THE APPLICATIONS

OF

WIRE ROPE

TO

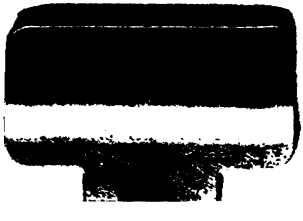
TRANSPORTATION

POWER TRANSMISSION, ETC.

1903

THE TRENTON IRON COMPANY

TRENTON, N. J., U. S. A.



THE

BLEICHERT SYSTEM

OF

WIRE ROPE TRAMWAYS,

WITH SPECIAL REFERENCE TO THE

Patent Locked-Coil Track Cable

AND THE

Webber Patent Automatic Grip.

No lugs required on the steepest grades.

Reversible Wire Rope Tramways,

with Self-dumping Buckets.

By WILLIAM HEWITT, M.E.

THE TRENTON IRON COMPANY,
MANUFACTURERS,
Trenton, New Jersey, U. S. A.

1903.

THE BRANDT PRESS, TRENTON, N. J.

Length of line, 9,000 feet.

BLEICHERT TRAMWAY,

Hourly capacity, 50 tons.

Built by THE TRENTON IRON CO., Trenton, N. J.,

For the Bunker Hill and Sullivan Mining and Concentrating Co., Kellogg, Idaho, showing portion of a span of 1,173 feet, across the town of Wardner.

The Bleichert System of Wire Rope Tramways.

THE general distinguishing feature of the BLEICHERT SYSTEM of wire rope tramways, is the use of stationary track cables of special construction for supporting the pendant carriers, and of a comparatively light endless traction rope for moving them. It is known to many as the "Double-Rope" system, in contradistinction to the "Single-Rope" system, in which one rope performs both functions.

The Bleichert system is adapted to the transportation of all kinds of materials, under every conceivable condition, and is especially recommended for heavy service, and mountainous localities where steep grades and long spans occur. Every detail has been thoroughly worked out and proved by actual practice, and *special attention is invited in the following pages to our* PATENT LOCKED-COIL TRACK CABLE, *and the* WEBBER PATENT COMPRESSION GRIP *with* PATENT AUTOMATIC ATTACHER, the merits of which have established the superiority of the Bleichert system.

The materials used in the construction of the various parts are of the strongest and best, and the workmanship first-class in every respect. All parts of the machinery are made to standard gauges, so that repairs can be made promptly and cheaply. The general design is such as to make the action of the tramway as nearly automatic as can be, so that but little labor is required in the operation of these lines. The cars can be raised or lowered at any terminal or intermediate station by our special hoists, from one level to another, or from one floor to another, in a warehouse or factory for instance, and upon arriving at the desired elevation or floor, can be conveyed by our elevated track or shunt rails to any point for loading or unloading. Scales are furnished of special

Length of line, 2,800 feet.

BLEICHERT TRAMWAY,

Hourly capacity, 80 tons.

Built by THE TRENTON IRON CO., Trenton, N. J.,

For the Royal Coal and Coke Co., Prince, West Va.,
showing span across New river.

design for weighing the loaded cars, or counters, which will automatically register the number transported.

By means of specially-designed cars (see page 23), the buckets can be transferred from the shunt rails to surface tracks and taken directly to the working faces of the mine or quarry, as the case may be, brought back and sent over the line without re-handling of the material. A common method of transferring the buckets to and from surface cars, which requires no mechanical appliance, is by laying the surface rails under the terminal shunt rails, so as to form a circuit with them, and on inclinations sufficient to lift the buckets from the hangers on one side, and drop them into the hangers on the other side, as the hangers and surface cars are moved along together. An instance of this method of transferring the buckets is in the line of the Mathieson Alkali Co., at Saltville, Va. Mr. W. D. Mount, the superintendent, writes that "the system of transferring the empty buckets to the cars and the loaded buckets from the cars to the wire rope tramway again, has not been changed in the slightest detail since it was erected, and is in every way satisfactory as laid out originally. We cannot see how it could be improved and would strongly recommend it in any future installations you may put up where such an arrangement is necessary."

Transferring Bucket to Surface Car.

We are also prepared to furnish a very ingenious and reliable hydraulic regulator for controlling the speed of lines operated by gravity under control of brakes. If the speed exceeds a predetermined rate for which the machine is constructed, the governor closes the valve through which

the fluid circulates to a degree sufficient to absorb the excess of power developed and maintain a uniform speed.

