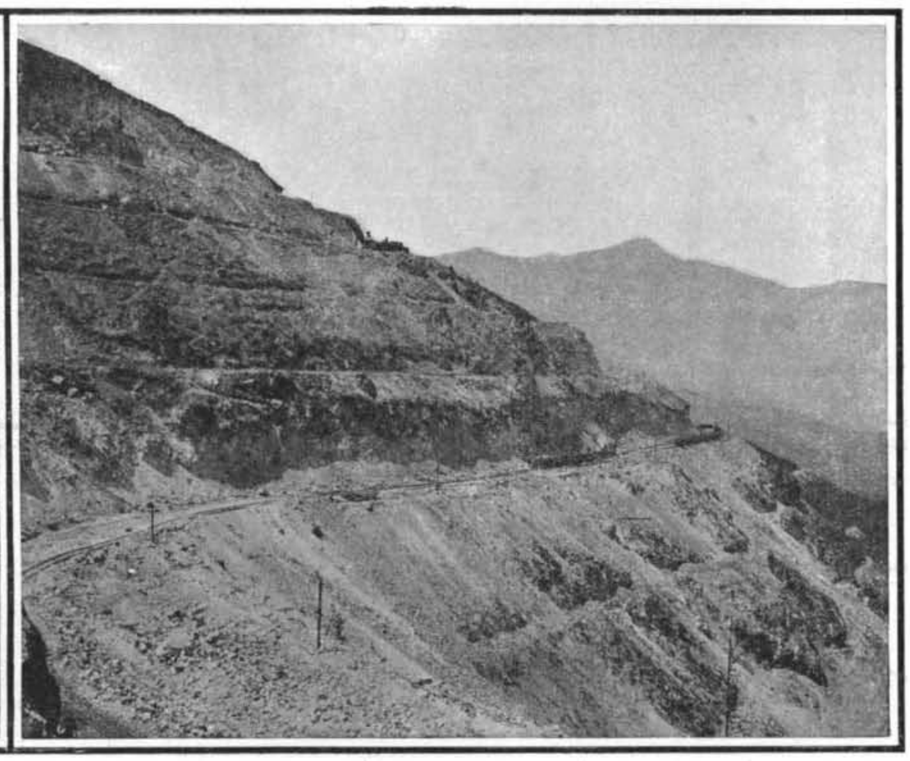
MOVING A MOUNTAIN IN UTAH.

One is accustomed to think of mining operations as being conducted deep in the bowels of the earth, and of miners working in cramped positions and an unwholesome atmosphere of powder-smoke and grime. In Utah, however, mining operations are conducted for the recovery of metal on a truly enormous scale, out in God's good air and sunlight, in the course of which a mountain is being leveled instead of caverns being hollowed out within the earth's crust.

Aerial cable tramway sending down to the railway ores from the Utah Apex mine.



One of the "benches" above the tramway shown in frontispiece of this issue.

Nor are the unusual, even sensational, methods of mining adopted the only interesting features in the history of the Boston Consolidated and adjacent mines at Bingham Cañon, Utah. In all the history of mining, always fascinating by reason of its surprises, there is no story more romantic than that of the transformation of the Highland Boy, on the verge of failure as a gold mine, into one of the largest copper producers of the world.

The iron gossan outcrop in Bingham Cañon had long been a local landmark, and was known to contain gold to the value of $4 to $8 a ton, but in a very refractory state; in 1895 the Highland Boy mine, upon which considerable development work had been done, was offered for sale as a gold mine for $300,000, and refused after examination by a Montana syndicate. Ten years later the Utah Consolidated Copper Company, with that mine as its principal asset, made a profit of $2,750,000 in a year, and is still making an increasing output.

Copper is the determining factor that has made all the difference.

In 1896 Mr. Newhouse secured sufficient capital to erect a cyanide plant, and the mine was a fairly profitable gold producer for a time, but profits dwindled and ceased, surplus capital evaporated, and total failure seemed imminent, when, toward the end of 1897, rock that was going over the dump as waste was found to contain 8 per cent of copper. The lowest development adit had penetrated a large body of iron pyrites containing enough chalcopyrite to bring it up to the above value.

