together, thus preventing moisture from creeping in to injure the insulation.

The oldest tin mines of which history tells us are in Cornwall, England. Long before Caesar's time vessels from Carthage took the long journey to what they called the Tin Islands. There is a story that one of these Carthaginian traders seeing that he was being followed by a rival from another nation, wrecked his own boat to keep the rival nation from learning his secret. The story ends happily, for the patriotic trader was not drowned and upon his return to Carthage was rewarded for keeping the trade secret.

In those days the tin veins at Cornwall must have been near the surface but through the ages they have been worked to a depth of 3300 feet and now the workings are down under the sea so that the miners can hear the Atlantic pounding on the shore above their heads.

These mines, which in times past were the only ones extensively worked, are now able to furnish only a small part of the world's tin supply. The United States, which uses more tin than any other country, has to import most of its supply. The Malay Peninsula and Banka, a small island across the Strait in the Dutch East Indies, now provide most of the tin. This tin finds its way to United States, England, Germany and France, as does that from Bolivia, a country which ranks second in tin production.

Condensers used in telephone circuits are made by rolling together alternate sheets of foil, made from tin and antimony, and thin paper. The finished condensers are enclosed in metal cases. (Some condensers are made by stacking alternate layers of mica and tinfoil.)

Tin is used in solder in your telephone and throughout telephone systems wherever wires are to be spliced, as in the case of cables or open wires strung on poles; in telephone switchboards to fasten wires permanently to connectors, relays and coils; and in the terminal rooms of central offices where thousands of wires coming from the switchboard are soldered to connectors from which wires go to homes, offices and factories.

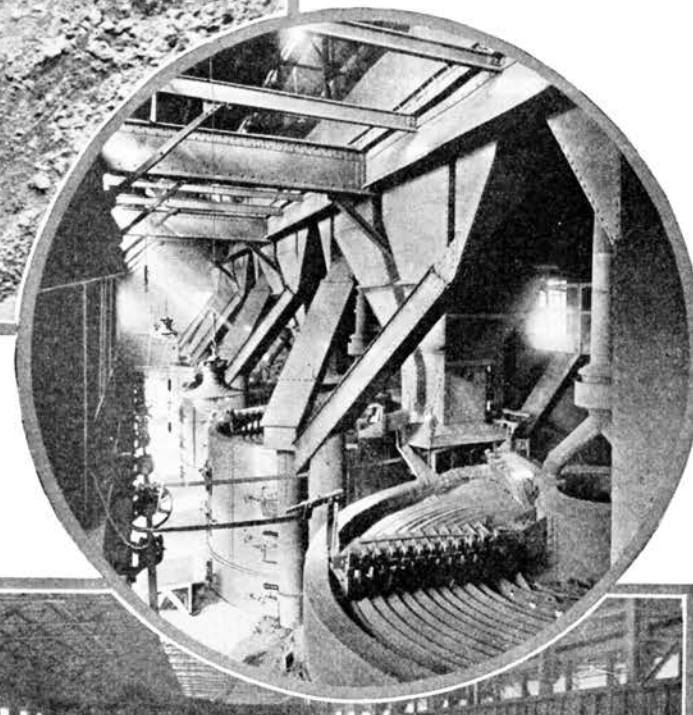
Tin is also used to coat some iron parts to keep them from rusting and is used instead of antimony in the lead sheaths of cables made for special purposes. For ordinary cable use, antimony gives the proper hardening to the lead sheath and is, moreover, less expensive. Tin is also used in condensers in the form of foil.

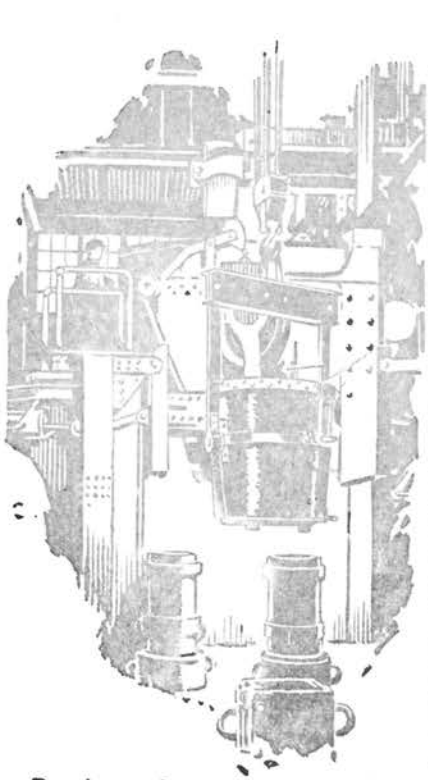
The Story of Nickel

Nickel is used frequently and in large quantities to protect and preserve the metals that it covers or "plates". Nickel as an alloy adds toughness to steel.

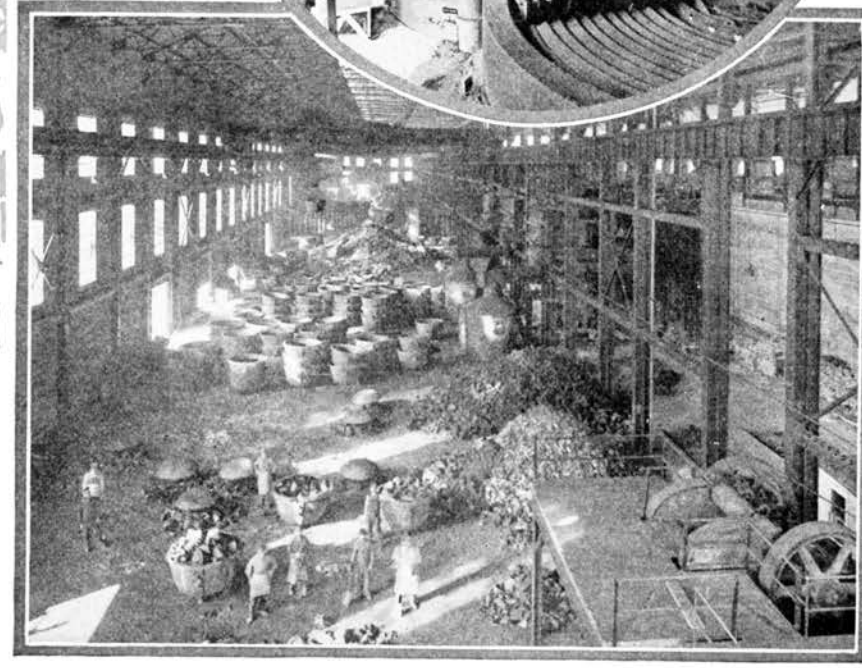
Up in Ontario, Canada, where most of the world's nickel is mined the ore is dug from an open pit like this.

Below—To separate nickel from the other materials in its ore, the ore is roasted in furnaces like these.





Pouring molten nickel from a furnace that can be tilted.



Part of the operation of securing nickel from its ore is done in cupolas such as these.

The superstitious people who lived during the period we call the "Dark Ages" believed that gnomes and even worse sprites were often behind the little petty troubles that arose from day to day. The old Saxon miners of the period, in fact, even went so far as to blame the Old Nick himself whenever they chanced upon copper ores which were hard to work and named one especially troublesome ore "Kupfernickel" because there was an "evil spirit in the copper" ("kupfer"—meaning copper, and "nickel"—an old German name for the evil spirit).

Many parts of the telephone system are very delicate and must be protected against the effects of atmosphere by plating.

That happened in the Dark Ages. Many centuries later, in 1883 to be exact, when a construction gang was grading for the laying of the new Canadian Pacific Railway across the cold stretches of little-known upper Ontario a blacksmith by the name of Thomas Flanagan noticed that a certain part of the earth along the right-of-way near Sudbury was of a reddish color. This led to the discovery of copper ores.

Prospectors swarmed over the region, staking out claims on practically all the deposits. Mining was started on a large scale and the first ore was soon on the way to the smelters. There the ore was put through the usual processes but for some reason could not be worked properly.

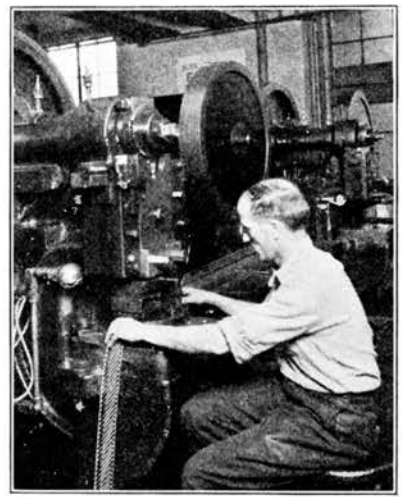
To find out what the matter was, some of the ore was taken to a laboratory where, much to the surprise of the mine owners, that old spirit that had so troubled the ancient Saxon miners was discovered hidden in the copper ore.

This troublesome nickel in the ore proved to be more valuable than the copper, and today the nickel from Sudbury, Ontario, is known and used the world over.

There is one other place especially noted for its nickel deposits. Thousands of miles from the Canadian Province of Ontario is an island east of Australia known as New Caledonia where the greater part of the one-quarter of the world's nickel supply not furnished by Sudbury is mined.

Not only is nickel particular about its home, but it is exceedingly wary in its friendships. For nickel, while it is found combined with copper, is really friendly only to iron while pure nickel occurs only with the iron in meteorites.

Nickel has a bright silver-white color, is one of the hardest metals of all, and takes a fine polish. Pyrrhotite, which is the ore chiefly mined in Canada, is taken from the mine to the smelter, where it is roasted and melted down to a substance composed of nickel, copper and iron. It is then put through one of the several methods used to separate the three metals, the one chosen depending upon the purity of nickel desired. If nickel silver is wanted, for instance, a method will be used which will get rid of the copper but leave the iron with the nickel.

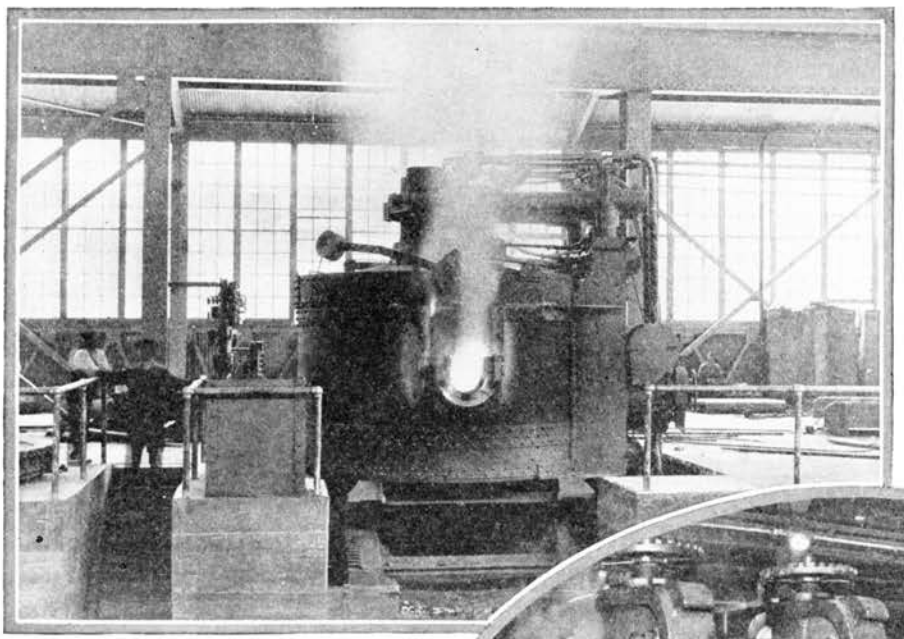


Tens of thousands of springs containing nickel are used in making telephone equipment. To make sure each is exactly like all the others for the same purpose machines like this punch them out of long strips of metal.

Of all the metals which are fused with steel to make alloys, nickel is the most widely used.

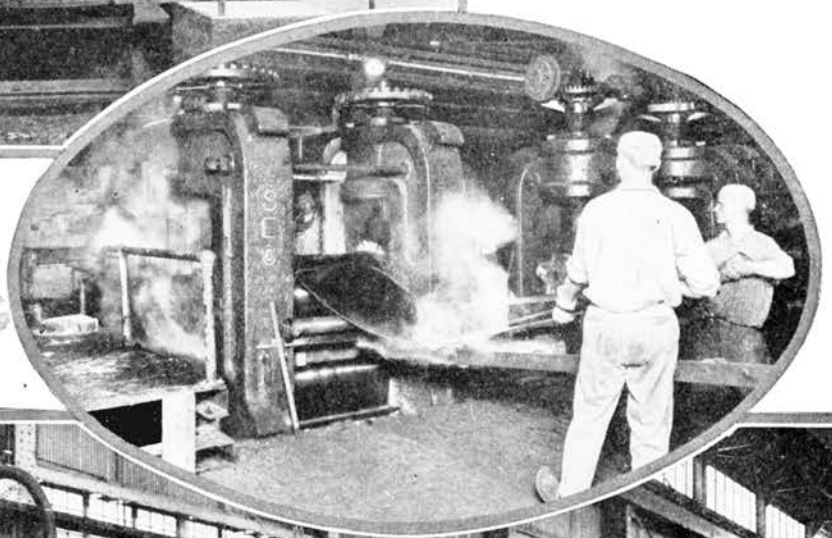
The Story of Nickel

Nickel steel is used in battleship armor and in industry where the same need for a hard surface exists. Then, too, as nickel will take a high polish it makes unattractive articles more pleasing.

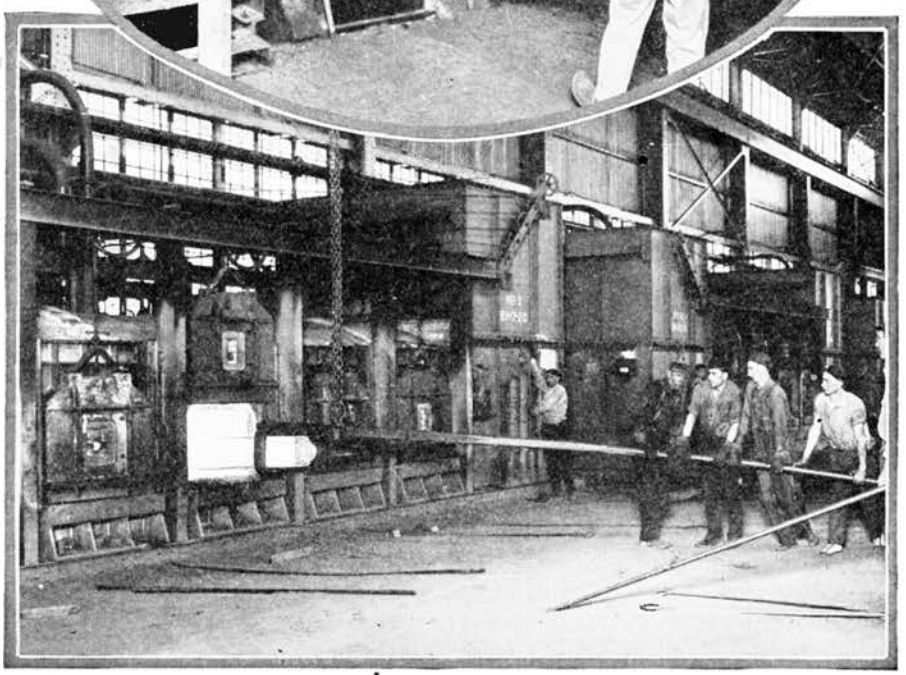


Below — Sheets of nickel are made by rolling bars again and again until they are of the desired width and thinness.

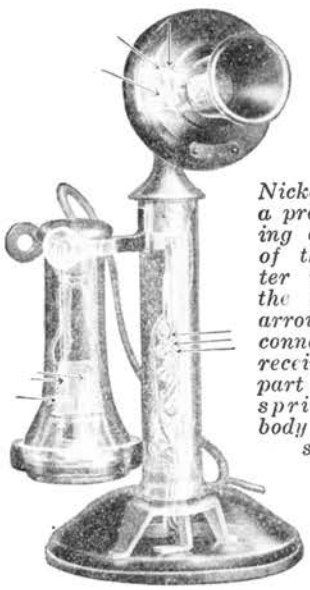
Frequently, nickel is melted by electric heat. This electric furnace holds seven tons. The nickel is poured out of the nozzle from which the vapor is rising.



Forging a 2-ton nickel ingot with a steam hammer.



Before nickel ingots are put under the big hammer and sometimes before they go into the rollers they are heated.