The Bleichert system permits of the introduction of intermediate loading stations at any point, which may be movable or permanent structures, as desired.

The illustrations and inset charts of details and profiles herein will serve to give a general idea of the various applications and adaptabilities of the system.

THE CABLES.

Ordinary wire cable composed of wire strands laid about a hemp or wire strand core is not at all adapted to the purpose of a track cable, since the traction of the carriage wheels on the uneven surface causes the rapid wear and fracturing of the comparatively small wires.

The construction of track cable that meets with the greatest favor (manufactured only by the Trenton Iron Co.) is known as the "patent locked-coil cable," from the fact that the outer wires are of such shape that they interlock, as illustrated in Fig. 1, presenting a smooth surface and yet possessing sufficient flexibility to be shipped in coils. The objec-

Fig. 1. Patent Locked-Coil Track Cable.

tion to fractures, which in other special constructions of track cables results in loose and tangled wires, is entirely obviated in the PATENT LOCKED-COIL CABLE, which gives the highest degree of service, with a minimum wear on the carriage wheels, and its superiority for this special purpose is now universally acknowledged. It is made of a select grade of steel, in lengths of from 800 to 1,200 feet, which are joined by patent couplings illustrated in Fig. 2.

Fig. 2. Patent Coupling.

The coupling is in halves, with an opening in each, in which the rope is inserted, this opening being funnel-shaped on the inside. The ends of the wires are spread apart in the funnel, and the intervening spaces are filled with wedges and conical rings, which are made approximately to the shape of the interstices, and are driven in tightly, which binds all the wires uniformly. The halves are joined by a plug with right and left-hand screw-threads.

The track cable known as the SMOOTH-COIL CABLE, illustrated in Fig. 3, is furnished where a cheaper construction is desired. It is composed simply of a number of comparatively large round wires coiled in concentric layers about a core wire, the number of layers and size of the

Fig. 3. Smooth-Coil Track Cable.

wires varying according to the size of the cable, which is practically a large strand, the surface of which, when new, resembles that of a spirally fluted cylinder, and when worn approximates that of a smooth round bar. It is vastly superior as a track cable to ordinary cables, owing to its smoother surface and larger wires, and with good care under favorable conditions it has given very satisfactory service.

The track cables are graduated to the loads and pressure they have to sustain and, being stationary, possess the great advantage of relieving the traction rope of the weight of the loads, so that on comparatively level lines the tension upon the traction rope is but little more than the

tractive force required to move the loads. Upon slopes, however, the weight of the loads is shared, to a certain extent, by both the track cable and traction rope, the amount borne by each depending on the inclination; the steeper the inclination the greater the weight on the traction rope and the less on the track cable, and *vice versa*. The stress upon the track cable however varies little with differences in the inclinations, since it is weighted to a maximum safe tension so that such differences result only in corresponding variations in the deflections, but the stress upon the traction rope will depend on the slope, and it is important, therefore, in estimating upon any line to know what the grades are. A further advantage derived from the use of stationary track cables is due to the high tension to which these are stretched, thus securing to the loads a comparatively direct path; in other words, they are subject to less fluctuations of rise and fall, or wave motion, than in single rope lines, since, in the latter, the deflections for similar loads must necessarily be greater to correspond with a practical safe working tension, and the double duty the rope has to perform of supporting and moving the loads, and the wear and tear therefore is very much less. For this reason, also, and owing to the greater strength of the track cables, the Bleichert system is adapted to the transportation of much heavier loads than is practicable in any kind of single-rope tramway.

Our practice is to lay out the line of the track cables very carefully for a certain safe working tension, and erect the supports to this line, the cables being actually stretched to a somewhat lower tension, so that there may be no possibility of their rising out of the saddles upon which they rest.

THE ROLLING STOCK.

The ordinary car, such as used for transporting ore and like material, is illustrated in Fig. 4. The complete car, it will be observed, consists of a carriage which runs on the track cable, a hanger depending from this which supports the bucket, and a grip, by means of which the car is attached to the traction rope. When the cars arrive at either terminal, or other station, the grips detach automatically, and the carriages are

switched off on to the shunt rails, supported by the structure of the station, by means of which they are conveyed to the points of loading or discharge as the case may be.