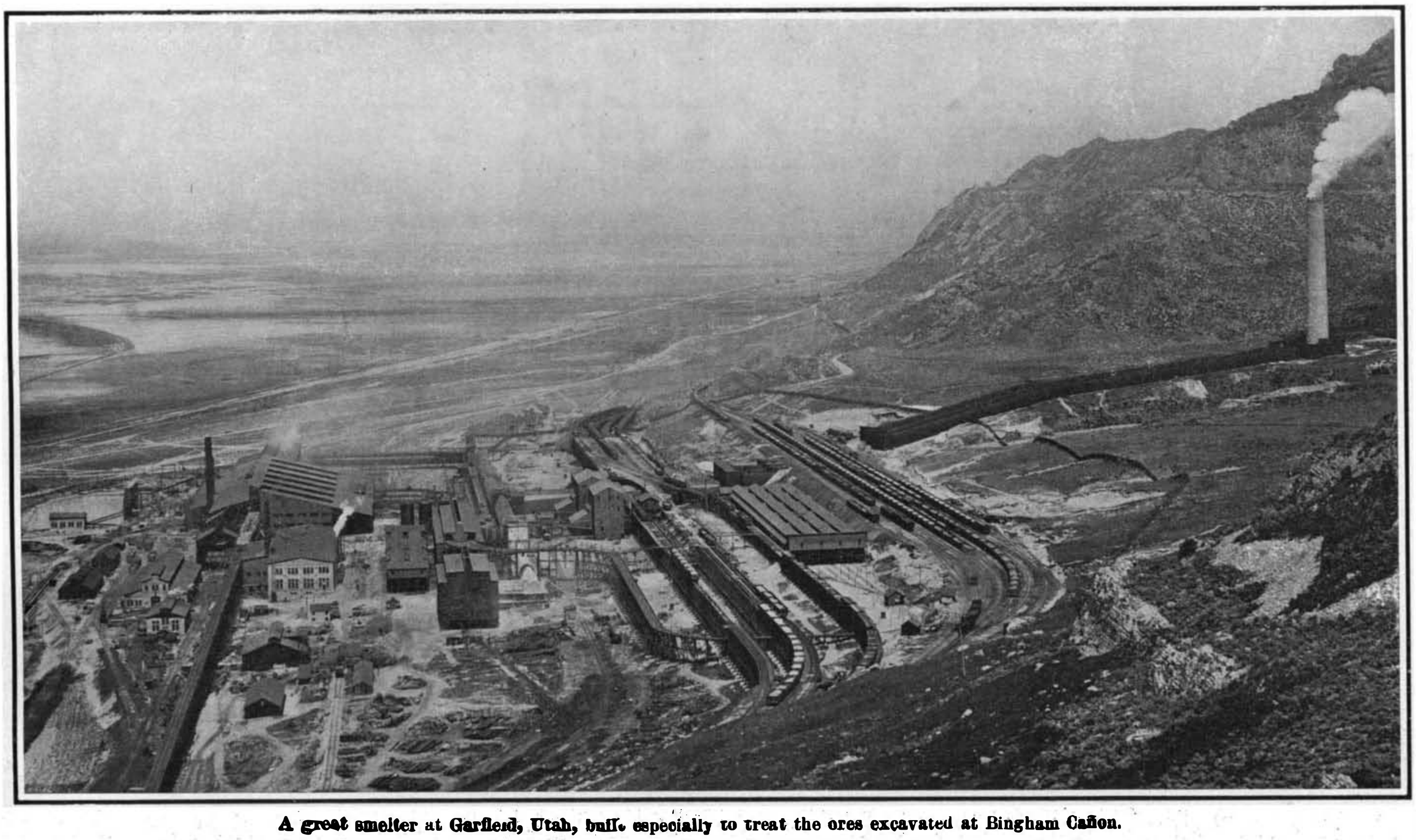
Prospecting in the same neighborhood by Col. E. A. Wall's associates disclosed a great laccolite of monzonite porphyry, half a mile long and extending well up the mountain ridges, containing—if everything assaying over 1.5 per cent copper is considered as ore—over two hundred and fifty million tons.

The overlay of the Highland Boy sulphide deposit was also found to be largely impregnated with copper, and this led Mr. Newhouse to acquire large holdings adjoining, but not included in the combination owning that mine, now known as the Utah Consolidated Copper Company. Prospecting on these revealed an enormous lenticular deposit of copper sulphide, formed by replacement in limestone, and even this was not the limit, later investigation showing hundreds of acres of old igneous intrusive monzonite to have been impregnated with copper solutions, possibly by the same later eruptive action as caused the replacements.

This forms the property of the present Boston Consolidated Copper Company, and the mountain now being moved, as shown in our front-page illustration.