Nickel is used as a protective coating on the parts of the transmitter indicated by the three upper arrows and for connectors in the receiver and as a part of the alloy springs in the body of the instrument.

One alloy, called monel metal, which contains nickel, copper and iron, is used for making valves for high pressure steam systems, propellers for vessels, and for many other articles that must resist the action of sulphuric and other metal eating acids.

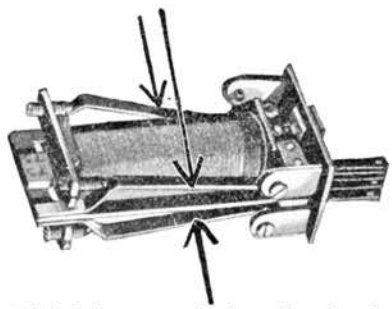
Nickel is also used in making white metals, in nickel plating, in resistance wires for electrical work, in contact points and in the familiar money we carry in our pockets and purses.

Nickel is used as a finish to insure resistance to atmospheric effects on many of the parts used in telephone apparatus.

One rather original use for nickel is said to have been adopted in the late war. Some artillery projectiles slightly undersized and not finished exactly smooth were nickel plated to make them fit the guns and be easier to handle, since otherwise in very cold weather the mittens of the artillerymen stuck to the rough-coated projectiles. Nickel plating gave the shells the smooth surface desired and proved a great help to the men.

In making certain types of steel for armor plate, guns, and some other articles, nickel is sometimes used. In white gold, nickel and gold are used in varying proportions.

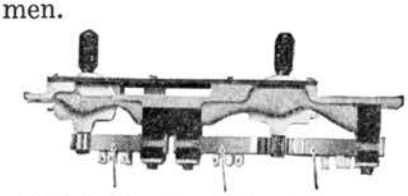
One of the uses of nickel that touches your daily life very closely is its use in alloy with zinc and copper for the contact springs inside your telephone. When you lift the receiver off the hook, these springs come together until the little points (described in the story on precious metals) toward the top of the springs make contact and complete the path to the operator's signal lamp. This light lets the operator know that you want a party and as she "plugs in" her head telephone to enable her to hear you, she answers your call with "Number, please."



Nickel is part of the alloy in the relay illustrated above, a type used by the tens of thousands in telephone systems.

This alloy of nickel, zinc and copper which is called German silver is also used to make contact springs in relays, those little devices which are always opening or closing various current pathways in the complicated telephone circuit.

Nickel as a fine wire is used in certain coils because it offers a high resistance to an electrical current and becomes hot if too much current passes through it. Because of this, these coils are used to protect the telephone exchange from stray currents—if an electric light wire, for instance, should touch a telephone wire, a coil of German silver wire would immediately become hot and by melting some solder cause a contact to be made which would protect the apparatus and at the same time notify the repair men.

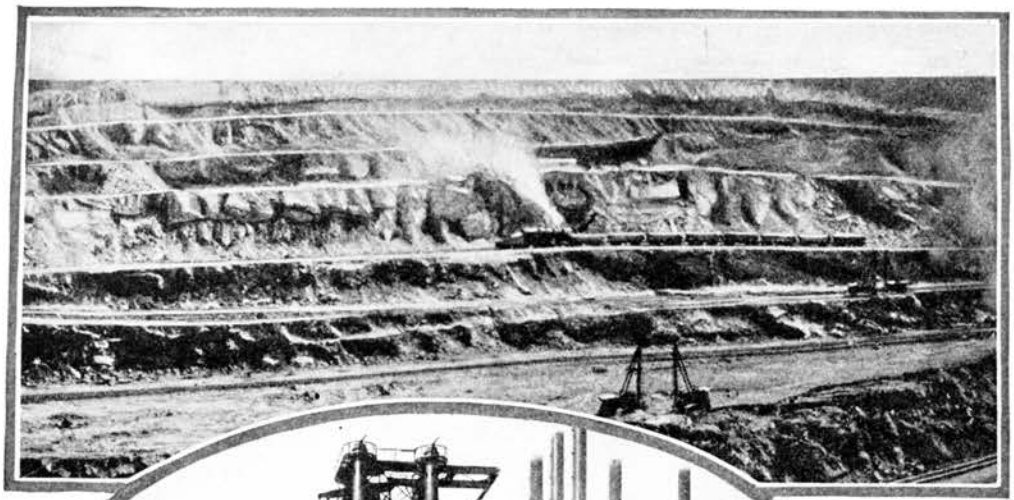


Nickel silver is used in the mechanism of the keys the switchboard operator manipulates to listen-in to learn what number is wanted and also to "ring" the called subscriber.

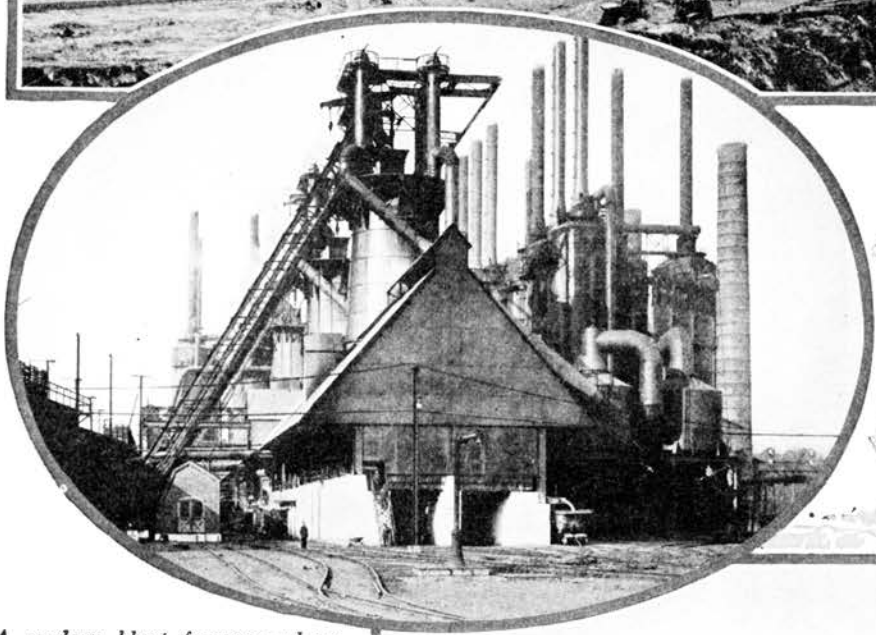
Nickel is also used to plate many parts used in the telephone system to protect them from rust or tarnish as well as to improve their appearance.

The Story of Iron

Since mankind learned of iron stone, iron has played a part in the progress of the world. First as arms and armor which opened up the old trade routes and now that we have steel, shiny rails and sturdy ships bear the trade and carry products of iron and steel to all parts of the world.



In iron fields where the ore lies just under the surface, steam shovels scoop it up as the first step leading to the vessels which carry it through the Great Lakes to the great iron and steel manufacturing cities.



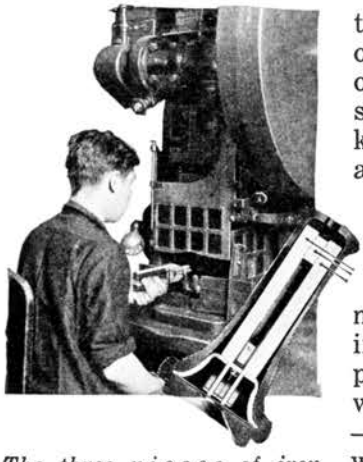
A modern blast furnace where iron ore is melted by coke and purified by limestone.

Steam shovel and ore railroad at a Mesaba iron mine.

A million ton storage yard for ore and coke and the ore bridge 507 feet long that picks up 14 tons of iron ore at each scoop of the shovel.

In Your Telephone

Gold is for the mistress—silver for the maid:
Copper for the craftsman cunning at his trade.
"Good!" said the Baron, sitting in his hall,
"But Iron—Cold Iron—is master of them all."
(From Cold Iron—by R. Kipling)

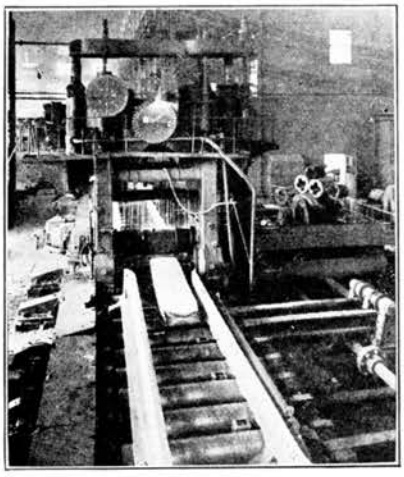


The three pieces of iron forming the receiver magnet of your telephone are welded by electric heat to form one solid piece. By making the iron all one piece a better electrical pathway is obtained than by hammering or swaging.

Iron was used in the very early days of history although our ancestors thousands of years ago knew very little about the metal compared to what we know today. But it marked a big advance when men began to use iron instead of copper and bronze for weapons and tools,—and so important was this in changing their way of living that historians today call that time the Iron Age.

Six thousand years have passed, and now, strangely enough, we are again in an Iron Age, or to be more exact a Steel Age, since our buildings, our machinery, our ocean steamers, our trains, all depend on steel in some form or other.

Lincoln's remark that the Lord must have liked the common people to have made so many of them, might also be applied to iron. For iron is everywhere,—in the leaves of trees, in plants, even in the blood of our veins and our arteries. If the iron-bearing corpuscles in our blood refused to work all the color in our cheeks would fade, we would grow weak and finally die.

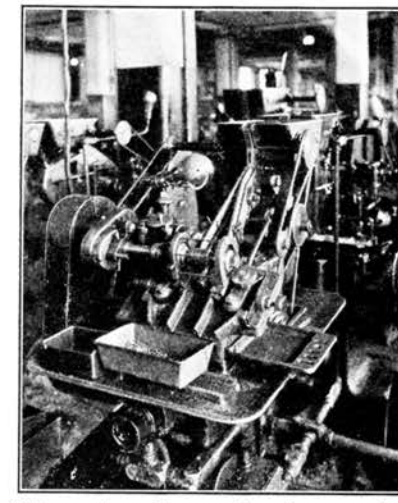


This huge blooming mill squeezes again and again the steel ingots as they pass through it. This does for the big blocks of metal what the blacksmith and his hammer and anvil do for small pieces of iron and steel.

But the iron in our blood is needed there and the iron in the soil is available only to the plants. So the iron for needles and skyscrapers must be found elsewhere.

Up in Minnesota where the Father of Waters starts his journey to the Gulf as a small, clear, musical stream, are vast deposits of a red ore called *hematite* which men have found to be of great value. Large prosperous mining towns have grown up because of the ore. It lies close to the surface so that the work of the miners reminds one of excavators making ready to build gigantic buildings. Steam shovels lift the red earth into hopper cars, locomotives haul the long ore trains to the docks in one of the two cities at the head of the Great Lakes, the hopper cars empty into large bunkers, and huge derricks or chutes load the ore into ships for the long journey to Gary, Cleveland, Toledo, Pittsburgh, Buffalo and other cities.

During all this time other miners near these cities and on down into West Virginia have also been busy. The coal which they mine finds its way to coking ovens where practically all the gas, moisture and ash are removed, leaving only the carbon.



This automatic machine is one of a series of three which make iron screws; the first draws in the iron rod, forms the head and cuts off the proper length; the second slots the head; the third forms the thread.

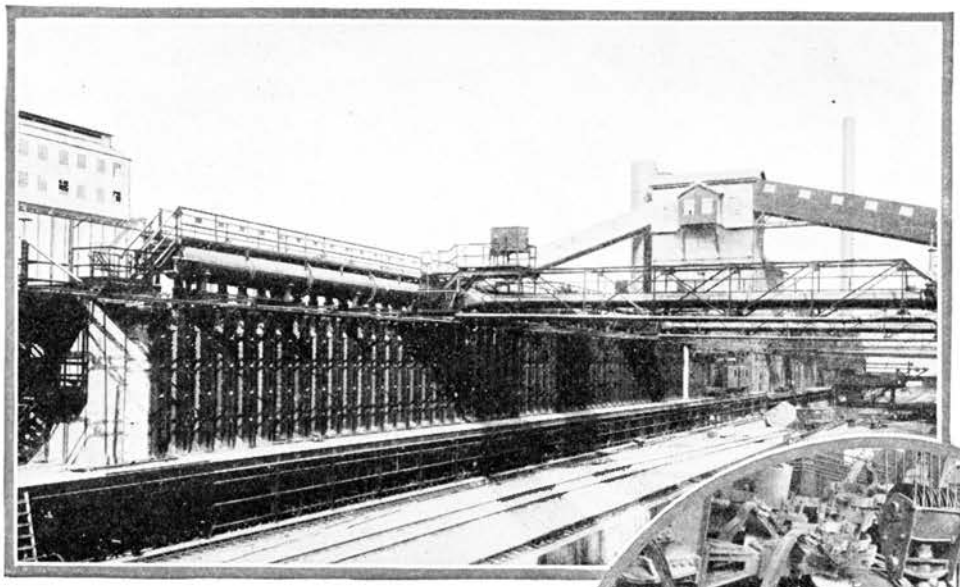
This coke made from coal from the Connellsville and West Virginia mines is ready to meet the iron ore from the North. To the meeting is added a third party. All three, the iron ore, the coke and common limestone are dumped in layers through the top of a furnace. As the coke burns, creating a terrific heat, a blast of air is forced through the mass. This melts the iron out of the ore. The iron flows to the bottom of the furnaces where it is "drawn off" and run out into molds, while the impurities which were in the iron ore are absorbed by the limestone and remain as "slag."

We now have pig iron but there are still carbon and other properties in it which usually are not wanted. So the iron generally goes through additional processes which vary according to the purposes for which the iron is to be used.

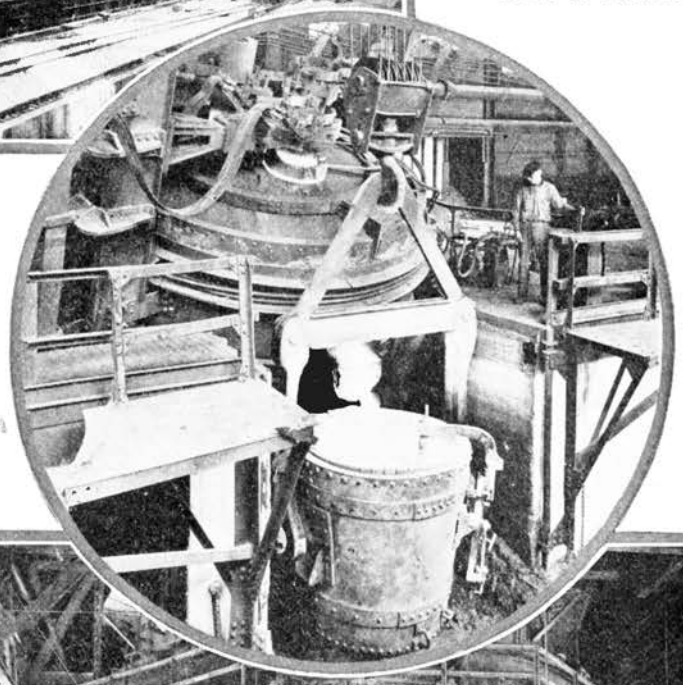
Steel differs from iron in that more slag and carbon has been removed by either the "Bessemer Process" or the "open hearth" method. Ingot steel, for instance, is a true steel

The Story of Iron

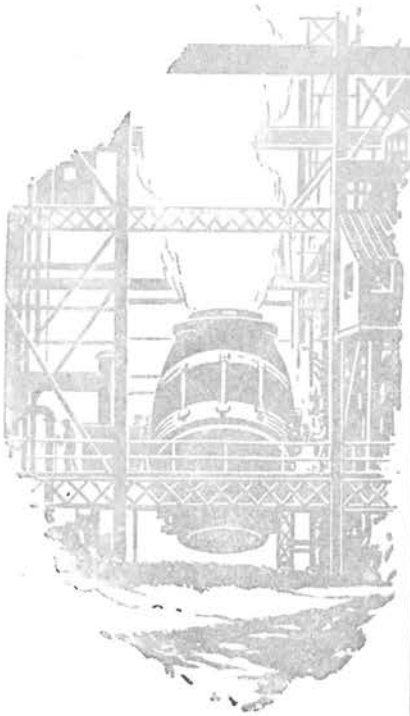
Wherever electricity and magnetism work together iron is a necessity. And in innumerable places where strength or keen cutting edges are needed iron or the steel made from it are used.