Fig. 4.
TRAMWAY CAR,
With Webber Patent Compression Grip, showing Patent Automatic Attacher.

THE WEBBER PATENT COMPRESSION GRIP *with which the cars are fitted can be used on the steepest grades. With this grip no buttons, lugs, or knots of any kind are required on the traction rope, and the troubles incident to the slipping of such contrivances are entirely avoided. A great economy is also effected in the life of the traction rope, owing to the fact that the wear is not confined to certain spots, but is distributed over the entire rope. The attachment to the traction rope is also effected with certainty and automatically by means of a patented device, shown in Fig. 4, the operation of which is such that the grip takes hold of the rope without the slightest jerk as the car is pushed out from the station.* This grip has proved so satisfactory in all the numerous lines on which it is now operated, that it has entirely superseded the old friction and lug grips formerly used.

With systems of wire rope tramways in which the carriers are permanently attached to the rope and the receptacles have to be loaded and discharged while in motion, it is necessary to resort to automatic loaders and dumpers, the use of which has led to an erroneous impression that they are economical of labor. Automatic loaders are not only unnecessary in the Bleichert system, since the cars are detached from the traction rope at the stations, and the loading and discharge of the receptacles effected while they are at rest, but they are to be avoided, as their use makes it necessary to operate at a slower speed, which requires a larger outfit of cars for a given capacity and adds to the wear of the rope.

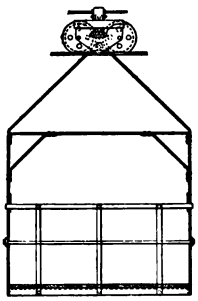


Fig. 5.

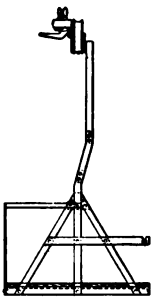


Fig. 6.

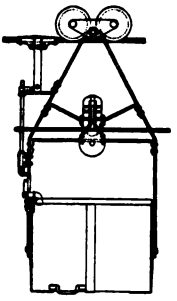


Fig. 7.

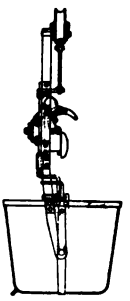


Fig. 8.

At angle stations, where there is nothing to do but pass the cars by the sheaves, it is reasonable to look for an economy of labor in the passage of the cars without detaching from the traction rope. With the ordinary tramway car however, having the grip between the carriage and the bucket, it is obvious that this is impossible, not necessarily because the grip must come in contact with the flanges of the sheaves, but because on the angle side of the bend the hangers would come between the rope and the sheaves, which would cause trouble. This difficulty is readily overcome by running the traction rope just above the track cables, and attaching the grips to the carriages, as illustrated in Figs. 5 and 6, showing style of carrier used on a line of the Plymouth Cordage Company, Plymouth, Mass., or constructing them as an integral part of the carriage mechanism, as in the car illustrated in Fig. 9, showing the latest construction of the Bleichert Patent Automatic Overhead Grip, in which the weight of the

Fig. 9.
TRAMWAY CAR,
With Bleichert Patent Automatic Overhead Grip.

car acts as the gripping force, which is therefore independent of any nice adjustment of the grip jaws. It is not always practicable however to run the traction rope above the track cables, as for instance in crossing mountainous ridges and other elevated points where the downward pressure of the traction rope is so great as to throw the empty cars out of plumb.

Self-dumping buckets are furnished when required, as shown in Figs. 7 and 8. At any desired point for dumping, a short bar attached to the track cable disengages a latch attached to the hanger, releasing the bucket, which is so hung that it instantly discharges its contents. Special receptacles are also made to suit the material to be carried, some of which are illustrated in the chart of details.

THE SUPPORTS.

The supports may be of wood or iron, as preferred, and the illustrations herein show the ordinary construction or tower support. Other designs, however, are made to correspond with the weight they have to sustain and to meet the special conditions involved.

