COPPER MINING IN AMERICA.

BY WALDON FAWCETT.

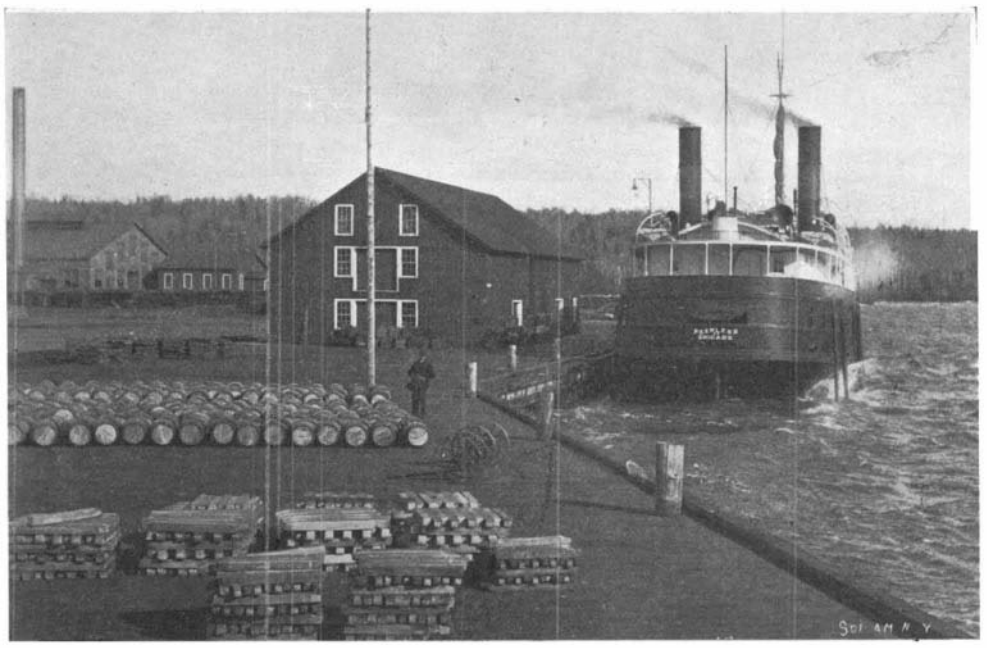
No phase of the development of the natural resources of the United States has been characterized by more rapid or more really remarkable progress than the growth of the copper industry. For one thing, this commodity holds the unparalleled record of having shown, even in the face of financial panics and business depression, an increase of production during practically every year since the inauguration of operations, until now the annual output of the metal is worth approximately $100,000,000, or considerably more than all the gold produced in this country during an equal interval. Perhaps even more impressive is the fact that the United States has within little more than a half century risen to the position of mining more copper than all the rest of the world combined, and in so doing has virtually established control over the markets of the globe.

Copper is produced in the United States principally in Arizona, California, Colorado, Michigan, Montana and Utah, although various other divisions of the Union, particularly the Eastern and Southern States, make contributions to the aggregate output. During the past two decades, however, the center of production has moved westward. In 1845, the year which marks the commencement of modern copper mining on this side of the Atlantic, the total production of the United States was estimated at one hundred tons, of which Michigan yielded a dozen tons. From that time forward the ascendency of the Lake Superior copper district over other sections became more and more pronounced. In 1856 Michigan miners took from the ground over nine-tenths of all the copper secured in the country, and as late as 1880 the Michigan output constituted more than four-fifths of the total production.

Then came the development of nature's great storehouse of copper in Montana, and although the record of growth was fully as meteoric as had been the career of the Lake Superior territory, it was not until 1892 that Montana finally displaced Michigan as the greatest copper-producing State. The same relative positions have been maintained ever since. On a rough estimate, Montana furnishes, at the present time, about 40 per cent and the Lake Superior mines perhaps a quarter of the American production of copper. Arizona, wherein is located the most recently discovered of the three great copper fields, ranks next to Michigan, her copper-mining operations footing up about one-fifth of the grand total. It is interesting, if not significant, to note that Arizona showed the greatest gains in production recorded during the closing year of the century, whereas Montana showed but a slight increase and the Lake Superior district barely held its own.