Operations were commenced upon the underground sulphides assaying as much as 8 per cent of copper, but it was at first a question whether the higher impregnations could be mined at a profit. Ore carrying as little as 1 per cent had been profitably mined at the Atlantic in Michigan, but that was native copper, whereas the Bingham deposit was all sulphide. On account of the latter being so readily accessible, however, practically no shaft sinking or pumping being required, it was very cheaply mined, and, with the present stripping methods breaking enormous quantities of rock at very low cost, a handsome profit over mill and smelter costs is shown.

The solid sulphide ore mined below still pays for the operations on the mountain top, ore being stoped



A great smelter at Garfield, Utah, built especially to treat the ores excavated at Bingham Cañon.

MOVING A MOUNTAIN IN UTAH.

from three underground levels in a deposit at some places 100 feet wide. The ore is discharged from the upper to the lower levels by chutes, and from the lowest directly into cars of the "high line" of the Rio Grande Western, which convey 750 tons daily from the Boston Consolidated to the smelter of the American Smelting and Refining Company at Garfield.

The stripping operations at the top of the mountain began with the removal of waste rock overlying the enriched monzonite, the ground having been leached of its values to a depth varying from 30 to 60 feet. This waste is carried round the mountain and dumped on the far side, where the ore body lies lower and could not be eventually mined by removal of the overlay. Now, however, sufficiently rich ore to be sent to the mill is being stripped in the same way, and sent down by the tramway shown in our illustration, the whole of the rock exposed by each blast being carefully sampled and assayed and sorted accordingly.

For the stripping operations five steam shovels were first sent up the mountain by a specially-built railroad with numerous switchbacks.

The hilltop is laid out in four benches from 40 to 120 feet high, the highest bench being kept farthest back, so that rock blasted there does not fall upon and impede the tracks upon the bench below. Well-drilling machines are used to drill 5-inch holes 30 feet apart in a line as far back from the face of each bench as the explosive will break. When the holes reach the level of the bench below, they are pumped out and "sprung" with 25 sticks of 40 per cent dynamite, again with 50 sticks, and sometimes again with 75 or more. This makes a chamber at the bottom of the hole large enough for the breaking charge, which is from 20 to 60 boxes of powder per hole. A row of holes is fired simultaneously by electricity, and the whole face of the bench is moved and shattered so that it can be handled by the steam shovels. On the average 2.8 tons of rock is broken per pound of explosive used, and 0.68 ton per foot of hole drilled. Masses too large to be handled by the shovels are drilled with percussion or air-hammer drills and split up.

Each of the shovels is of 90-ton capacity, with a 5-ton dipper. Two trains of wooden dump cars attend each shovel, and the latter fill the 4-ton cars at the rate of about one a minute. Four shovels, each working two shifts of ten hours, have handled 14,000 tons in a day, making 175 tons per hour each. The cost of excavation has been as low as 12 cents per ton of ore delivered in the cars, including explosives, labor, and shoveling.

The ore selected to go down to the mill is dumped by the cars in a 400-ton receiving bin at the top of the incline shown in our illustration, which feeds it into the 12-ton skips of a balanced gravity tramway. The latter has two pairs of tracks 2,100 feet long descending the hillside at a gradient varying from 23 deg. to 27 deg. The skips discharge about 150 tons per hour into the steel-tank receiving bin at the foot of the tramway, having a capacity of 3,000 tons, which discharges directly into the railroad cars of the high line.

The smelter at Garfield shown in our illustration was built especially for treatment of the ores of the Boston Consolidated Utah Copper Company, and other mines of the neighborhood after contracts had been made with them providing for a certain constant supply.

On account of the mountainous and irregular nature of the ground aerial cable tramways are found to be the cheapest means of transporting the ore in some cases, that of the Utah Apex mine being shown in one of our illustrations. In these buckets suspended from rollers travel upon a fixed cable supported on towers, the buckets being clamped to an endless traveling cable passing round drums at the head and foot of the line, the weight of the loaded buckets descending carrying up the empties on the other side.

From present indications only the price of copper can limit the alteration of the horizon in Bingham Cañon, the time being measurably distant when the gulches will be filled up with waste rock and the mountain top reduced to about their level.