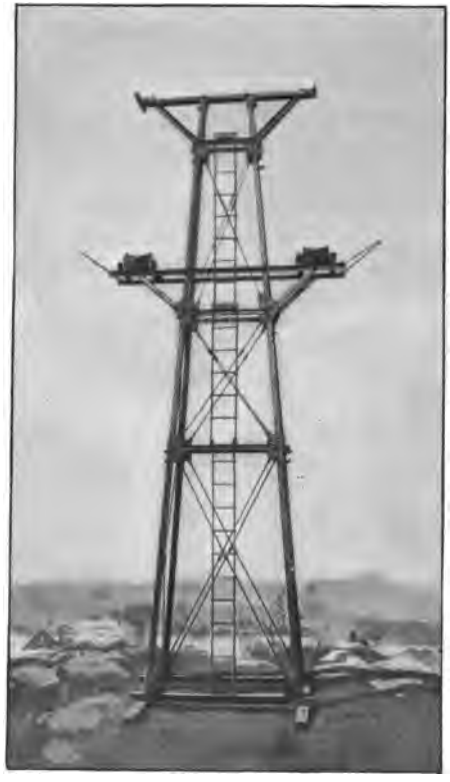


Fig. 10. IRON SUPPORT.

The spacing of the supports depends altogether on the contour of the ground. On level stretches, the distance is from 200 to 250 feet, according to the

Length of line, 16,500 feet. BLEICHERT TRAMWAY, Hourly capacity, 75 tons.

Built by THE TRENTON IRON CO., Trenton, N. J.,

For the Solvay Process Co., Syracuse, N. Y. View showing wood and iron supports.

Length of line, 2,400 feet. BLEICHERT TRAMWAY, Hourly capacity, 2½ tons.

Built by THE TRENTON IRON CO., Trenton, N. J.,

For The New England Talc Co., Stockbridge, Vt., showing platform car.

capacity of the line. Where the contour is rugged and irregular (see profile sheets), the distances between the supports will vary greatly, being closer on the ridges and wider apart in the valleys. Where the ridge is a very sharp one, structures known as "rail stations" are erected, which consist of a series of bents, from 15 to 20 feet apart, supporting rails which overlay the track cables, and save the latter from undue wear at these points. In crossing ravines, valleys and rivers, on the other hand, clear spans have been made up to 2,200 feet, one of this length occurring in the line of the Silver Lake Mining Company, Col., experience having demonstrated that long spans where practicable are not objectionable.

If the line is over a mile in length, it is necessary to apply tension to the track cables at intermediate points on account of the saddle friction, and special stations are erected for this purpose. The track cables are parted at these stations, and the ends either rigidly anchored or counterweighted. The cars pass from one section of the cable to the next by means of intervening rails, so that no interruption occurs in the continuity of the track.

ADVANTAGES OF THE BLEICHERT SYSTEM.

1st.—*It is adapted to the heaviest traffic.* Loads up to a ton in weight may be carried and from 800 to 1,000 tons per day transported, which is not possible with any kind of single-rope tramway.

2d.—*A speed of 3 to 4 miles per hour can be maintained,* which is not practicable in single-rope lines of the Hallidie type, not only on account of the trouble due to the dropping of the rope from the shallow supporting sheaves, but mainly on account of the fact that the buckets are permanently attached to the rope so that their loading and discharge must be effected while they are in motion.

3d.—*The number of cars required for a given service is less than on other lines.*

4th.—*The steepest grades can be surmounted without difficulty.*

5th.—*Less power is required, or more developed, as the case may be, than in any other system.* This is due to the fact that the traction rope,

instead of being loaded down by the cars, as in single-rope lines, is itself supported by them, to a certain extent, as already explained. In other words, a Bleichert tramway will work by gravity on a lesser grade for a given output than any other. For instance, the line of the Old Dominion Copper Co., which has a fall of only 100 feet in a total length of 1,250 feet, runs by gravity on a daily output of 150 tons.

6th.—*The most important advantage is the low cost of operation and maintenance.* This is due not only to the substantial manner in which these lines are constructed, the less wear and tear, and less power required, but also to the fact that the greater amount of material handled requires no extra labor.

TYPICAL LINES.

Of the many lines that we have built, a brief description of a few, illustrations of which appear in these pages, will be of interest as demonstrating the practical economy and efficiency of the system.