The expansion of the scope of the copper-mining industry has been attended by an improvement of methods and facilities fully as great as, if not greater than, has been afforded in any other branch of mining operations. To appreciate the extent of the betterment it is only necessary to compare the economical and efficient mining systems and reduction plants in use to-day with the primitive methods of half a century ago, when much of the copper was taken from the rock by means of drills and gads. The introduction of black powder for blasting purposes was a long step ahead and opened the way for other innovations.

Under the present plan, new shafts are sunk with incredible rapidity. Diamond drills are extensively employed in making explorations, and power rock drills are in almost universal use in mining operations proper. Instead of being dependent upon oxen, hoisting buckets of rock by means of a windlass, as in the old days, the modern copper mine is equipped with hoisting engines of from five thousand to eight thousand horse power, which hoist ten-ton cars of rock from a depth of nearly a mile at a speed of 55 miles an hour.



COPPER, READY FOR SHIPMENT, LAKE SUPERIOR DISTRICT.

Originally the copper mine operators introduced gravity stamp mills, but these proved totally inadequate, and latterly steam stamps have been provided, of such power in some instances that an average of 350 tons of ore can be crushed daily at a single mill. The equipment of a large modern copper mine also includes powerful air compressors, capable of supplying perhaps fifty air drills, and fans thirty feet in diameter with a capacity of one hundred thousand cubic feet of air a minute for underground ventilation.

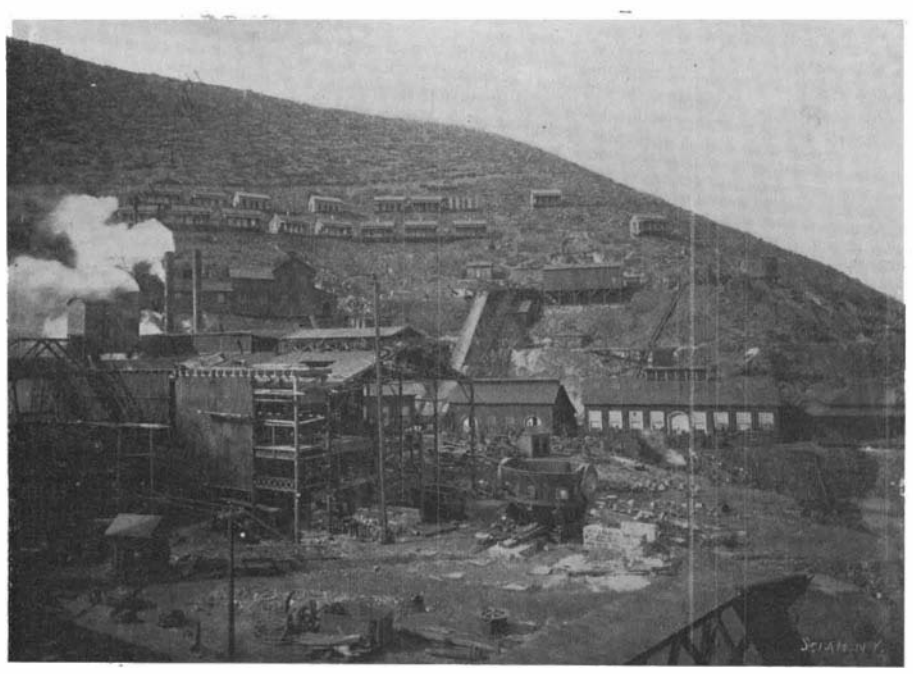
Some of the older copper mines in the United States rank among the deepest holes in the world. The Red Jacket shaft in the Lake Superior district, for instance, an opening about twelve feet by twenty-five feet in size, has been sunk vertically to a depth of nearly five thousand feet, and is claimed to be the largest and deepest shaft of its class in the world. Branching from the main shaft are innumerable "crosscut" tunnels through which the copper ore is carried to the main artery of communication and hoisted to the surface in ten-ton cages, each of which makes half a dozen round trips in an hour, enabling the hoisting of more than five thousand tons of ore from this one mine every working day in the year.