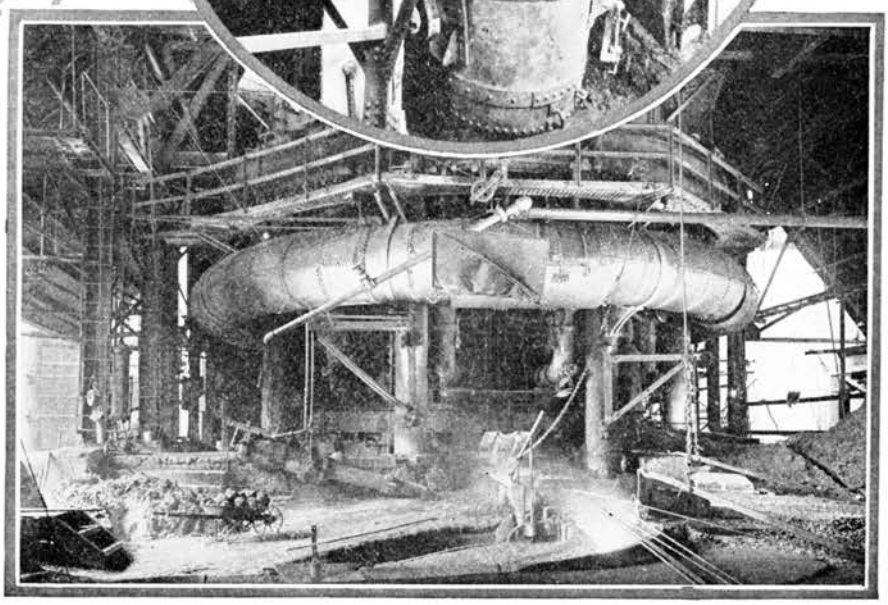
Part of the operation of iron and steel making is coke making. To make coke, coal of the kind needed is heated in ovens like these to get rid of the volatile materials (gases, etc.)



Below—The equipment for making steel is changing but principles remain unchanged. One change is to use electric heat. This furnace heats ten tons of material at a time.

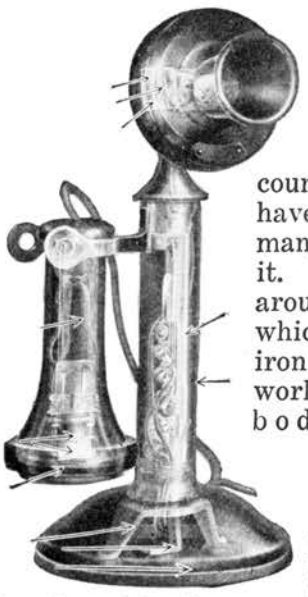


A Bessemer Converter where tons of metal are handled at a time.



After the metal has been melted out of the ore, the furnace is "tapped" and the molten iron drawn off.

free from slag but containing a small percentage of carbon. There are also commercial irons and steels which differ in the amount of other metals they contain. Among these are manganese steel, chrome steel, and nickel steel.

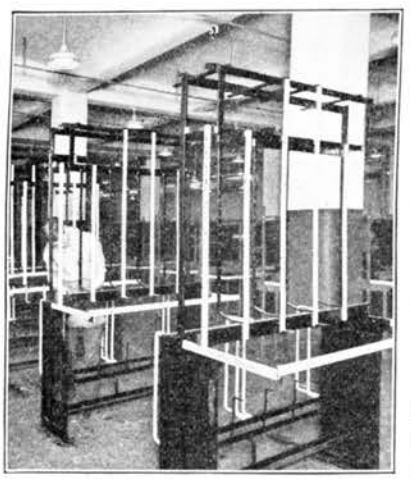


Iron is used in the magnets and diaphragm of your receiver and with a coating of zinc over it for the frame of your telephone instrument.

Iron ores are so common in the earth that there is hardly a country which does not have some iron, although many countries do not mine it. Besides the deposits around Lake Superior—which form the greatest iron mining district in the world—there are also great bodies of iron ore in Alabama, France, Brazil, Newfoundland, the United Kingdom, Germany, Luxembourg, old Russia, Spain and Sweden.

An interesting feature of iron making is that some countries which possess coal but have little iron, import the iron. Great Britain, for instance, is an important coal mining country but before the War it mined only about two-thirds of the iron ore blasted in British furnaces. Belgium and old Austria-Hungary were similar cases.

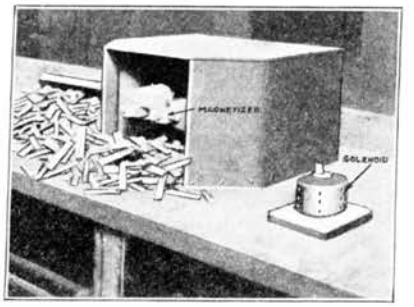
There is another important iron ore besides the hematite which is mined in Minnesota. For many centuries men have known of the lodestone which has the power of attracting iron filings and fragments. This name is given to any piece of iron which is a natural magnet made of the iron ore called magnetite. This kind of iron ore, which is supposed to have been discovered in Magnesia, a part of Asia Minor, is found in many places in this country as well as in Norway and Sweden.



Iron is used to make up much of the framework of the switchboard sections where thousands of telephone lines come together and where the called party is selected. Both the black and white sections shown above are of iron.

At one time all iron used for magnetic purposes was Swedish magnetite. Later a way was found to use hematite which today is the iron used for electro-magnets.

Iron which is not naturally magnetic, as you know, becomes a magnet when a wire is wrapped around it and an electric current passed through the wire. For this reason iron is used in all electrical equipment which makes use of the principle of magnetism in its operation. For instance, in completing a telephone call from one party to another an electric current puts a number of electro-magnets to work to make and break other contacts so that electric currents may flow or cease to flow. On the other hand if you are talking from one dial telephone to another there are scores of relays which control circuits to light lamps and ring bells from the moment you pick up your receiver until you and the party called both hang up. Many of these relays work not once but several times.



Some magnets in telephone systems must be permanent magnets. Permanent magnets are made by bringing the piece to be magnetized into the field of a powerful electro-magnet.

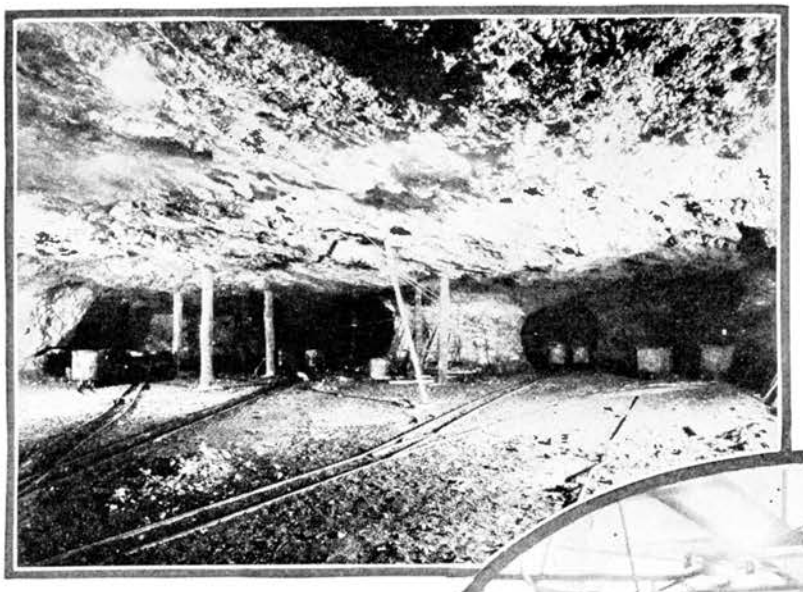
Then, too, there is iron in alloy with nickel in the permalloy that is wrapped around the new Atlantic cables. By wrapping a thin tape of it (six-thousandths of an inch thick) around the copper wire beneath the gutta-percha insulation of telegraph cables, the speed of sending messages has been increased eight fold so that 2400 letters a minute can now be sent.

Another place where iron is used is in the receiver of your telephone instrument. That diaphragm you see when you look into your receiver is of thin iron and when you are listening to a message it is made to vibrate by a magnet made of two small coils wound on iron cores located just behind the diaphragm. The distance from the ends of these magnet cores to the diaphragm is carefully adjusted to within a few thousandths of an inch.

Besides the use of iron for its magnetic properties, it is of course used throughout the telephone system for making parts of apparatus and in the telephone instrument where it is used to form the skeleton of the stand.

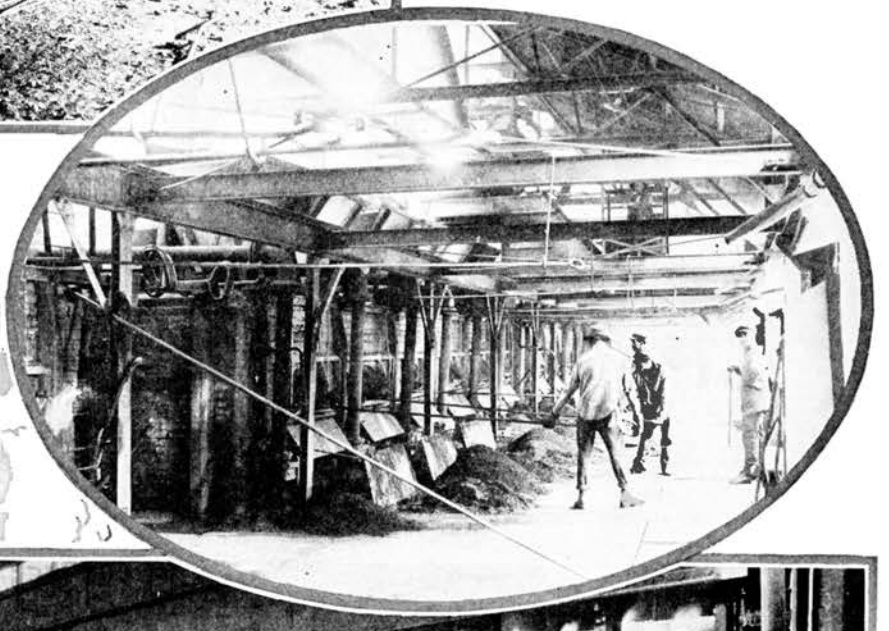
The Story of Zinc

Zinc is almost as widely used as is lead but usually teams up with some other metal to form a useful alloy. It is not often used alone.

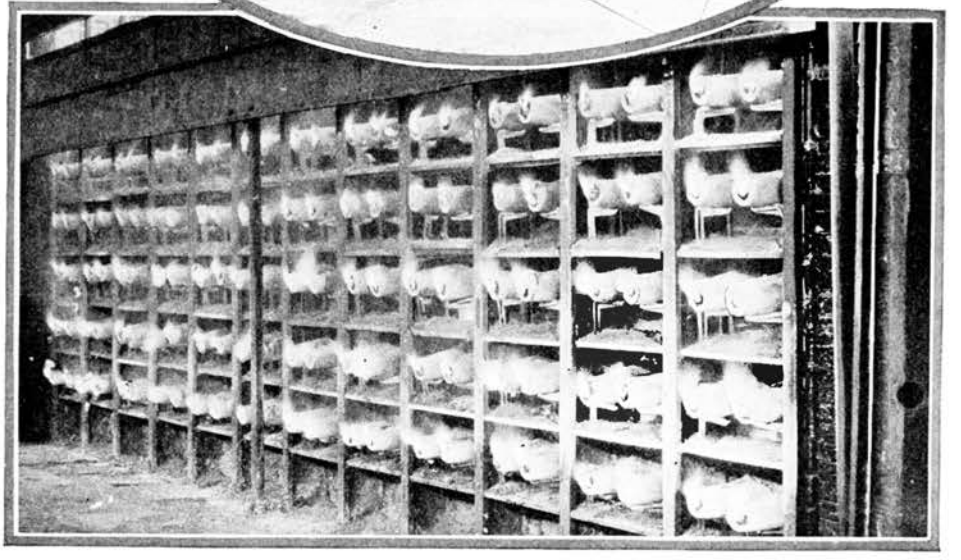


Left—Underground where the mine railways lead to where the miners are mining lead and zinc ore.

Below—This furnace produces the zinc oxide used for paint and rubber. The oxide, a white fume, is sucked away through big pipes by powerful electric fans.

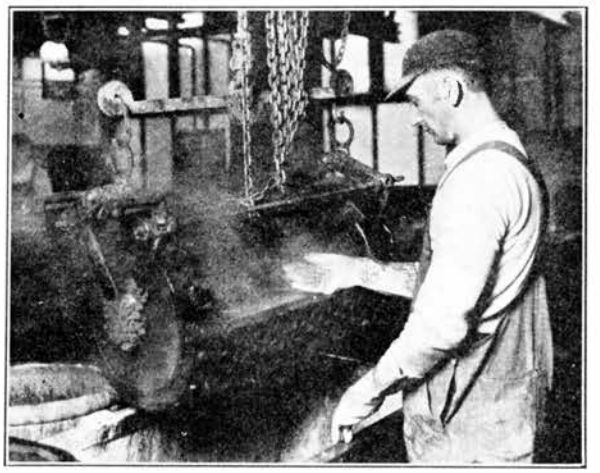


The head-frame of the shaft at a zinc mine.



A zinc slab furnace where the zinc ore is reduced to molten zinc and, after tapping, cast into slabs.

Zinc is a fox hard to corner. By melting a mixture of finely granulated copper and zinc ore the ancients were able to make brass for arms, armor, mirrors and various articles for decoration, but they did not know it as an



Galvanizing, a process that protects iron from moisture and rust, is done by immersing the parts to be coated in molten zinc.

isolated metal. Indeed it was not until after Columbus sailed the unknown Atlantic that metallic zinc was imported into Western Europe from the East. In the trade today, metallic zinc in slabs is sometimes called spelter, a word which has come down from the sixteenth century *spiauter*.

Zinc seldom occurs alone and, when the ancients heated the ore, the zinc part mixed with the oxygen which changed it into a white vapor, zinc oxide, which thereupon escaped into the air. Methods of distillation and chemical processes now make it possible for modern nations to secure the large quantities of zinc they need.

Zinc is usually found with lead and the ores of both metals are commonly mined together by the same operations. In fact the Franklin Furnace district in New Jersey and the Anneberg district in Sweden, among the first rank zinc districts, are almost alone in not also yielding lead.

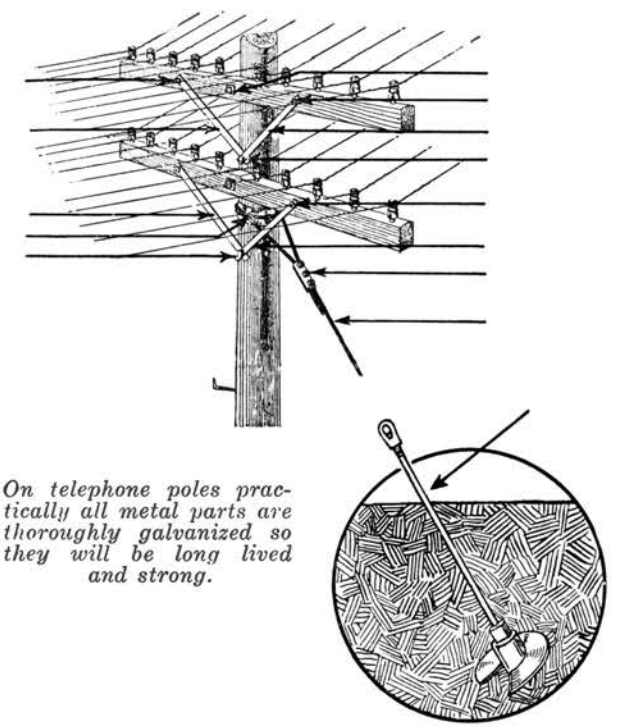
After zinc has been produced it is almost equally liable to lose its identity again, for it is widely used in alloys such as brass and bronze and as an ingredient in rubber and paint. Other uses for it are in processes by which other things are produced. Some are chemical as photo engraving, preventing boiler scale, precipitating gold in the cyanide process, and the preparation of salts, one of which is used to preserve wood.

Most zinc, however, finds its way to Industry in slabs which correspond to pigs in the iron trade and ingots in the copper industry. The largest quantities of slab zinc are used for galvanizing described further on.