A NEW AUTOMATIC ELECTRIC SIGNALING SYSTEM FOR RAILROADS.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

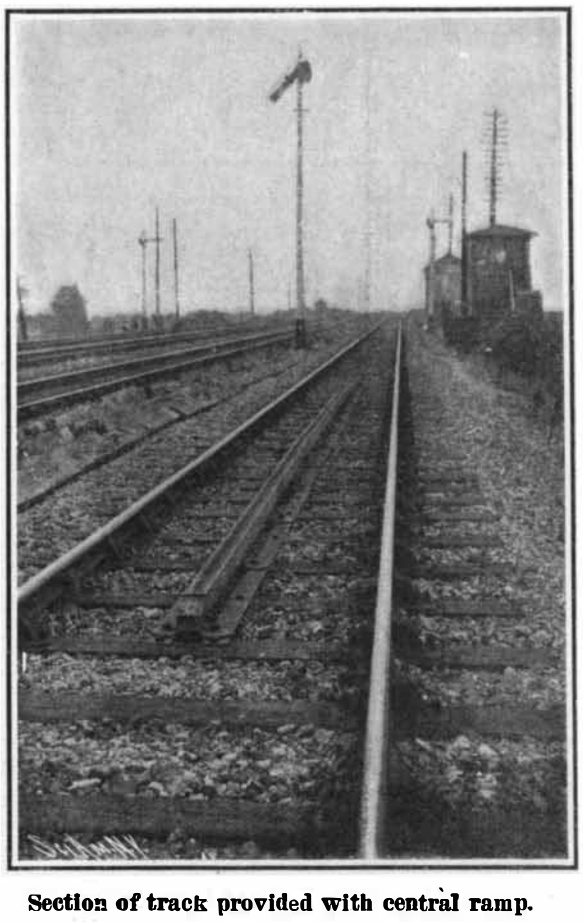
An important development in automatic signaling for railroads has recently been introduced in Great Britain by the Great Western Railroad, the foremost trunk line in the country. Despite the elaborate nature of the block system, and the strict rules laid down in connection with its working, several accidents have recently occurred in the country owing to the ordinary semaphore signals, especially those at the distant point, being inadvertently overrun by the engineer, more particularly in the case of express trains, the mishap being due to the signals being obscured by fog, snow, or rain. Notwithstanding the excellence of the block working, this dependence upon the human element has proved its weakest link. The Board of Trade department of the government, which is responsible for insuring the safe operation of railroads, has long advocated the adoption of an automatic signaling system whereby the engineer is given on his engine not only a visual but also an audible indication of the condition of the section upon which he is entering at any time, since it is realized that the momentary occupation of the engineer's attention to any other detail on the locomotive at the instant of passing a signal might easily jeopardize the safety of his train.

The Board of Trade officials have subjected the latest idea, which has been adopted by the Great Western Railroad, to the most severe and exacting tests; and although it is valuable as an auxiliary to the ordinary semaphore, it can be safely operated without the latter, and as a result of their investigations have conceded to this railroad permission to remove their semaphores and operate a section of their track solely upon this new system, which concession is the first that has ever been granted to any English railroad and consequently marks an important era in the safer working of railroads.