The average cost of producing a pound of copper does not greatly exceed eight cents, and at the prices which have prevailed for many months past some of the operating companies have made a clear profit of from nine to eleven cents on every pound produced. If the copper taken from the ground in America during an average year is estimated to be worth $100,000,000, it is safe to credit $50,000,000 as net profit. How rapid has been the growth of the industry is attested by the fact that a year's profits under present conditions more than equal the total value of the American product for a corresponding interval half a decade ago. The great improvement in prices and market conditions of late years may be largely attributed to the growing foreign demand. Europe consumes an enormous quantity of copper, and for a heavy proportion of it she must depend upon the United States.

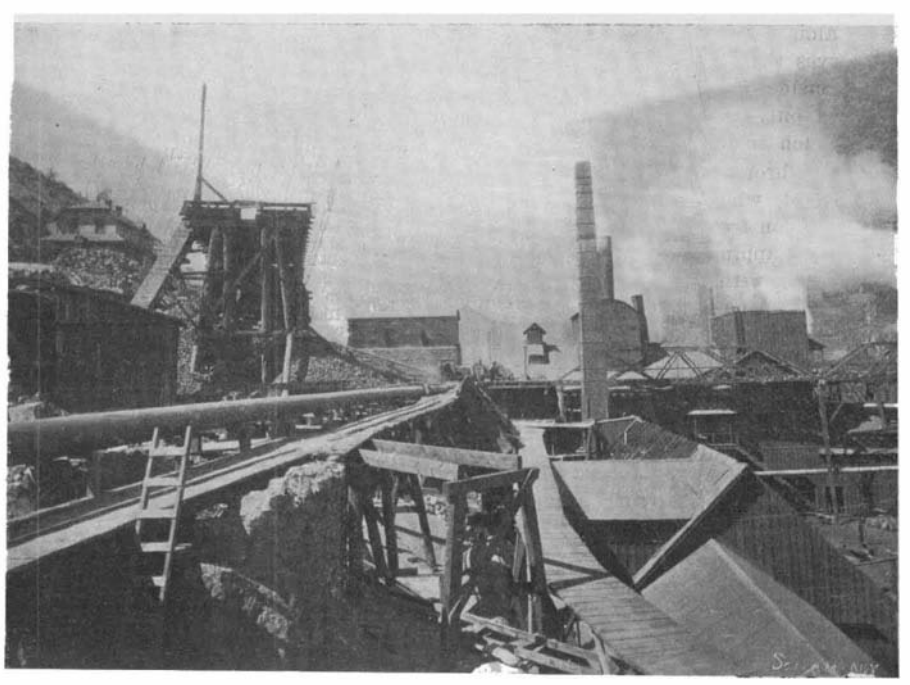
One of the most interesting copper mines in the world is the United Verde, at Jerome, Ariz., of which Senator W. A. Clark, of Montana, is the principal owner. The smelting plant is one of the largest in existence, consisting of six water-jacket furnaces, each of which has a capacity of 160 tons of ore a day. The metal is transferred by electric cranes from the furnaces to the converters. There are six of the latter, and they have a daily capacity of 1,200 tons. A curious process which the molten metal must undergo after it has been poured from the converter into the broad, shallow, tilting furnace is found in the placing of green cypress poles in the caldron to afford a chemical antidote for a certain existent acid condition. The bullion copper is cast in the form of "anodes"—slabs about three feet in length, with a hook at one end which facilitates the suspension of the piece of copper in the electrolytic bath in which it is submerged when it reaches the refinery. The machinery installation at the United Verde smelting plant is reported to represent an expenditure of over $1,000,000. Thus far the mining shaft at the United Verde property has pierced the ore body to a depth of only about 600 feet, but exploration by diamond drill has disclosed the fact that there is rich ore to a depth of 1,400 feet farther. The ore body varies considerably in width, but is not less than 600 feet in breadth at any depth yet reached in the development.