Zinc ore is found in every part of the world but, as is so often the case, the United States produces and uses more zinc than any other nation. Joplin, Missouri, in the Ozark Mountain district, is the center of the most important zinc mines in this country. In New South Wales, Australia, and in that part of Prussia known as Upper Silesia, zinc mining and the extraction of the metal from the ore form an important industry.

The metal is bluish-white and is brightly lustrous when polished. The pure metal is harder than aluminum but softer than silver, while the commercial zinc is moderately hard and difficult to file, and when bent, after having been melted and cooled, makes a crackling noise similar to tin.

Many of the industrial uses of zinc call for the material as a dust or oxide. Originally, this oxide was obtained by heating slab zinc in a specially constructed furnace until the zinc was vaporized. It then came in contact with the



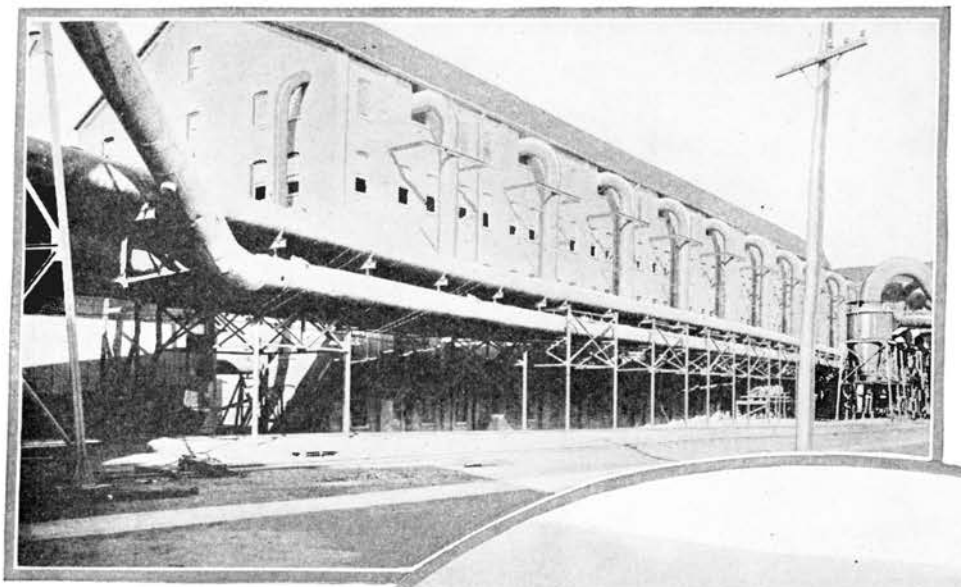
On telephone poles practically all metal parts are thoroughly galvanized so they will be long lived and strong.

oxygen in the atmosphere after which the air laden with zinc oxide was cooled and the oxide was gathered in hoppers or bins.

The first zinc oxide produced in this country was made by burning metal in reverberatories or muffle furnaces, but another and new process was discovered in this country by accident.

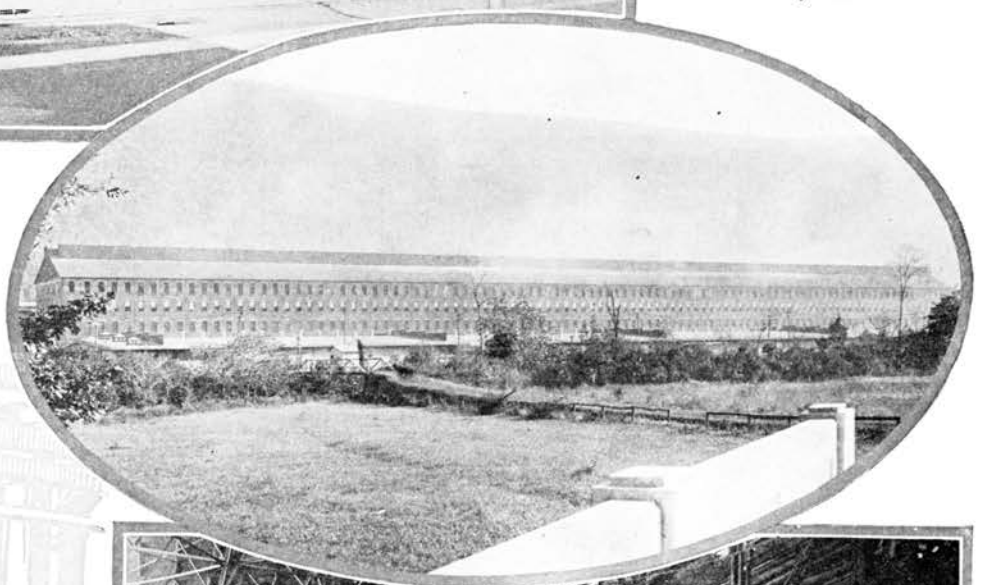
The Story of Zinc

Zinc is the great protector of iron and steel products which it shields from rusting from the effects of air and water, with a protective coating called galvanizing.

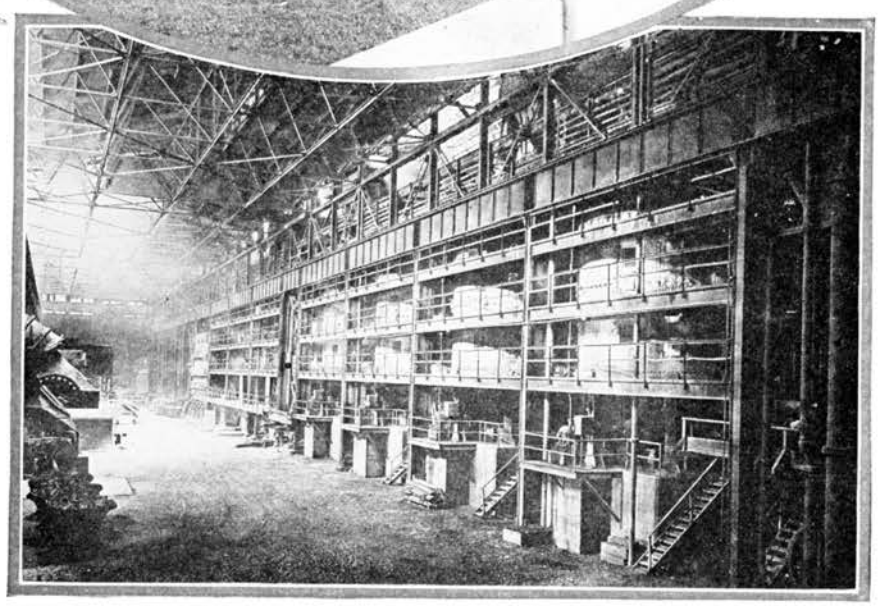


Left—Zinc oxide is sent through these big pipes by means of powerful blasts of air which blow the oxide to its destination.

Below—Zinc oxide used in making paint and rubber is collected in this building which contains what is probably the largest undivided single room in the world and is part of the plant of the New Jersey Zinc Company at Palmerton, Pa.

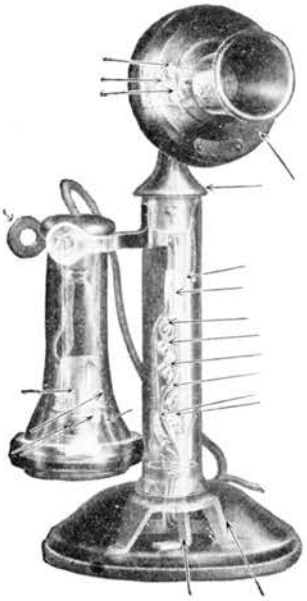


The zinc oxide falls through these bags to bins from whence it is barrelled while the gases pass out through the pores of the bags.



In zinc roasting furnaces the zinc and lead sulphides are converted into sulphate and oxide, the excess of sulphur is expelled and the iron and other metallic substances in the ore are oxidized to make a product suitable for leaching.

The principle is a short cut, as the zinc oxide is made directly from the ore instead of making metal first. It was discovered in this manner. A workman found a fire flue leaking badly. He tossed an old piece of fire grate over the hole and then shoveled zinc ore and coal on top of the grate. A short time after he saw a cloud of zinc oxide arising from the mixture. When news of this got to the ears of the engineers in charge of zinc production, they started experiments and the result was the short cut method.



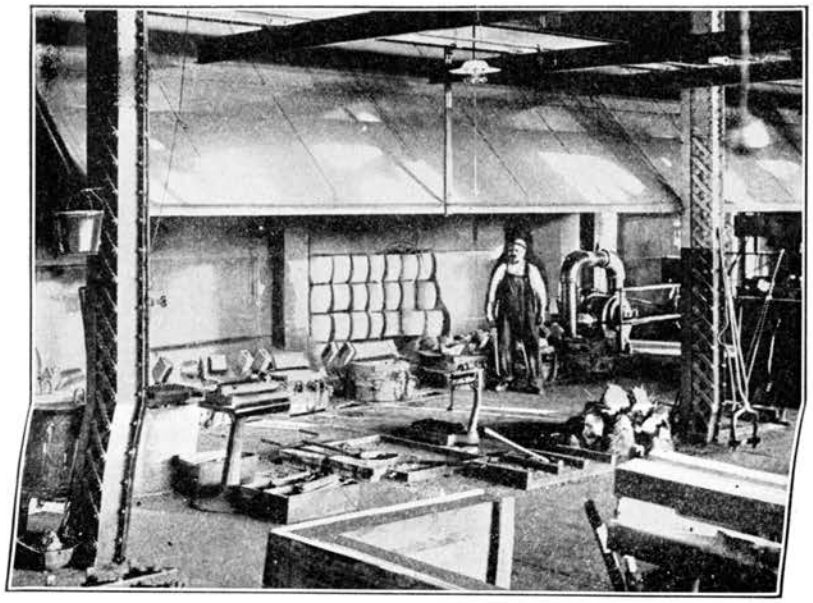
In your telephone instrument zinc is in the brass and is also used to galvanize parts susceptible to moisture and other atmospheric conditions.

The process that resulted consists of vaporizing the zinc directly from the ore. To do this a mixture of zinc ore and coal is spread on a bed of burning coal laying on a grate through which more air is blown than is needed just for a good fire. The excess air carries the vapors along through cooling pipes to muslin bags through which the oxide drops to collecting bags at the bottom while the fumes escape through the meshes.

Zinc is used chiefly in galvanizing iron and steel and in making brass which is an alloy of zinc and copper. Galvanizing consists of covering sheet iron or steel with a thin coating of zinc in order to protect it from the effects of moisture. About 50 per cent of our output of metallic zinc is thus used. Another large use for zinc is in paints. Zinc oxide is used in making the millions of automobile tires produced every year.

In the electrical industry zinc is used in most wet and dry batteries, and, to prolong the life of the pole-lines which carry the electric light, power, telephone and telegraph wires. All metal bolts, nuts, braces and clamps are zinc-coated or galvanized since zinc by resisting the effects of moisture prevents iron and steel from rusting and helps it to keep its strength.

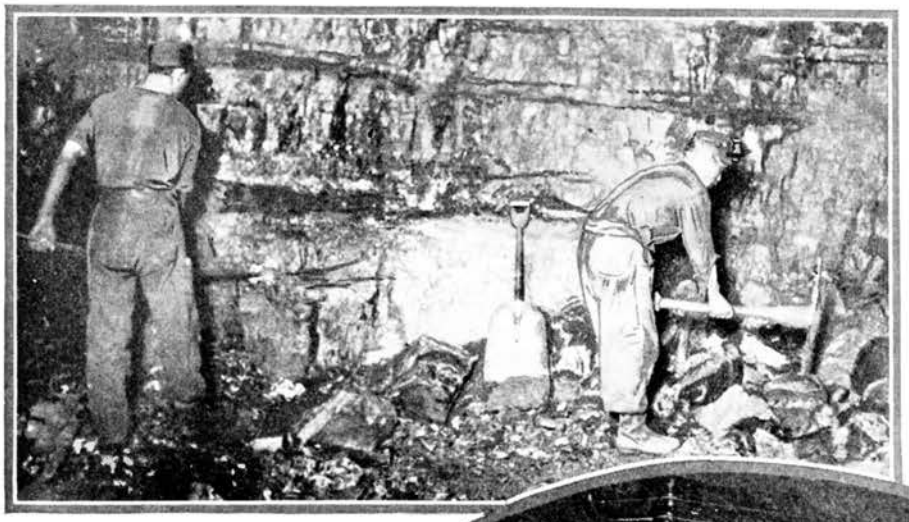
Another place where zinc is used, but one you are not apt to see is in brass screws and springs used in your telephone instrument and throughout other telephone equipment. There is also zinc in the brass which forms the front and back of the transmitter case of your telephone.



In this brass foundry immense quantities of zinc are alloyed with other metals to make the thousand and one brass parts used in telephone switchboards and elsewhere in telephone apparatus.

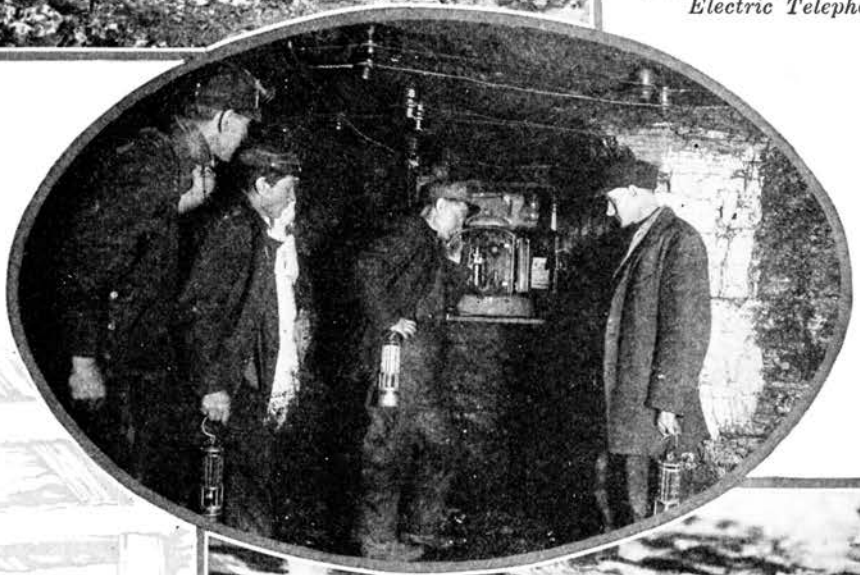
The Story of Coal

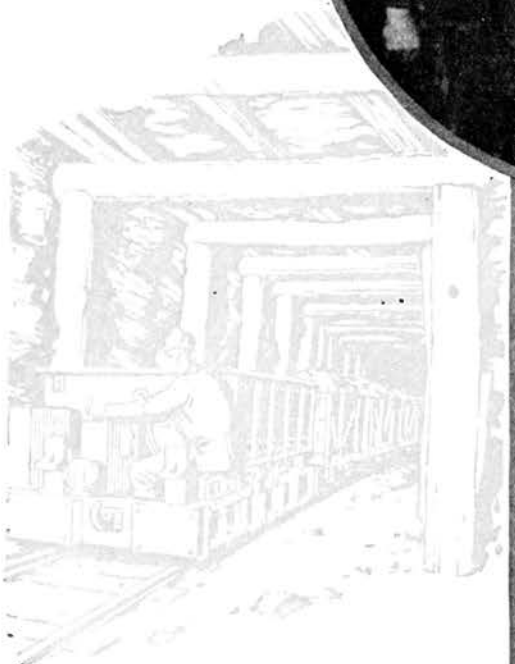
Though coal is found in practically every part of the world, you can almost measure the commercial importance of a country by the tonnage of coal it mines.



A miner and his helper.

Below—Communication in a mine is always necessary and sometimes a matter of life and death. Therefore, mines have complete telephone systems and many use Western Electric Telephones.





Electric mine locomotives have freed the mules which used to haul out one or two cars of coal at a time. To prevent walls and ceilings from falling, timbering is used extensively.

PHOTOS © KEYSTONE VIEW CO

A new method of mining coal is by electrically driven coal cutters.

The widespread use of coal is comparatively recent. Although in England—probably the first country to use coal to any extent—the

Carefully selected coal is used in the transmitter of your telephone. The operations of washing and drying granular carbon are performed with the simple machinery shown above.

Anglo-Saxons used it as early as 852 A.D. But coal mining as a real industry did not begin until James Watt, the Scotch inventor, designed and improved the steam engine, about 1784. From then on coal did its part to change the methods of industry.