Its adaptability to mountainous sections is well represented in a number of lines, among which that of the Bunker Hill and Sullivan Mining and Concentrating Co., Idaho, is especially interesting, from the fact that it passes over the town of Wardner in a clear span of 1,173 feet, as shown in the frontispiece. The total length of the line is 9,000 feet, and the fall 713 feet, which is amply sufficient for it to run by gravity. At two points where the tramway passes over mountain crests it is supported by rail stations, such as referred to on the preceding page. These are low structures and are therefore roofed in to protect them from snow. The tramway is used to transport silver and lead-bearing ores from the mines to the concentrating works, at Kellogg, and has carried as much as 50 tons per hour, which is somewhat remarkable, in view of the fact that the buckets hold but from 700 to 750 pounds each, making the corresponding intervals between them 25 to 27 seconds. The line was designed to carry only 40 tons per hour. The average output is 15,000 tons of ore per month, which is transported at a cost of less than 5 cents per ton per mile, two-thirds of which represents labor and the balance supplies and repairs.

A line built for the Silver Lake Mining Co., near Silverton, Col., for transporting gold and silver-bearing concentrates, is operated in two sections. The first section, or original line, is 8,400 feet long with a fall of 2,100 feet, and the second section is 6,200 feet long with a fall of 659 feet, terminating at the new mill. The upper section was originally designed for a capacity of five tons per hour, but with the installation of the new mill the capacity has been increased to thirty tons per hour. The latter output is sufficient to develop about 50 horse-power. From the loading terminal, the line ascends a mountain slope for a short distance on an inclination of 1:2½, and rounding the crest of the mountain it pitches down on the opposite side on an inclination of 1:1.8, crossing snow slides in long spans, one of which is nearly half a mile in length, and is the longest span of any similar wire rope tramway in the world. There are but 19 supports in the upper section, making the average spacing outside of the long span referred to over 300 feet. Another line near this, built for the Iowa Gold Mining and Milling Co., contains an equally long span.

Mr. T. A. Rickard, in an article on "Mining at High Altitudes," published in Cassier's Magazine for October, 1902, says: "One of the best installations in Colorado is, I think, that of the *Camp Bird* mine, near Ouray. This *Bleichert Tramway* connects the mine with the mill, the distance being 9,000 feet and the descent 2,109 feet. * * * Each of the buckets, of which there are forty-six, carries 750 pounds of ore. They travel at the rate of 350 to 450 feet per minute. Under these conditions the tramway has a capacity of about 120 tons in ten hours, but both speed and number of buckets can be increased without danger, so that the capacity could be 450 tons per twenty-four hours.

"The cost of transporting the ore, in this case, with an output of 3,100 tons per month, is fifteen cents per ton, but this includes the carriage to the mines of supplies of all kinds which are loaded into the empty returning buckets. This feature of mountain tramways is most important, because during several months the trails are often impassable by reason of snowdrifts."

A notable western line is that erected at the Highland Boy mine, near Bingham, Utah, in the fall of 1898. The length is 12,700 feet. The

Length of line, 12,700 ft. Hourly capacity, 35 tons.

BLEICHERT TRAMWAY,

Built by THE TRENTON IRON CO., Trenton, N. J.,

For the Highland Boy Gold Mining Co.,
Bingham, Utah.

elevation of the loading terminal is 1,120 feet above that of the discharge terminal, and the line therefore operates by gravity. It was originally designed for a capacity of 25 tons per hour, but the development of the mine and increased capacity of the smelter made it necessary to carry 35 tons per hour, which was readily and economically done by simply adding a few more cars and slightly increasing the speed of the traction rope. Over 350,000 tons of ore have been conveyed at a cost of 7¾ cents per ton of 2,000 pounds for labor and repairs, without any apparent deterioration in the condition of track cables and traction rope.

A carrier specially designed for the conveyance of ore in sacks is illustrated in Figs. 11 and 12. This style of carrier was used for several years on a line built for the Consolidated Kansas City Smelting and Refining Co., of El Paso, Tex., to transport ore across the Rio Grande, from the Mexican to the United States side, a distance of 2,500 feet. It has since been removed and re-erected in another location as part equipment of a longer line.

Figs. 13 and 14 illustrate a type of carrier used on a line built for the

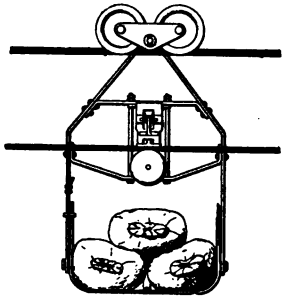


Fig. 11.

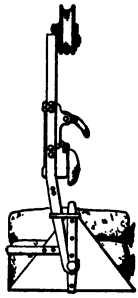


Fig. 12.