The great demand for copper is doubtless responsible for the fact that in no other branch of metallurgy has a higher degree of scientific attainment been reached than in the treatment of copper-bearing ores. Improvements are constantly being introduced at every stage in the evolution of the metal. It is interesting also to note that practically every nationality on the globe is represented among the artisans of the copper industry. At Calumet, Mich., the center of the Calumet and Hecla Company's interests, and the largest mining camp in the world, the population includes natives of twenty-three different countries. The Calumet and Hecla Company employs five thousand men, of whom two thousand are miners. The latter receive from $2.10 to $2.65 a day; the drillers are paid from $3 to $4 a day, and the pay of the captains of mines or shafts is at the rate of $5 or $6 a day. Some of the most highly skilled workmen receive nearly $10 a day.

One of the dangers which ever threatens copper mines is found in the havoc wrought by disastrous



COPPER MINE WORKINGS AT JEROME, ARIZONA.



CLARK'S COPPER MINES, JEROME, ARIZONA.

fires, and every precaution is taken to guard against these conflagrations. At most of the older workings, as well as at the new mines, there are complete systems of fire alarms, fire doors, and pipe lines; the employes are organized into thoroughly drilled companies of firemen; and steam fire engines and duplex fire pumps are provided. Supplementary to the regular alarm apparatus, connection between all the various workings of a mine is maintained by means of a system of electric bells and private telephones. That all possible precautions have not made the natural storehouses of copper invulnerable, however, is evidenced by the fact that some time ago one of the shafts of the Calumet and Hecla mine caught fire and burned fiercely for weeks, entailing a loss of $15,000 a day, and this in spite of the fact that this mine has a private water works system which daily pumps two million gallons of water a distance of nearly five miles.

ELECTRIC AUTOMOBILE—KRIEGER SYSTEM.

One of the latest types of electric automobiles is the new two-place machine of the Krieger type, or "electrolette," as it is called. This is the smallest machine of this type which has been designed up to the present. In this system the front wheels turn at the end of a fixed shaft, and each is driven by a separate motor with reduction gearing, thus doing away with the differential and making a less complicated arrangement. This machine has been designed to meet the demands for a light electric automobile and to overcome the objection that an electromobile must necessarily be heavy, on account of the weight of the accumulators, as well as costly. It has thus been necessary to design a vehicle which should be free from these objections; it should be light and easily operated, and should not require more than ordinary attention from its owner. It must also cover a considerable distance without recharging, in spite of the light weight of the vehicle, and its average speed should be somewhere near that of a petroleum automobile. M. Krieger, owing to his previous experience in this direction, has succeeded in solving the problem of a light electric vehicle, and the present machine is the result. As will be seen, it is a two-place vehicle, but as the carriage body is made removable, a four-place body may be substituted, in spite of the small size of the machine. The front axle, which is fixed, is carried well in front, and at each end the wheel turns like that of an ordinary carriage. The fixed axle supports near the wheel an electric motor of 3 horse power, which is of the latest design and entirely inclosed by its circular casting and end-pieces. The pinion comes out at the side next the wheel and engages with a large gear wheel which is fixed against it. The gear and pinion are inclosed in a tight case. Thus each wheel is turned independently by its own motor, and the result is a great gain in simplicity, owing to the suppression of the differential; it is this system which has made the Krieger type one of the most successful of the electric automobiles. The truck is supported upon the front shaft by a curved spring. The whole system turns about a central pin, and is steered by the hand-wheel above, by means of a pinion and toothed sector. The accumulators are contained in a box which is fixed in the truck below the carriage body and is arranged so that it may be easily slid out from the rear. The batteries are of the Fulmen type, and have a total weight of 800 pounds, allowing a run of at least 65 miles on a single charge. The two motors, each of 3 horse power, give a total of 6 horse power for the machine, which enables it to climb heavy grades without injuring the motors. The latter are arranged so as to be accessible from above, which renders their inspection and cleaning much easier than in the ordinary type of electric vehicle. The total weight of the machine, in spite of the 800 pounds of accumulators, is only 1,700 pounds, of which the motors represent 220 pounds. The mean speed on a level grade is 21 miles an hour, or 12 to 15 miles over an average road. The controller of the Krieger type has the advantage that