Coal was first mined in this country about twenty-five years before our Revolutionary War. Since that time coal mines have brought us untold wealth and prosperity.

You have no doubt often read of the story of how coal was formed. It makes a fascinating pastime to send our minds flying back over the centuries to a time when the regions now yielding coal were swamps covered with rank luxuriant vegetation which in time dried, fell into the waters of the swamp and, as the deposit became thicker and thicker, sank below the water and gradually became covered with sand, mud and other earthy substances carried out from the shore.

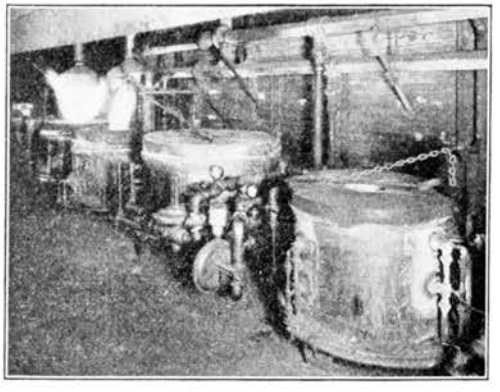
Today coal is being formed in much the same way in the lower valley of the Amazon, in the Dismal Swamp of Virginia and North Carolina and in the peat bogs in Minnesota.

This buried vegetation has, through the ages, gone through various changes. Compare a piece of anthracite and a piece of bituminous coal. The anthracite is changed much more than the piece of soft coal due mainly to the fact that it has been subjected to greater pressure which squeezed out most of the moisture as well as other compounds.

Thus anthracite, containing as it does, over 80% carbon, has a great heating power and burns with a smokeless flame. Bituminous is more brittle, contains more gas and burns with a smoky flame. Below bituminous in the order of usefulness of fuels is a brown colored lignite hardly deserving the name of coal. Peat, which is dried and used for fuel in Ireland, Holland, Germany and the Scandinavian countries, is not even coal, although if left long enough under pressure it would change into lignite, while that lignite in time would change into bituminous coal and so on.

As you know, the twentieth century is often called the Age of Steel. But coal is necessary to make steel and so it would also be true to say that this is the Age of Coal. In fact the greatest industrial nations are those which consume the most coal. Of these nations United States ranks first both in coal mining and the use of coal, Great Britain second, and before the World War the German Empire ranked third.

Of the two common methods of mining coal the "room and pillar" is mostly followed in this country, and machinery is used a great deal in mining operations. Shafts are sunk to the coal seams where the coal is then mined from small rooms in which pillars of coal are left to support the roof. In the "long-wall" method instead of leaving pillars of coal for support, the roof is allowed to settle as the mining goes forward. Care is taken, of course, to keep haulageways clear through the falling material.

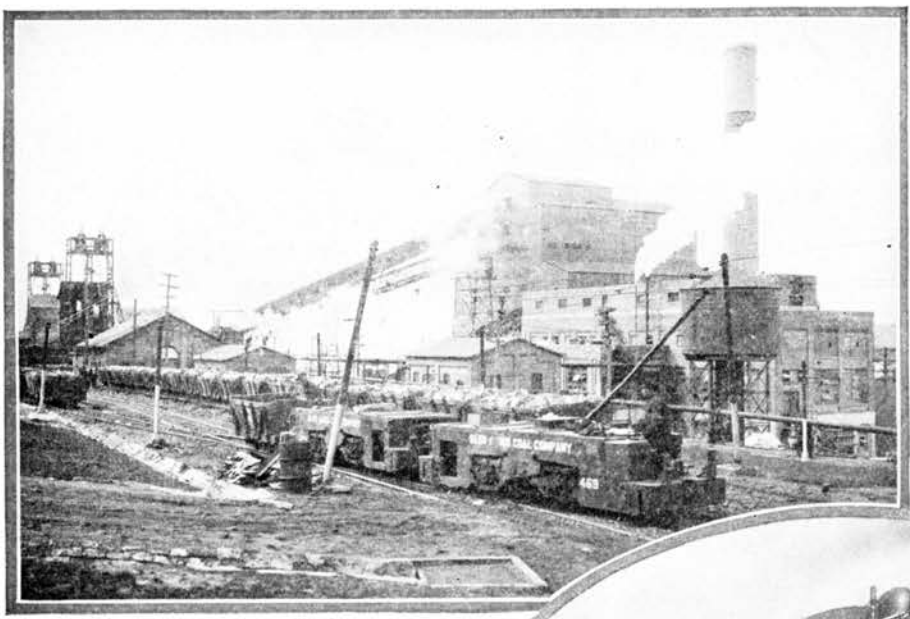


The granular carbon (coal) is roasted in ovens like these and it is in these operations that the gases leave the carbon in the flame shown coming from two of the ovens.

The greatest miner and consumer of coal—the United States—uses it to raise steam under locomotive, marine, and stationary boilers—to heat houses and other buildings—to manufacture coke—to fire lime, cement, brick kilns, fur-

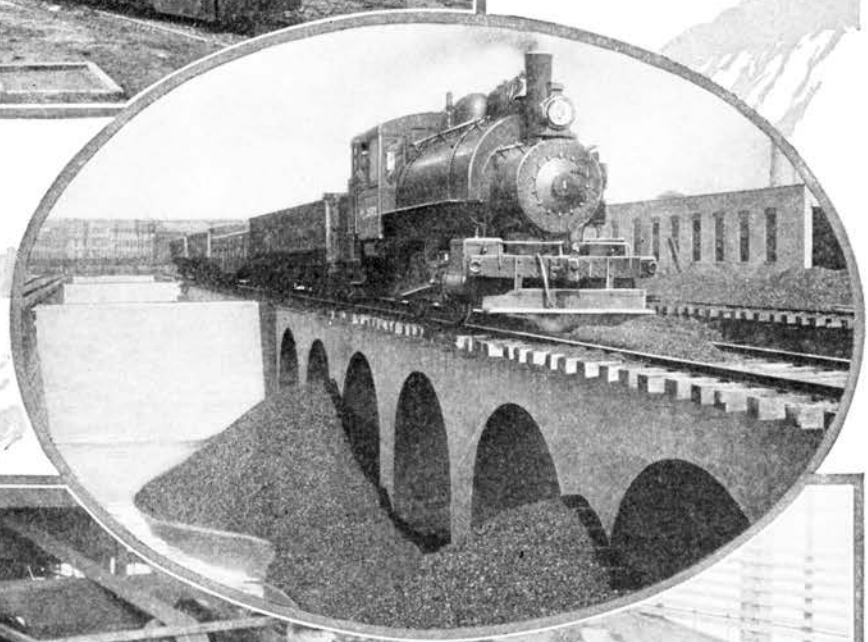
The Story of Coal

Coal is used not only to make the wheels of Industry turn but is also important for its wide use in the processes of producing other raw materials.



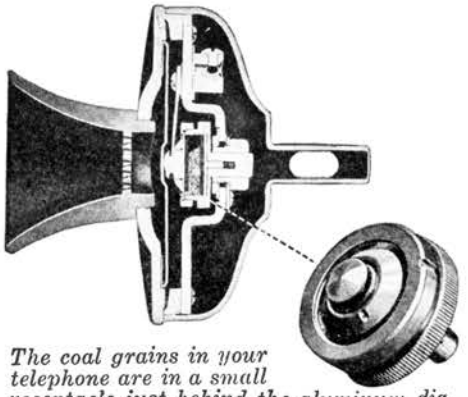
At the mouth of the mine is the equipment which makes the mined coal available for use.

Below—Huge coal piles sometimes set themselves afire through spontaneous combustion, so one of the modern ways to store coal is in water.



A typical coal railway to tidewater.

In the buildings at the head of the mine, coal is broken into the desired sizes and the slate and other non-burnable materials are picked out.



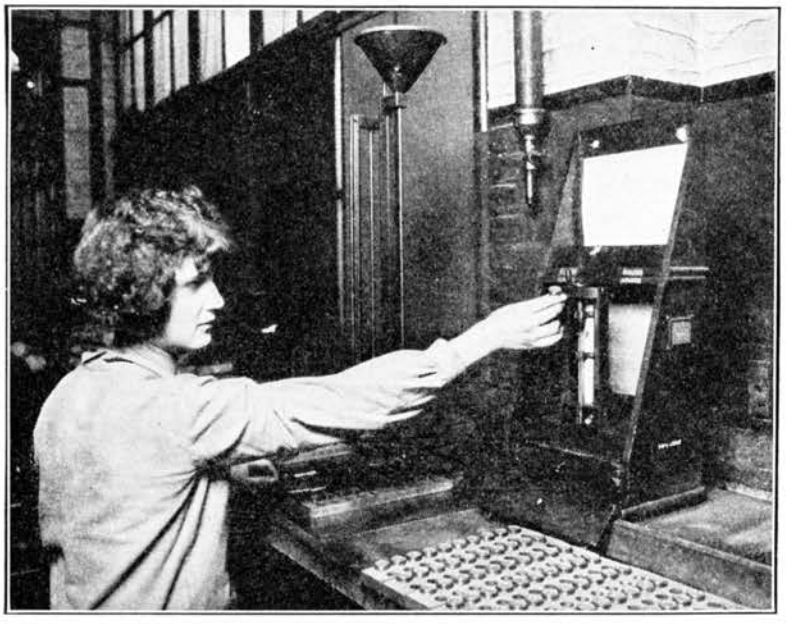
The coal grains in your telephone are in a small receptacle just behind the aluminum diaphragm of the telephone transmitter.

naces used to obtain metals from ores and to separate metals, and for other industrial uses requiring the direct application of heat—to manufacture gas—and for smithing. These are about the principal uses in other countries too, though different climates and industries may vary the amount applied to each need.

Coke, a by-product of coal, is used in smelters, in foundries, and to some extent as a smokeless domestic fuel. Turning coal into coke also gives us sulphate of ammonia, tar, crude light oil, and gas. The ammonia is used in refrigeration and in making high-explosives and fertilizer. From the tar are obtained many organic compounds such as aniline dyes. What is finally left of the tar—coal-tar pitch—is used in surfacing roads, in making roofing, and as a binder in fuel briquets. The crude light oil yields materials that are essential in making the very powerful explosives used in modern warfare. Another valuable product of the distillation of coal is illuminating gas.

Strangely enough coal is used in your telephone. In every transmitter into which you speak are some grains of coal. The amount of coal is carefully measured. Every grain counts. Either too many or too few would interfere with the transmission of the speaker's voice. These grains of coal pack together or loosen up as the diaphragm is vibrated by the voice of the speaker. By coming closer together or loosening up, the resistance to the flow of the current is changed and the electric currents varied. These variations make the magnet in the diaphragm of the listener's receiver pull strongly sometimes and faintly at others so that the diaphragm is moved exactly like the diaphragm in the speaker's transmitter and therefore reproduces the same sounds.

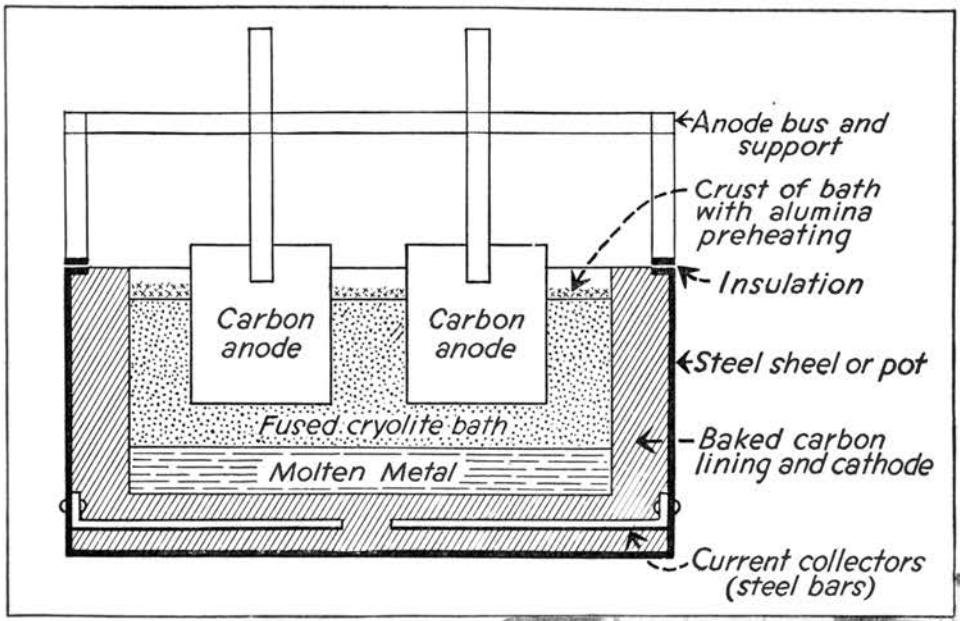
Only a fine grade of anthracite coal is used for this delicate work and at the telephone factory it is put through a special treatment which fits it to perform its duties. There the coal is ground fine into granular form, sifted and washed, after which it is roasted carefully, away from the air, to drive off the gas and to change it in other ways. An exact amount of this treated coal which has by this time been reduced to carbon finally is put into each of the little transmitter buttons and thus plays an important part in your telephone.



The few essential grains of coal in the telephone transmitter are measured. The amount used is only five hundred and ninety-five thousandths of a cubic centimeter and only one one-hundredth of a cubic centimeter more or less is allowable.

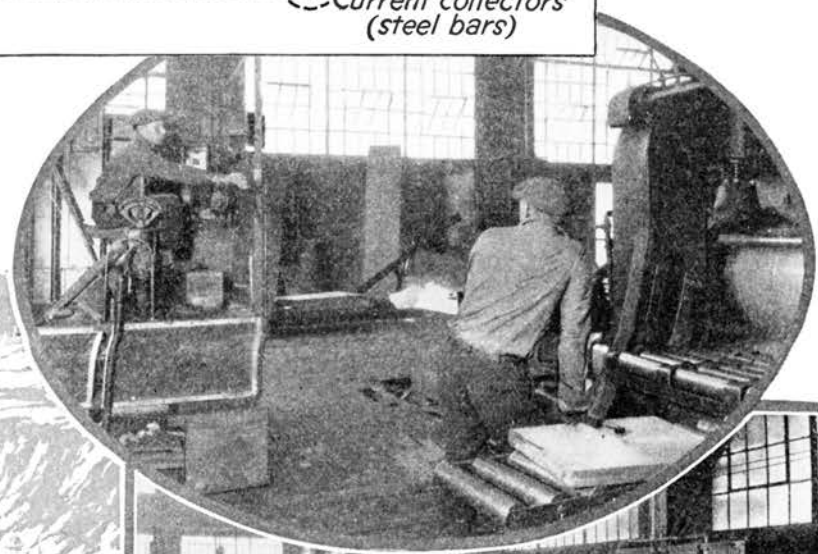
The Story of Aluminum

Aluminum is a splendid example of the importance of commonplace things. It is made of claylike minerals dug from the earth and electricity generated by tumbling rivers.

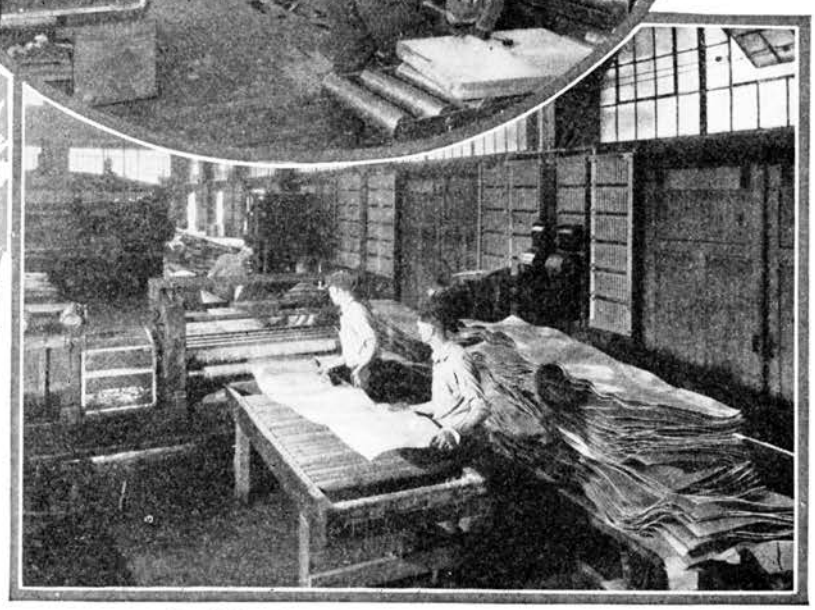


Left—This sectional view of an aluminum furnace or "pot" shows the arrangement of the parts and materials described in the text.