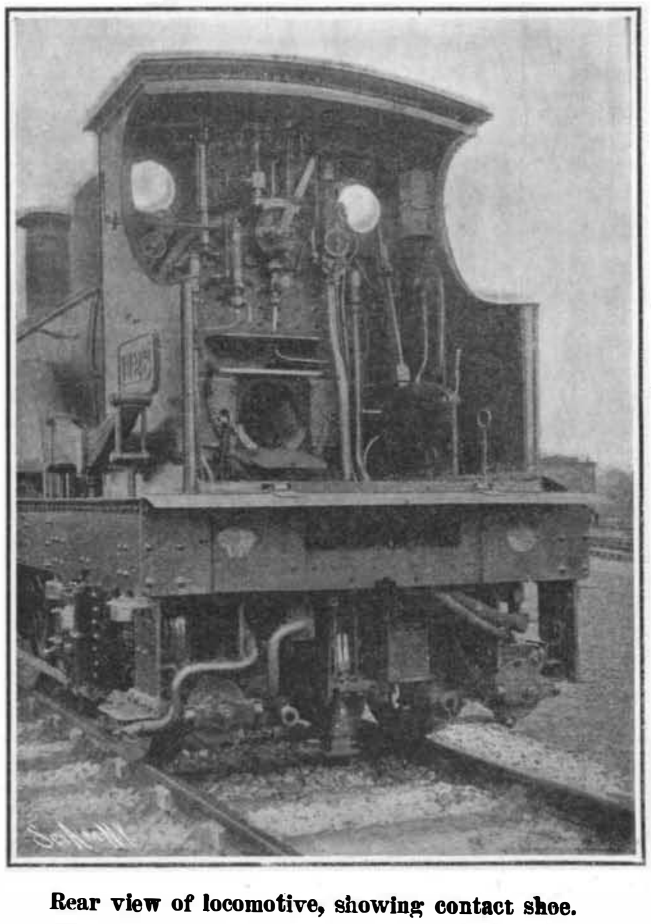
The system adopted is entirely electric, there being no mechanical parts, such as triggers, to come into contact, so that no concussions can result which might imperil the durability of the invention. Upon the locomotive is carried a downward projecting shoe, similar in design to that utilized upon street railroad cars to collect the current from the feed rail, and this shoe comes into contact with a long section of ramp laid between the tracks, thereby establishing electrical communication, and notifying the engineer in the cab both visibly and audibly whether the section of road he is entering is blocked or clear. These audible signals comprise a steam whistle or siren, which is sounded to notify that the signal is at "danger," while "line clear" is signified by means of an electric bell. Either of these signals, when once set in action, continues to sound until it is stopped by the engineer, so that the latter must inevitably realize the condition of the track by stopping the whistle or bell, thereby accepting the warning extended to him. Both signals are given by the operator in the signal cabin to the engineer without the movement of any apparatus on the track, this latter constituting a fixed ramp. Moreover, should there be any breakdown in the electric circuits a danger signal is conveyed to the engineer whether the road is clear or otherwise, so that his attention is drawn to the fact instantly. Also, should the insulation of the ground apparatus be broken by the presence of grease, dirt, snow, water, etc., so that the electric circuits cannot be connected, the danger signal is instantly sounded. In addition to the siren and electric bell placed in the locomotive cab, there is an indicator extending corresponding visual signals, the danger signal being represented by the word "danger" printed on a red ground appearing in the glazed aperture of the indicator, while "line clear" is represented by a clear white space. It will be realized therefore that much of the value of the system lies in the fact that the danger signal is operated whenever any untoward circumstance exists, such as apparatus breakdown, disturbed insulation, etc., whether the line be clear or *vice versa*.

Immediately beneath the cab of the locomotive is placed the shoe (in the accompanying photograph the tender of the locomotive has been removed to show its position), which comes in contact with the fixed ramp, during the passage over which it is lifted. The normal position of this shoe is 2½ inches above rail level, but when passing over the ramp, owing to the latter projecting some distance above rail-level, it is raised about 1½ inches. This contact shoe is of stout construction and is capable of adaptation to any type of engine. The contact face is 7 inches wide and it is case-hardened. There is a strong spiral spring provided which insures the shoe returning to its normal position directly it leaves the ramp. This shoe is insulated from the mass of the engine, and the caution signal is operated by the disruption of a local electric circuit on the locomotive. In its normal position the shoe serves to complete this electrical circuit; but directly it is raised, as when passing over the ramp, and even if only raised ½ inch, the circuit is broken. The result of this circuit interruption is that a steam whistle is brought into action which has previously been held closed by the circuit.

In connection with the whistle and bell signals, an indicator board is attached at the side of the cab. There is a large slot before which appears the notification "Danger" upon a red ground, when the signal is against the engineer, giving way to a blank white space when the line is clear, these two notifications coinciding with the whistle and bell signals respectively. Thus the engineer is given a clear positive visual warning in addition to the positive audible signals. The push button shown on the side of the indicator is that by which the engineer stops the ringing of the bell, and the lever the means by which the steam whistle is closed. The ramp is laid down at the point where the distant signal is desired to be given, and, if the semaphore is still to be retained, is installed beside it, centrally between the running rails. It comprises a bar of T iron mounted and insulated upon a timber base, and is bolted to the crossties to insure rigidity. Upon tracks upon which fast-running trains are maintained the ramp is made 60 feet in length; while for branch lines a 40-foot length has been found to be sufficient.



Section of track provided with central ramp.



Rear view of locomotive, showing contact shoe.

A NEW AUTOMATIC ELECTRIC SIGNALING SYSTEM FOR RAILROADS.

The cause of the disappearance of rust from iron bars, etc., used in the erection of reinforced concrete structures, has been traced by Rohland, in Stahl und Eisen, to the presence of acid carbonates and sulphates in the cement, these salts dissolving the iron oxide and leaving the metal bright. The cement in setting absorbs carbonic acid from the air, thus forming the necessary acid carbonates; and experience has shown that the de-rusting process is effected while the concrete is setting and commencing to harden. This discovery affords an additional guarantee for the safety of reinforced concrete structures, inasmuch as the metal is protected from rusting by the alkaline reaction of the cement during the mixing process, and any rust on the bars is removed by the action of the acid carbonates at an early stage in the erection of the structures.