THE KRIEGER ELECTRICAL AUTOMOBILE.

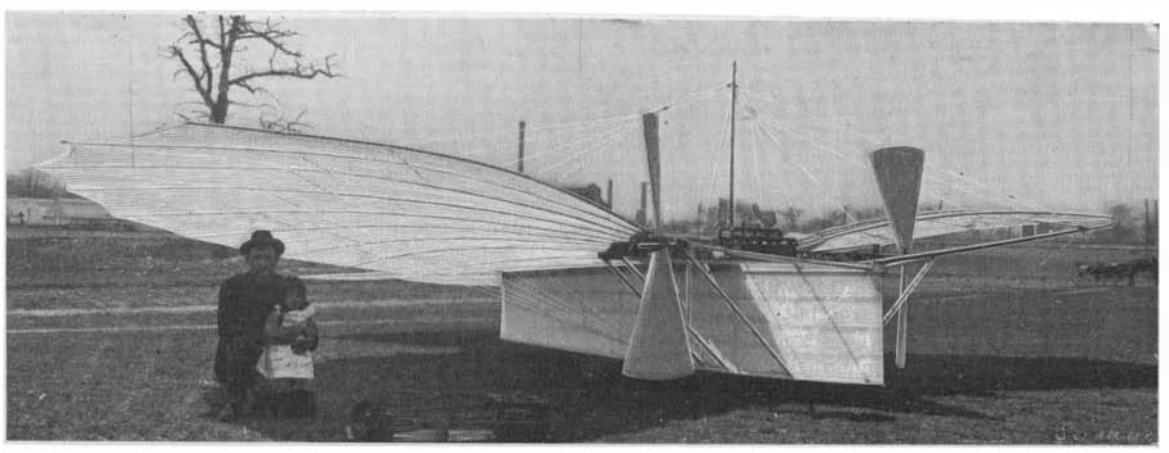
the steering wheel and controller are mounted in a single device and the whole direction of the machine is brought to one point. The shaft of the steering wheel passes down through the carriage body, while surrounding it is a hollow shaft upon which is mounted the controller drum. The latter is turned about the main shaft by a handle directly under the steering wheel. The controller is formed of an insulating cylinder carrying a series of contact rings which rub against the contact spring-pieces at the side of the box. The controller may take 11 different positions, including start, slow, mean and high speeds, an extra speed, electric brake and reverse. The electric braking action is carried out by placing the motors in short circuit, thus giving a powerful brake upon the front wheels; besides this, the rear wheels carry a band-brake.

A NEW FLYING MACHINE.