Below — Taking the temperature of an ingot of aluminum alloy is very important if it is to be rolled still more to change its shape.



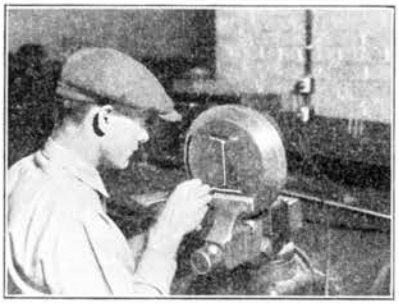
Mining bauxite the ore from which aluminum is obtained.



Straightening sheets of aluminum by rolling them.

In Your Telephone

Not more than fifty years ago a distinguished group of Frenchmen sat about a dinner table that has a place in the history of metals. On the table lay a scant dozen forks and spoons of a new metal; a metal as bright as silver and with a beautiful sheen. These utensils were remarkable for their lightness, for at least a half dozen of them were needed to balance even one of the decorative silver forks which also appeared on the table.



A die through which aluminum is forced by a press to form an I-beam.

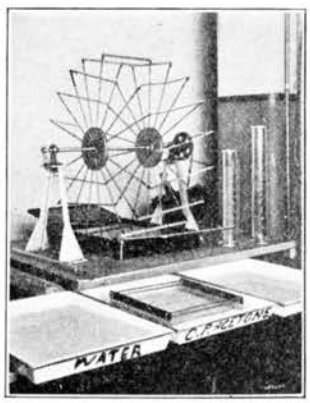
These utensils were made of aluminum, then so rare as to place it with gold and silver in the ranks of precious metals.

Since those days the process of procuring aluminum has moved from the laboratory to great factories, usually located near waterfalls; for cheap electricity, as produced by water power, is an essential in making aluminum at the costs which have brought it wide use in industry.

Aluminum is derived from bauxite, which gets its name from the French district of Les Baux where the ore was discovered.

The ores containing aluminum are found in many parts of the world. In the United States the deposits in Arkansas have produced in recent years most of the output of the country.

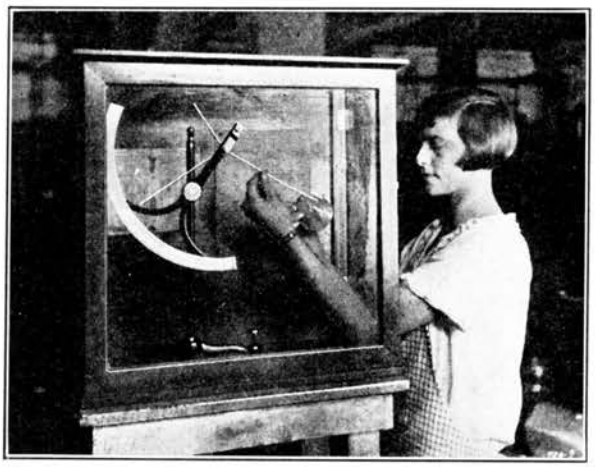
Aluminum is one of the chemical elements of clay and of many rocks and minerals, including ruby, sapphire, garnet and turquoise. As far back as 1826 the Danish scientist Oersted extracted from the minerals in the clay a tiny button of this silvery metal, then recognized for the first time by science. A quarter of a century later a French chemist, Deville, succeeded in producing enough aluminum to make a famous watch-charm presented to the King of Siam, and then in turn came the previously mentioned dinner with the forks and spoons of aluminum.



One after another thin strips of aluminum are immersed by this machine to learn how much, if at all, the aluminum is affected by corrosion from the bath they dip into.

For a generation little progress was made with aluminum. Aluminum in clay, plentiful as it was, did not exist in metallic form and to extract the metal took days of work by highly skillful chemists, laboratories full of apparatus and pounds upon pounds of expensive chemical reagents. And all this merely produced a few small button-like pieces of the silvery substance.

Aluminum making, as we know it today, began with the experiments of a college student, Charles Martin Hall, in the family woodshed at Oberlin, Ohio. His method differed from the chemical processes of Oersted and Deville. He used electricity, which was then just coming into its own. In the summer of 1886 Hall fished out of the tiny crucibles containing his chemicals and into which he dipped the wires connected to a string of electric batteries, a lump of aluminum about the size of a pea.



Inspecting aluminum foil to make sure that the thickness is right. Disks punched from each end of a strip of foil are one after the other attached to the arm of the balance. The disks are the same size and should weigh the same if they are the same thickness. Therefore, if the scale of the balance reads too much or too little the inspector knows the strips are not of even thickness.

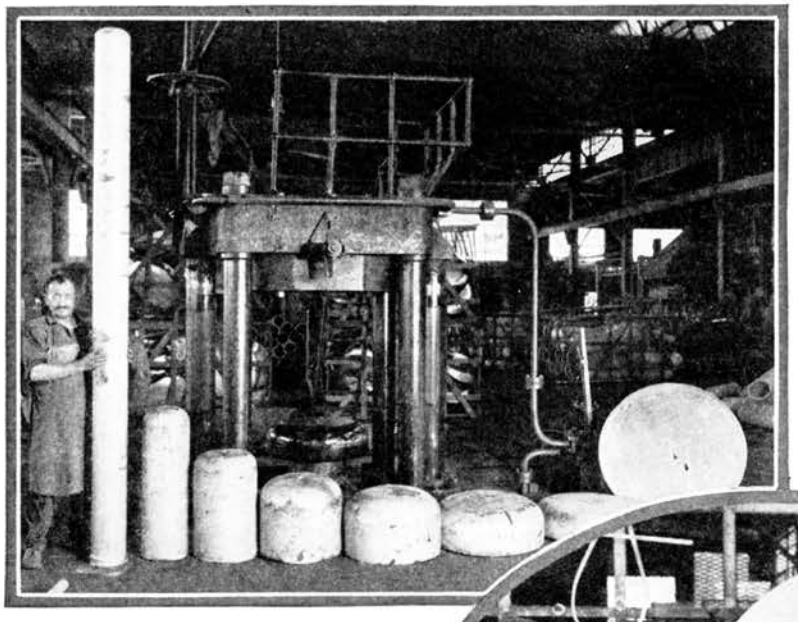
Hall's principle for making aluminum is the one used today in the great industry which rose from a production of thirty pounds a day after he started to make commercial aluminum, until in 1926 some 400,000,000 pounds of the metal were produced in the world.

The Hall process does not produce the metal from clay. That world-wide material is too difficult to handle commercially. Another raw material was used, the chemical compound called alumina. This is the same compound of which rubies and sapphires are composed.

With increased demand for aluminum the available supply of raw alumina was insufficient

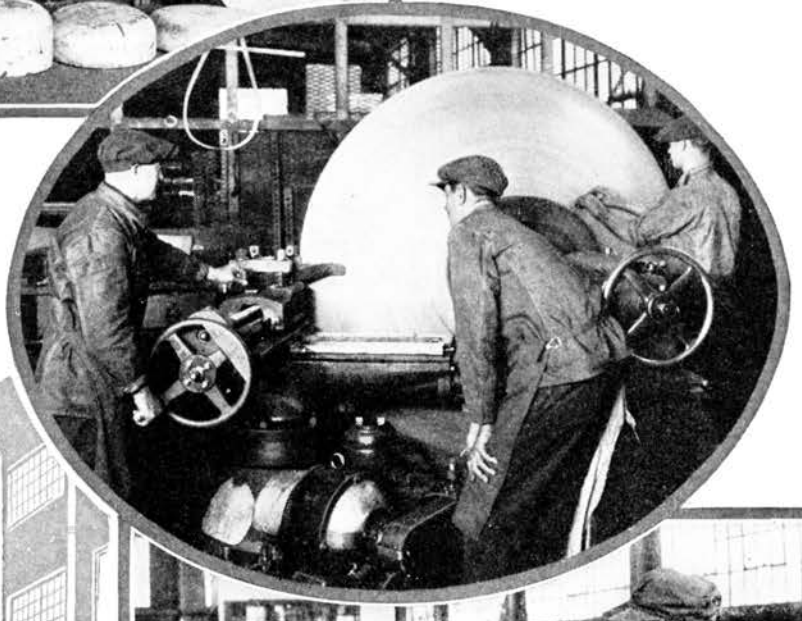
The Story of Aluminum

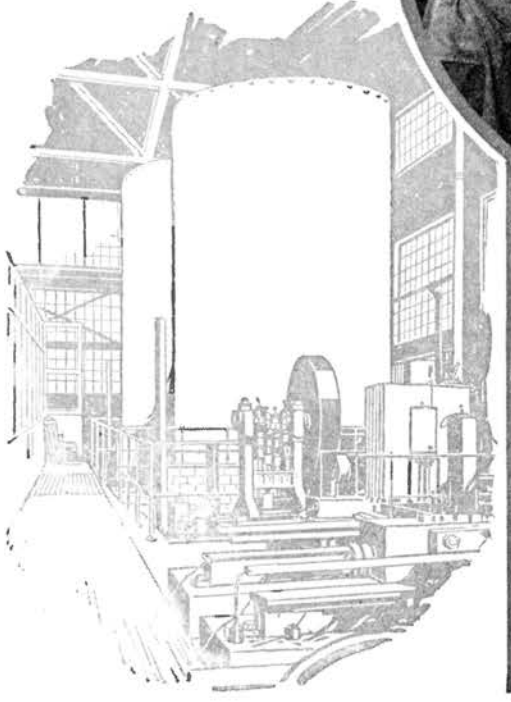
Aluminum has brought to Industry strengths comparable with steel in beams and rods and castings but weighing only a fraction as much.



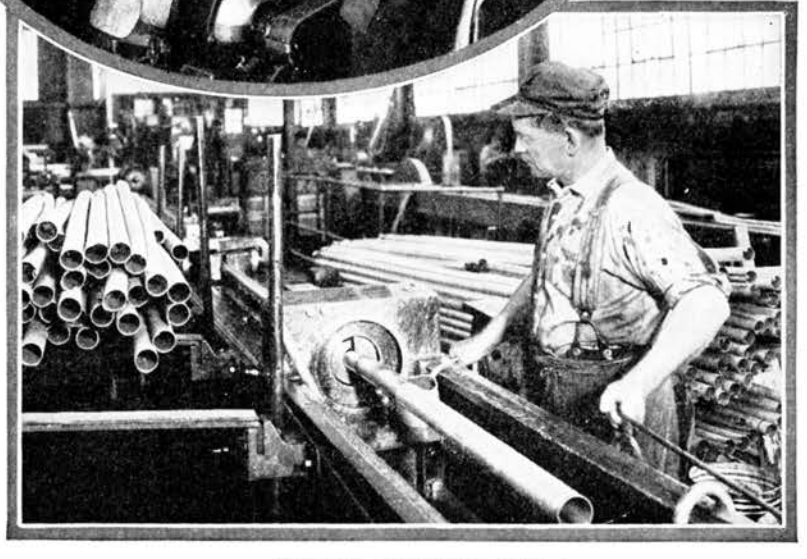
The flat disk of aluminum at the right changes shape, as shown from right to left, with each drawing process until it becomes the tubing at the extreme left.

Below—To form aluminum disks into bowl-like shapes, the disk is spun rapidly like a wheel and while it is turning the machine presses against it, so it gradually curves more and more into the bowl shape wanted.





These huge hydraulic accumulators move up and down as the presses squeeze out shaped pieces of aluminum.

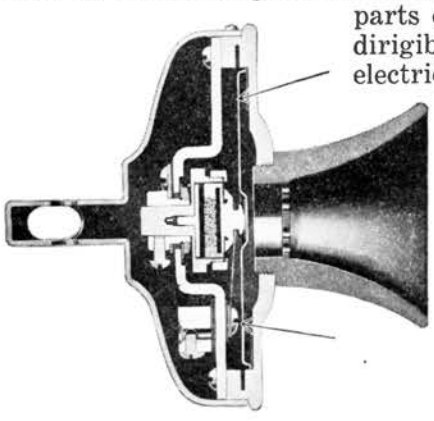


Drawing aluminum tubing.

and hence gradually the aluminum industry started to use bauxite which contains the necessary alumina.

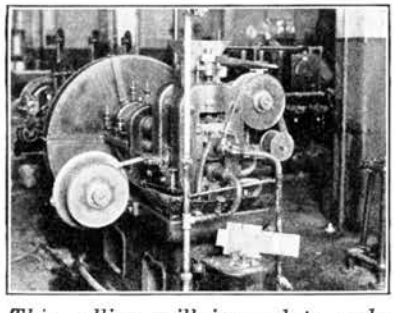
With the adoption of bauxite as the raw material there followed a process of development to solve the scientific problems in mining engineering, chemical engineering and electrical engineering which arose.

Aluminum is a jack of many trades. It helps to prepare our meals as pots and pans and enables us to eat them by means of aluminum knives, forks, and spoons; it floats in the air as parts of planes and dirigibles; it carries electric current as wire; it protects buildings as paint; it assists in our entertainment in radio receivers, and in small metal tubes brings to us the materials with which we brush our teeth and shave. Gongs, too, are made of aluminum for aluminum helps retain the tone of gongs and bells longer than do the more usual bell metals. As a paper-like foil, aluminum is wrapped around candy.



The diaphragm of your telephone transmitter is a thin sheet of duralumin, an alloy of aluminum.

Since aluminum can be rolled into very thin sheets it is part of the diaphragms which assist to reproduce sound in the telephone and in talking machines. In the telephone the amount of aluminum required is not large. The diaphragm which is made of an aluminum alloy is the one in the transmitter, the one which your voice causes to vibrate as you speak. The vibrations of this plate of aluminum cause variations in the electric current which flows to the receiver at the ear of the listener. These variations of current move the diaphragm in the listener's receiver in exactly the same way the aluminum diaphragm in the transmitter is moving. Therefore, sounds are produced in the receiver that are the same as the sounds which vibrate the diaphragm in the transmitter.

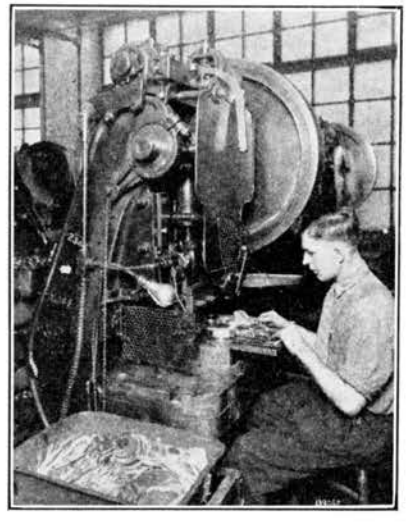


This rolling mill is used to make the thin strips of duralumin from which is made the diaphragm in the transmitter of your telephone.

Aluminum has many uses in scientific equipments and in surgical instruments, though much more is used by the automotive industry in car bodies, engines and accessories.

Probably, the greatest advantage of aluminum as an industrial metal is the fact that it does not rust, and rust is the great handicap of iron and the products containing it. Aluminum, however, is affected by lye and under some conditions by sea water. In general, however, it stands exposure to weather and constant use better than many cheap and common metals.