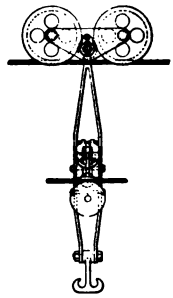


Fig. 13.

Fig. 14.

Chilkoot Railroad and Transport Co., which was seven miles in length, operated in two sections. This line ran over the famous Chilkoot Pass, and was used for about two years for conveying merchandise and passengers to the Klondike Mines, and ore from the mines to the terminus at Canon Camp, where it connected with the railroad to Dyea. It has since been purchased by the White Pass Railroad Co. and dismantled, communication now being effected entirely by railroad. (See illustration on the following page.)

It is frequently desired to convey material across a river where a bridge would be impracticable or too expensive, and in such instances, which are numerous in the mining regions, the Bleichert system offers a most convenient and economical means of transport. The illustration on page 6 is a view of such a line, operated by the Royal Coal and Coke Co., at Prince, West Va., for the conveyance of coal from their mine on the south side of New river to the Chesapeake and Ohio railroad on the opposite side. It served the purpose very satisfactorily for about ten years, when a railroad having been built on the south side, there was no occasion for its further use, and the coal is now conveyed to the new road by a gravity plane. The wire rope tramway was 2,800 feet long with a fall of 820 feet, and developed about 50 horse-power in carrying an output of 80 tons per hour. The span across the river was 665 feet.

A similar line, illustrated on the following page, is operated by the Keystone Coal Mining Co., at East Brady, Pa., for transporting coal from

Length of line, 7 miles. BLEICHERT TRAMWAY, Hourly capacity, 5 tons.

Built by THE TRENTON IRON CO., Trenton, N. J.,

For the Chilkoot Railroad and Transport Co.
View at the Chilkoot Pass.

Length of line, 1,400 feet. BLEICHERT TRAMWAY, Hourly capacity, 80 tons.

Built by THE TRENTON IRON CO., Trenton, N. J.,

For the Keystone Coal Mining Co., East Brady, Pa.

the mine on one side of the Allegheny river to the railroad on the opposite side. This line is 1,400 feet in length with a fall of 200 feet, and develops about 5 horse-power on an output of 40 tons per hour, the line being designed to carry eventually 80 tons per hour. The span across the river is 1,009 feet.

The line of the Trinidad Asphalt Co., on the Island of Trinidad, for conveying asphalt, is an instance of the adaptability of the system to comparatively level ground, where the conditions preclude the use of surface tracks, and also its adaptability to the loading of vessels at sea. The length is 5,100 feet and the entire structure is of iron, including the framework of the terminal stations as well as the intermediate supports. The loading terminal is located at a point upon the edge of the lake, and the discharge terminal is an iron pier, 350 feet long, built out in deep water, 1,750 feet from the shore. A view of this end of the line is shown on the following page. The fall from lake to pier is but 80 feet, most of which occurs in the last 500 feet. Seventy-five tons per hour is the capacity of the line, requiring about 20 horse-power. At the loading terminal, the line connects with a surface tramway, running in a circuit over the lake, the consistency of the material being such as to render this practicable. While the material is quite soft in the center of the lake, it is hard enough for a considerable distance from the border to support heavy weights; so hard, in fact, that the original design contemplated an extension of the Bleichert tramway over this lake, with loading terminal near the center and lateral branches to the diggings. It was discovered, however, that the whole mass was in slow motion, the movement being discernable only after the lapse of long intervals by the relative changes in the positions of the small islands and other objects. This led to the adoption of a surface tramway for the lake haul, the termination of the wire rope tramway at the border of the lake, and the transferring of the buckets from one line to the other. The surface cars each hold two buckets, and are propelled by an endless rope running continuously in one direction, to which they are attached by means of grips. The same engine that operates the wire rope tramway also drives the surface tramway. In order to avoid the slow submergence of the track, which would occur if it had been laid directly on the asphalt surface, the

Length of line, 5,100 feet.

BLEICHERT TRAMWAY,

Hourly capacity, 75 tons.

Built by THE TRENTON IRON CO., Trenton, N. J.,

For the Trinidad Asphalt Co., La Brea, Trinidad,
showing discharge terminal on iron pier.