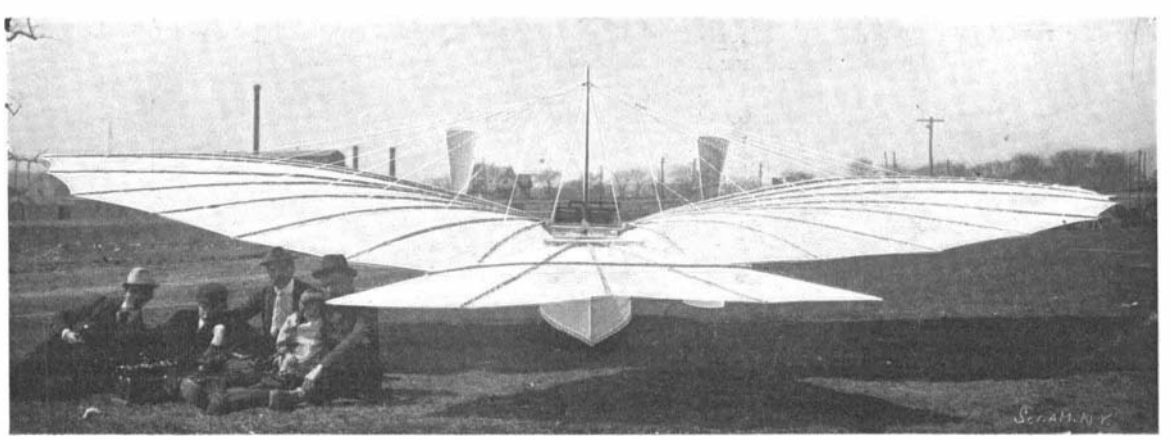
A novel flying machine has just been completed by Mr. Gustave Whitehead, of Bridgeport, Conn., and is now ready for the preliminary trials. Several experiments have been made, but as yet no free flights have been attempted. The machine is built after the model of a bird or bat. The body is 16 feet long and measures 2½ feet at its greatest width and is 3 feet deep. It is well stayed with wooden ribs and braced with steel wires and covered with canvas which is tightly stretched over the frame. Four wheels, each one foot in diameter, support it while it stands on the ground. The front wheels are connected to a 10 horse power engine to get up speed on the ground, and the rear wheels are mounted like casters so that they can be steered by the aeronaut. On either side of the body are large aeroplanes, covered with silk and concave on the underside, which give the machine the appearance of a bird in flight. The ribs are bamboo poles, and are braced with steel wires. The wings are so arranged that they can be folded up. The 10-foot rudder, which corresponds to the tail of a bird, can also be folded up and can be moved up and down, so as to steer the machine on its horizontal course. A mast and bowsprit serve to hold all the parts in their proper relation.

In front of the wings and across the body is a double compound engine of 20 horse power, which drives a pair of propellers in opposite directions, the idea being to run the machine on the ground by means of the lower engine until it has the necessary speed to rise from the ground. Then the upper engine actuates the propellers so as to cause the machine to progress through the air to make it rise on its aeroplanes. The wings are immovable and resemble the outstretched wings of a soaring bird. The steering will be done by running one propeller faster than the other in a way analogous to the way in which an ocean steamer having twin screws can be turned, a special aeroplane being provided to maintain longitudinal and transverse stability.

The lower engine is of 10 horse power, and weighs 22 pounds. The diameter of the cylinder is 3 7-16 inches by 8 inches stroke. The upper engine is a double compound cylinder, the diameters being 2¼ and 3 7-16 inches with a 7-inch stroke. The engine weighs 35 pounds, and calcium carbide is used to develop pressure by means of explosions. The propellers weigh 12 pounds, and are 6 feet in diameter, with a projected blade surface of 4 square feet. With a drawbar test, the upper engine being run at full speed, the dead pull was 365 pounds. The weight of the body and wheels is 45 pounds. The wings and tail have 450 square feet of supporting surface, and the weight is 35 pounds.



WHITEHEAD'S FLYING MACHINE, SHOWING ENGINE AND PROPELLERS.



WHITEHEAD'S FLYING MACHINE, SHOWING AEROPLANES.

Messrs. William Jessop, the famous steel manufacturers of Sheffield (England), are about to establish extensive steel works in this country. This decision has been caused by the American Steel Combine and the high prohibitive tariffs imposed upon foreign steel. Messrs. Jessop have a large business connection on this side, and by the establishment of local works, owing to fuel being cheaper, they intend to force the market, and thus to oppose the Steel Trust. The proposal has excited the greatest interest in the steel circles of Sheffield, and other manufacturers who also have an American connection contemplate a similar step. The enterprise is being substantially supported financially. Already several English manufacturing firms have established works in foreign countries protected by heavy tariffs. Notably is this the case with Russia, and the enterprise has been attended with signal success.