Modern day aluminum making in simple terms consists of dissolving alumina in molten cryolite in huge pots lined with carbon and passing an electric current through the molten mass. This current travels between electrodes,



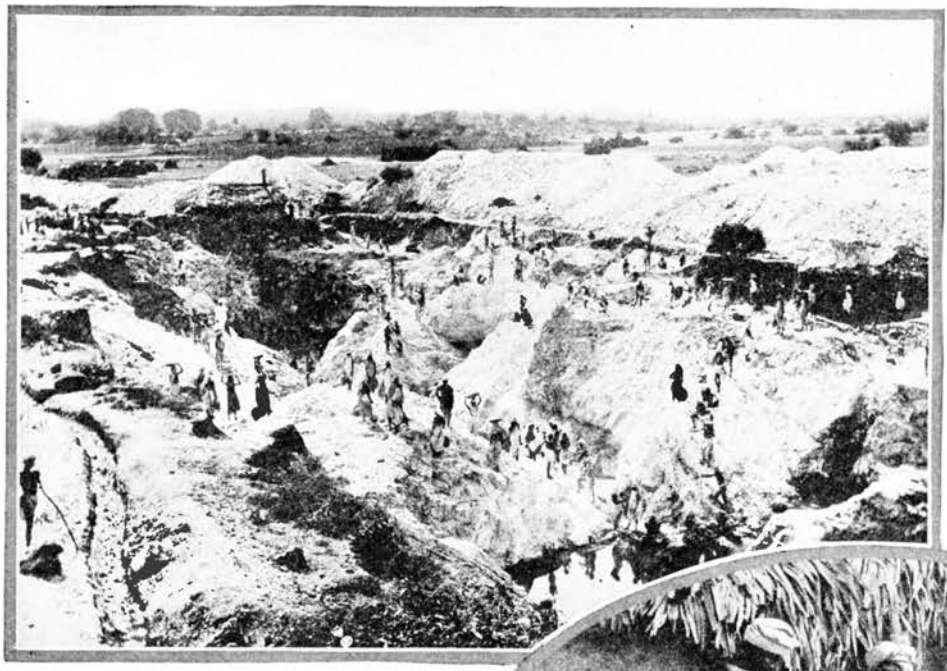
Diaphragms for telephone transmitters are punched out of strips of duralumin by machines like this.

which dip into the molten mass, as zinc rods dip into wet batteries, and the carbon sides of the pot. Passage of this current, when carefully regulated, deposits metallic aluminum in melted form at the bottom of the pot. This metal is drawn off in the same manner as is iron from an iron furnace.

The art of aluminum making lies in the exact construction of the pots and electrodes and last but not least in the careful and exact control of the electric current. These jobs are so important that it is possible to go through all the operations of aluminum making and still not have a successful aluminum process at the end of the operations.

The Story of Mica

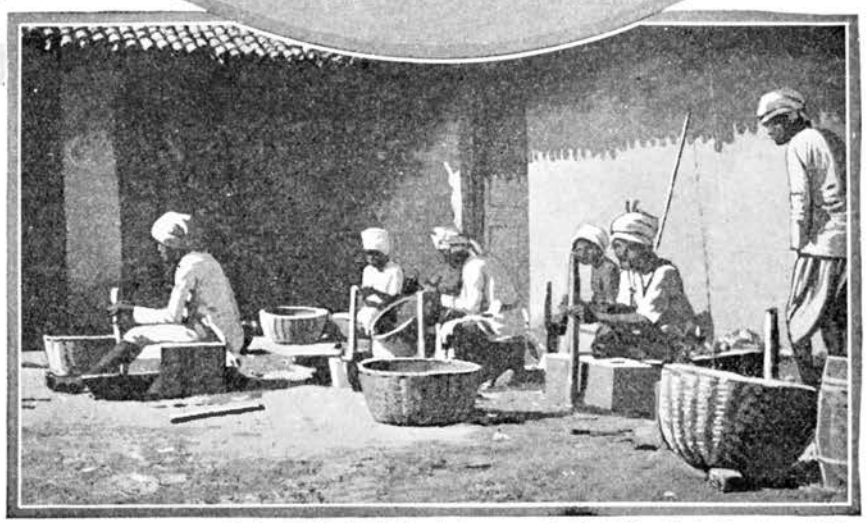
Mica, the window glass and lantern lenses of centuries ago, still plays a part in bringing us light and heat for it is an insulation in many different kinds of electrical machinery, providing light and heat and in addition it finds a place in electrical communication by telephone.



A view of a mica mine in India.

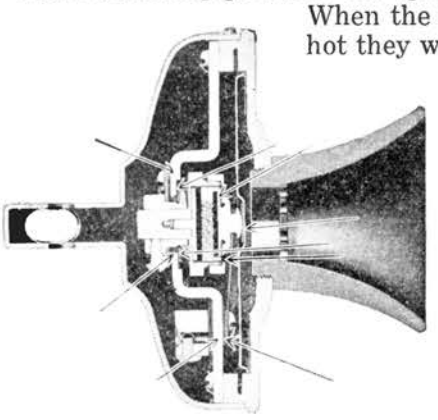
Below—Indian mica cutters trimming books of mica.

Among the hills where sheets of mica are found in the form of books.



Photos © T. H. Holland, Survey of India Office, Calcutta, Jan., 1901.
Indians splitting and cutting mica.

American Indians had a novel way of securing mica. They built a great fire close by a rock containing pieces of the sparkling mineral. When the stone was red-hot they would withdraw the fire and cool the rock by pouring water over it. This sudden change of temperature would split the rock and the Indians could then extract the treasured mineral which they used for mirrors and for burying with their dead.



Mica is an insulator in about a dozen places in the transmitter of your telephone.

Practically all peoples have sought out mica for its transparency. The ancients greatly valued this shimmering mineral and talked a great deal about its wonders. The Roman General, Agricola, wrote that many call it a metal on account of its glitter and others name it cat's silver. Our name for the mineral comes from the old Latin verb, micare, to shimmer or sparkle.

In ancient Greece and Rome where clay oil-vessel lamps and lanterns were used, great care had to be taken to keep the wick flame from going out for, of course, there were not matches in those days and it was difficult to secure a light. So the wicks of these lanterns were encased in horn, bladder, oiled linen or in mica which was probably the best substitute they had for glass.

In addition to this important use the windows of living rooms, baths, porticos, and carrying chairs were also made of mica and even beehives were constructed of this material so the insects could be more easily observed.

Thin sheets of mica are assembled for the condenser which controls the flow of current and gives the greatest possible clearness to words.

Mica is found in various shapes and sizes. It undergoes no conversion processes. as do most minerals, to make it suitable for commercial use. The only treatments it does pass through are those required to eliminate the defective parts of mica, parts cracked or containing non-mica materials.

These processes are simply to split the large "books" of mica into thinner "books" and then, either by breaking off the defective edges with the fingers, or cutting them with a knife, or putting them under a fixed knife like a guillotine to trim them to the desired sizes. From these sizes, the mica is cut as it comes to manufacturers of electrical goods. These smaller pieces vary in size according to the sizes of the large pieces and the need of the commercial buyer. Some are small, approximately 2 inches square, and others range from four to six inches square. Size is one of the means by which mica is graded for the market and quality of the mica itself offers another standard of comparison for grading.

Thumb-nails or small knives are generally used by the workers in India to split the sheets of mica and since a delicate touch is required most of the workers are women and children. India, Brazil, and the United States produce about 95% of the world's sheet mica.

A round piece of mica forms one end of the carbon transmitter button of your telephone instrument.

The most extensive and valuable use of mica is for insulation in dynamos, electric light sockets, telephones and other electrical appliances. Mica was formerly extensively used in phonographs. During the World War a great deal of mica was used in condensers for wireless apparatus and in the magnetos of gasoline engines of trucks and airplanes.

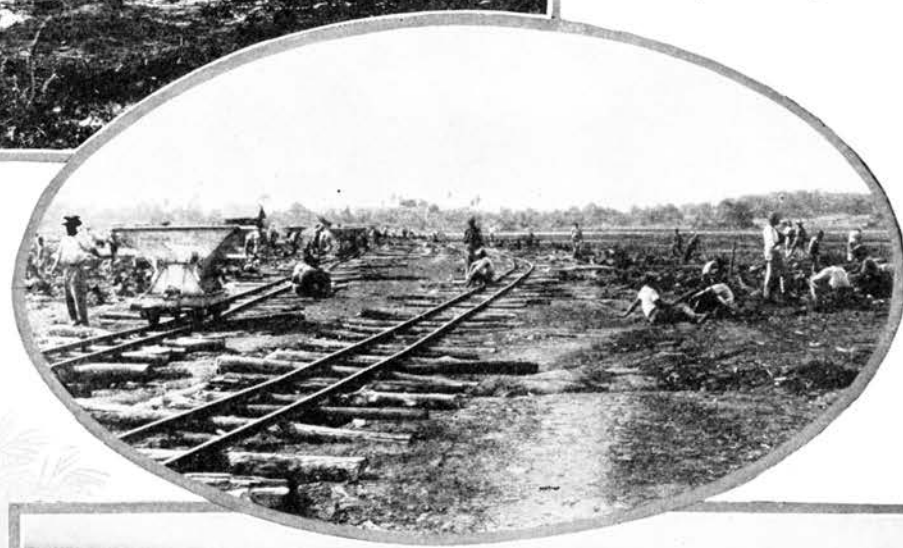
Mica is in your telephone instrument itself and there it is used in thin strips and round pieces in the carbon transmitter button described and illustrated under "Coal." It is this button which helps to transform the sound waves in your voice into the electric waves which pass over the copper wires to the receiver of the listening party. Besides insulating the instrument this mica protects the powdered coal from the effects of heat and atmosphere. Another use of mica in telephone systems is in the condensers where thin sheets are used by the thousands in the telephone circuits.

The Story of Asphalt

Through the centuries asphalt has followed human needs. It started as an aid to the defense of the great Mesopotamian cities and today under the world wide rule of Commerce, asphalt provides good roads and streets.

Below—The Trinidad Lake of Asphalt is very different in appearance from the Bermudez Lake. It is practically an uninterrupted sheet of asphalt. Here, too, light railroads that are moved as the surface of the lake moves, transport the asphalt.

The Bermudez Asphalt Lake in Venezuela is like a swamp with earth and pools of water scattered about. Here the natives are digging out asphalt and loading it into small cars for transport.



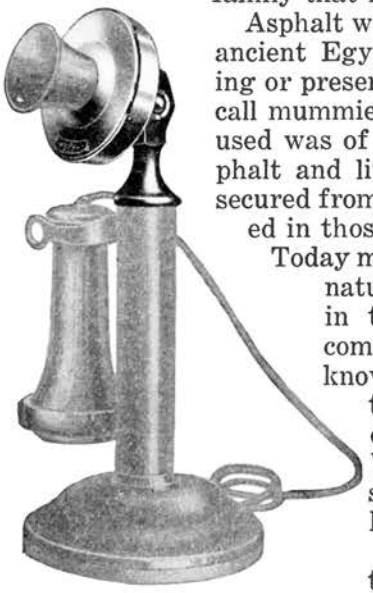
Digging asphalt from a Venezuelan asphalt lake.

© F. H. ALLEN.

In the United States most asphalt is distilled from petroleum and here is a section of an oil field showing the derricks used to drill for oil.

In Your Telephone

Herodotus, the first historian, wrote that the huge walls of Babylon were wide enough at the top for four-horse chariots to pass each other, were miles in length and made of bricks cemented together by bitumen, the mineral family that includes asphalt.



Asphalt forms a part of the finish on the front and back of the transmitter indicated above by the darkened part of the telephone.

Asphalt was also used by the ancient Egyptians in embalming or preserving what we now call mummies. The asphalt so used was of course natural asphalt and little if any is now secured from the sources worked in those days.

Today most of the so-called natural asphalt used in the United States comes from the well-known asphalt lake on the Island of Trinidad in the British West Indies and a somewhat similar lake in Venezuela.

About 90% of the asphalt used in the United States is produced in American oil refineries by distilling asphaltic petroleum obtained in Mexico, California, and the Gulf Coast States.

The largest of the Trinidad Lakes is nearly circular and covers more than 100 acres. There is grass along the edges and, here and there on the lake, are islands bearing shrubs and small trees. These islands move about with the movement of the asphalt.

Borings made some years ago show the lake to be over 175 feet deep in the center and uniformly of asphalt. With its surface 138 feet above the sea the lake extends several feet below sea level and probably comprises the largest deposit of solid native bitumen in the world having millions of tons in its mass.

The finish containing asphalt used on your telephone is sprayed on as if by an atomizer.

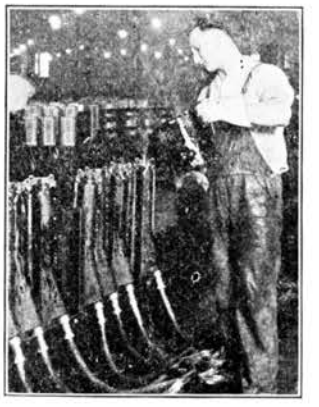
The material forming this deposit contains water, gas, bitumen and some mineral matter such as clay and sand, as well as decomposed vegetable matter.

The whole mass is honeycombed with gas cavities and resembles in structure a huge Swiss cheese. Owing to the gas it is always in motion and so when a hole is dug in it, whether deep or shallow, it fills up to the original level in a short time.

Another peculiar thing about the lake is that its temperature is no greater than the surrounding air except when it is exposed to the noon-day sun, when it may rise to 130° F. or over. The soft asphalt is no warmer than any other part of the deposit.

In the rainy season the lake in Venezuela is mostly flooded and because it is no higher than the surrounding swamps is at all times very wet so that any holes made by removing the asphalt soon fill up with water. The asphalt is comparatively shallow, being at the deepest only seven or nine feet with the average depth two or three feet.

At both lakes crude asphalt is dug out in heavy flakes with picks, and thrown into small cars which run on rails laid on palm tree ties chained to the rails to keep the railway line together as the movement of the lake twists the railway about. On these cars the asphalt is transported to the shore from whence it goes to the piers and thence away to Europe or America where it is refined and used.



Asphalt in cable terminals, used when telephone wires are joined to a lead covered cable used as a main voice highway, prevents moisture working in among the wires and spoiling the insulation, thus enabling currents of electricity to stray from their proper paths.

Asphalt is used in making japan which is baked on many parts of telephone equipment, such as the transmitter case, to give them a beautiful and enduring black finish.

In making telephone condensers the units of paper and tin foil which have been rolled, pressed and treated with wax are dipped in an asphalt preparation, a special mixture which does not become soft and crawl in warm climates nor become brittle and crack in cold regions.

These dipped units are next placed in cans and these are filled with the same compound. Several fillings are necessary to fill the cans since the asphalt settles on cooling. Waterproof coils are also dipped in an asphalt preparation and wires in the central office which are by themselves or in pairs and so open to the atmosphere are coated with it to protect them from moisture.

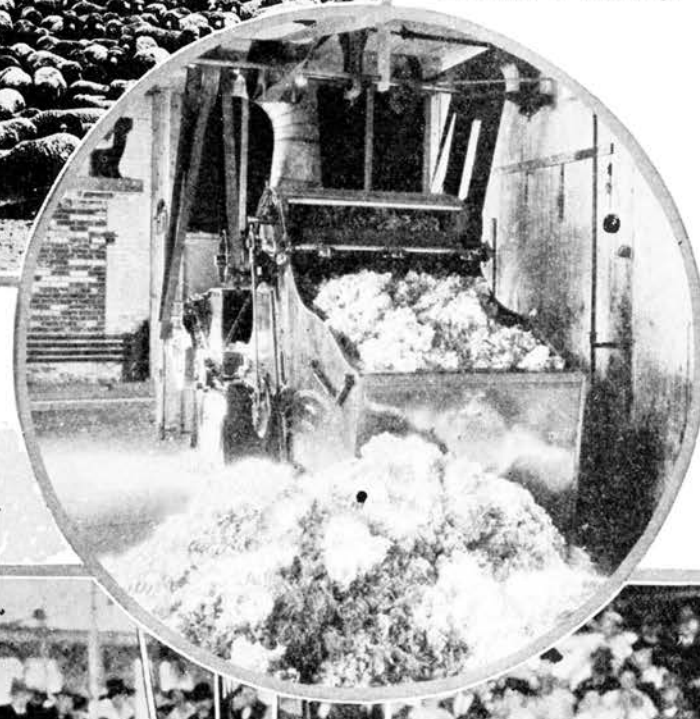
The Story of Wool

The humble sheep for centuries have been contributors to the national wealth of their native lands be they England, Spain, Africa or the early American colonies and today sheep create wealth and commerce for the Argentine, Australia and New Zealand.

PHOTO by KEYSTONE VIEW CO.

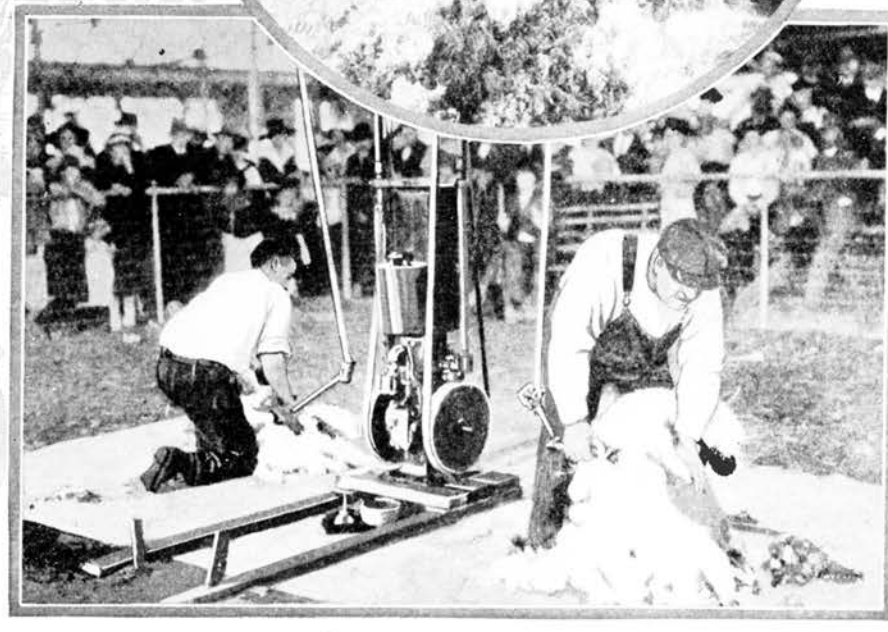
Where sheep raising on a large scale is a national business.

Below — After different kinds of wools are blended to obtain the best results for the finished product, the dust is loosened by spiked teeth on rolls and then blown away, after which the wools go to a Burr Picker, which removes the burrs and gets the blended wool ready for scouring or cleaning.



Commonwealth of Australia Government Photo.

A merino with his heavy fleece.



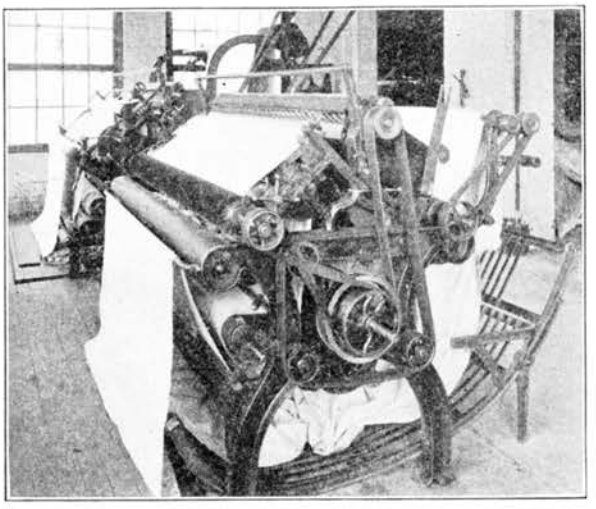
Shearing by machinery.

In Your Telephone

Throughout long centuries cotton was a luxury. But wool has been a necessity and has been for so many ages that no one knows when it was that man first clothed himself from a sheep's fleece or kept flocks for food.

Certainly sheep must have been among the first animals domesticated by man who has taken care of them for so long that one wonders whether they could survive today without the protection of the shepherd and his dog.

The Moors of Spain, by crossing hardy African sheep with weak, delicately reared, but high-grade Roman sheep produced the world-famous merino. This breed Spain zealously guarded for a number of centuries, forbidding any merinos to be exported upon penalty of death.



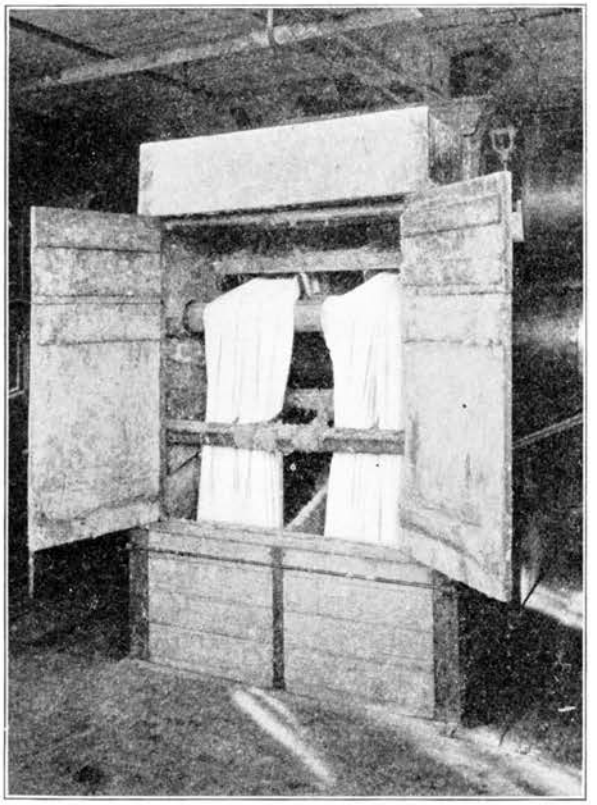
After the woven felt is made it is put through cleaning processes and dried and then sheared in a machine like the one above, which really gives it a haircut, trimming the fuzz off each side.

George III of American Revolutionary fame, secured a few merinos by way of a present, and eight of them were taken to Australia and became the ancestors of the vast Australian flocks of today. In Australia the pure merino grown primarily for its wool, is more largely raised, and on the whole, better raised, than elsewhere.

Columbus carried sheep to the new world on his second voyage. When the Virginia colonists set sail for America in 1607 they brought sheep along and thirteen years after the Pilgrims set foot on Plymouth Rock, sheep were introduced into Massachusetts. The main purpose in bringing these sheep was to clear and fertilize the land, but they also supplied wool for the members of the household. As a rule this wool was prepared, spun and woven in the home.

The first merino sheep were brought into this country in 1773. Merino wool in the early years of the nineteenth century was so valued that it brought at one time four dollars a pound. Pure blooded merinos were greatly prized and one $10,000 ram which sickened and died in Vermont received as much notice in the newspapers as would a distinguished statesman.

Long after cotton mills were flourishing, the manufacture of woolen yarns and cloths remained a household occupation. Gradually, however, with the improvement of the wool due to the importation of merinos, through betterment of machinery and processes, and increased demand for woolens, the industry shifted to town and factory.



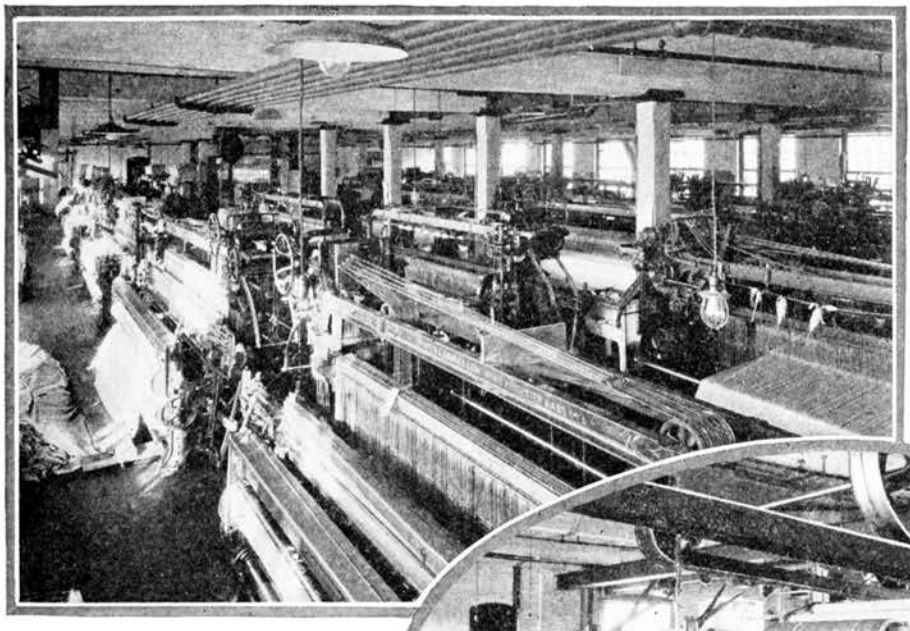
This fulling mill is the modern method of felting. It succeeds the old-time method of stamping the cloth with the feet. In the fulling mill heat, friction and moisture combine to make one fibre interlock with another.

A change in men's fashions was one cause of the increased demand for woolens. About 1812 men discarded knee-breeches for trousers. Up to that time only sailors and laborers had worn trousers which were made of coarse cotton duck or denim. Since the new trousers were of cotton and wool and had never been made in the homes, it was quite easy for the woolen mills to secure this new business.

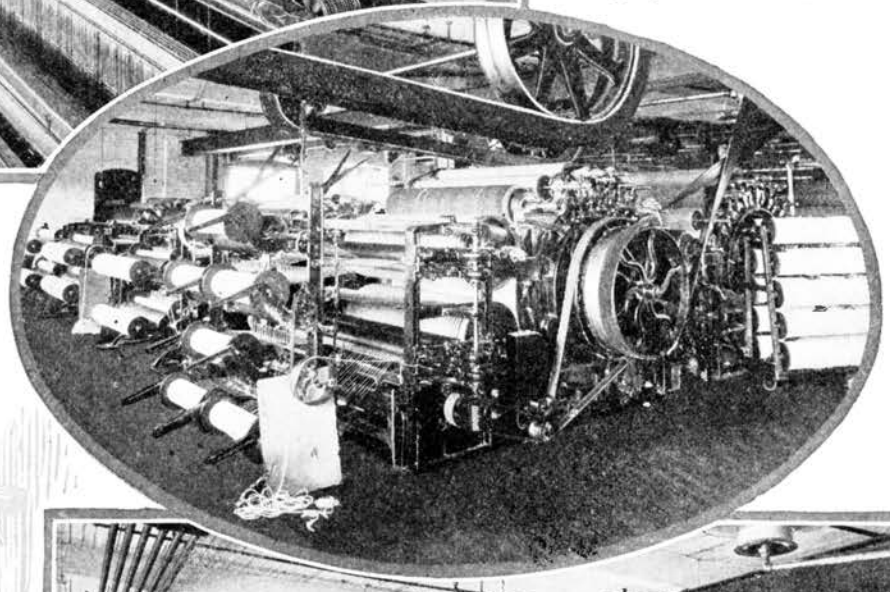
To prepare cloth made by the usual weaving process, the wool must be changed into a continuous yarn or thread. The bulk of the raw material comes in the form of fleece wool which is cut from the body of the living animal. The first clip, of about eight months, is called lamb's wool. When not shorn

The Story of Wool

In the years between the reigns of spinning wheel and the spinning mule, the making of woolen cloth has moved from the cottages to huge mills that have in turn caused cities to grow up around them and brought prosperity to ranchers and city dwellers.

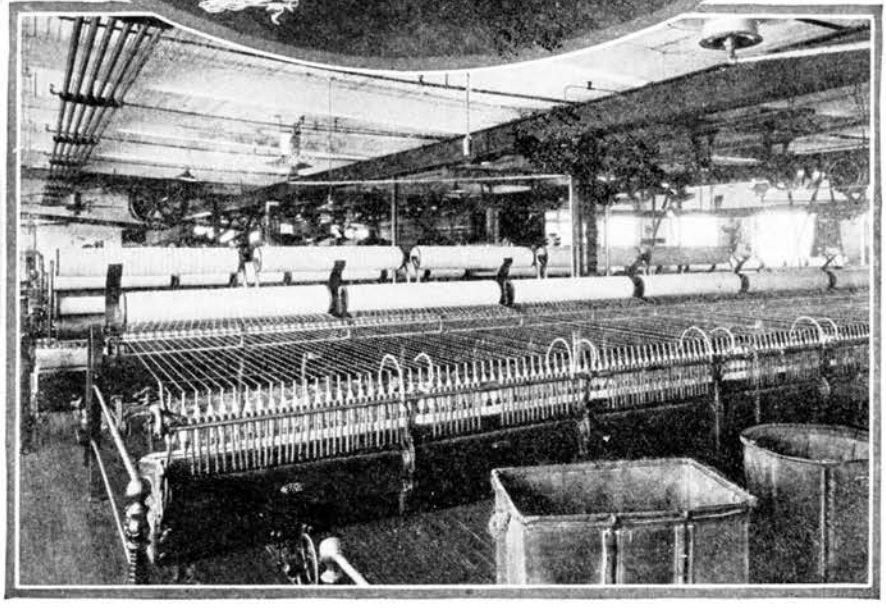


Below—Carding machinery combs the wool by means of huge cylinders whose thousands of teeth tear apart or straighten the wool fibers. Carded wool is rolled into a fluffy white roving which is separated into smaller strands and wound on spools preparatory to spinning.



Looms weave or interlace the yarn or threads of wool to produce a fabric.

The old-fashioned spinning wheel that was the woolen mill of a century ago.



Spinning consists of transforming the roving into yarn by drawing and twisting, a process that includes winding the yarn on spools preparatory to weaving. The machine is called a spinning mule.

until twelve or fourteen months, the wool is known as hig or hogget and is, like lamb's wool, fine and tapers to a point. All other fleeces cut

Wool is used in the pad on the base of your telephone instrument.

are known as wether wool. To make woolens the fleece is carded and loosely spun. To make worsteds the thread is twisted until it becomes very hard.

Wool has become one of the staple products of the world not only because it is useful as a fibre to spin and weave into cloth but also because it—unlike cotton, flax and silk—can also be matted or felted. Since before the days of history men have known of this quality of wool and pounded and pressed and pushed the fleece which they clipped from the backs of sheep until it became a stout warm fabric.

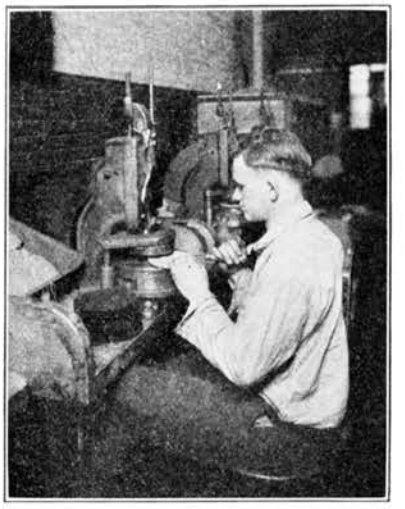
The reason why a fabric could be made this way was probably not discovered, however, until centuries after the first felt was made. This was learned when some one discovered that each fibre of wool is covered with minute teeth or barbs pointing toward its tip and that by pressing a number of these fibres together, those which lie in opposite directions to each other and in contact will interlock at those barbs and stay attached.

The fabric made by this ancient method is called pressed felt. There is still another kind of felt made today by weaving soft wool yarn into a fabric which is then passed, while in a moist condition, through heavy rollers. This product is called woven felt and is extremely durable and uniform.

Whether or not a certain wool felts well is very important. Merino wool felts strongly. Rug wools felt loosely. Wool for clothing must also be carefully chosen as to its felting qualities and the same applies to the wool used, for instance, in the telephone system.

Felt is used for women's hats, cloaks, garments, covering for floors, shoe linings, hammers in pianos, and for men's hats mixed with the fur of raccoon, beaver or rabbit.

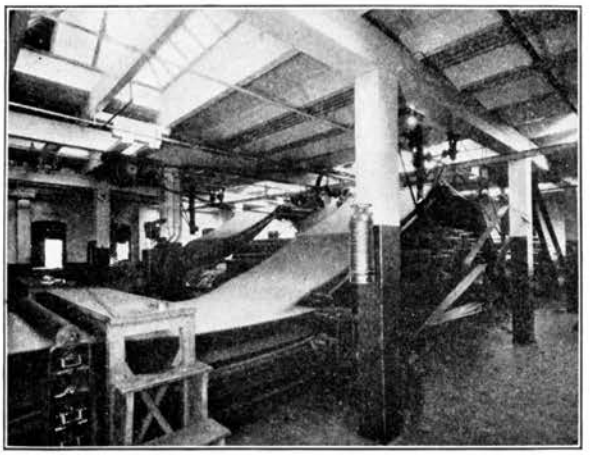
Woven felt is used to make the pad on the base of your telephone instrument and while this felt pad has nothing directly to do with the sensitive currents which enable your voice



Attaching the woolen pad to the bottom of the desk stand.

to be heard by someone, perhaps miles away from you, it is a part of your telephone and as such is made carefully and out of material which has been found to be the best for the particular place it fills.

Another use of felt is for washers in the machinery which make various telephone parts. Another interesting use of wool in tropical countries is to cover telephone conductors to protect them from the effect of the climate.



Giving felt its last treatment by rolling it into a more compact sheet.

The generous contributions of facts and photographs that have helped to make this book possible are hereby gratefully acknowledged by the Western Electric Company.

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3-K-28 200 Printed in U. S. A. WECO—T-826-B