ENDLESS ROPE HAULAGE,

Built by THE TRENTON IRON CO., Trenton, N. J.,

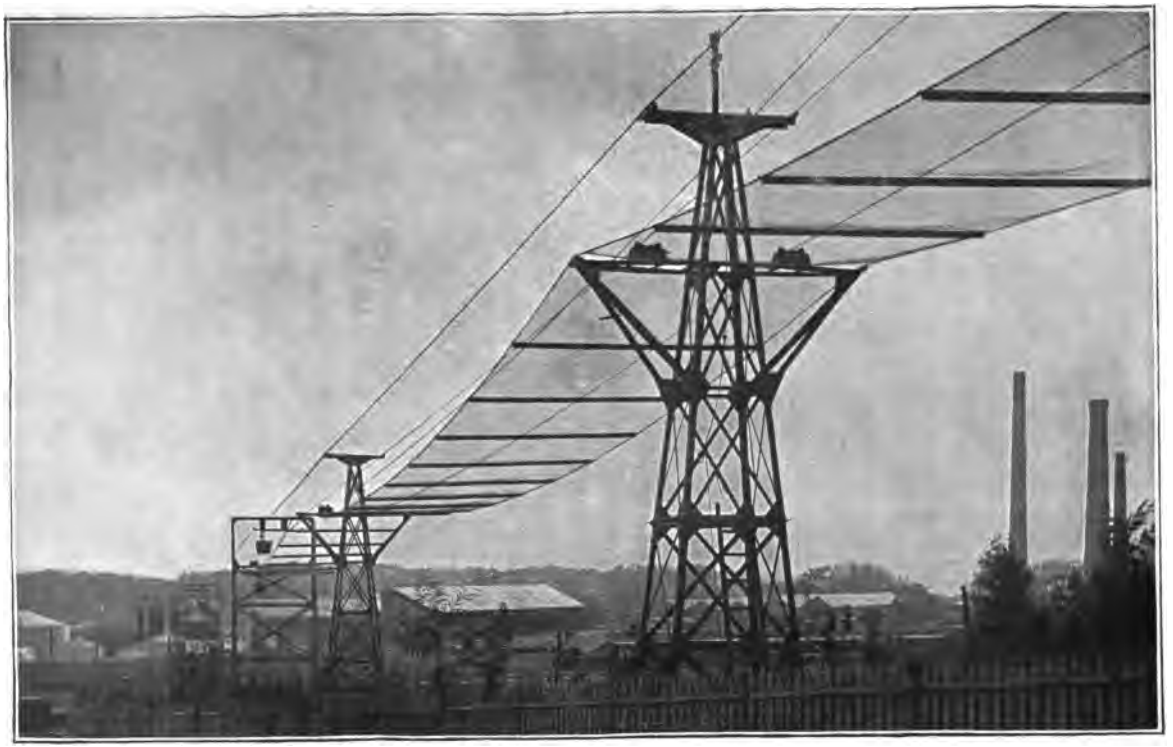
For the Trinidad Asphalt Co., La Brea, Trinidad. View of Pitch Lake.

rails are laid on a corduroy of palm, resting on a mattress of cocorite palm leaves, as shown in the view on the preceding page. At certain points in the circuit, guy lines extend to anchorages on the shore in order to keep the track in place.

The line of the Solvay Process Co., near Syracuse, N. Y., used for the transportation of lime rock, is 3⅛ miles long, and has an hourly capacity of 75 tons. It passes over ordinary rolling ground, much of which is farm land, and the contour presents no unusual conditions. This line has been running day and night for twelve years, and the cost of operating, as determined from actual records, is about 6 cents a ton per mile, which includes, in addition to labor and repairs, the expenses of right of way and taxes. The line has proved so satisfactory that the company have built an extension and branch lines, the total length of which is nearly equal that of the original line. The elevated station at the works has been entirely re-modeled and built of iron and now constitutes not only the terminal of the main line that brings the rock from the quarries, but also the terminal of a couple of branch lines for handling coke, ashes, and refuse material, etc., making it a central point from which all the materials are brought in and sent out to their various destinations. In collecting and distributing the materials about the works, transfer cars, such as shown on the preceding page, are extensively used, and the tramway cars are raised and lowered at the central station by elevators specially designed for the purpose.

The Compagnie Haitienne, of New York, are operating a Bleichert tramway on the island of Hayti for the transportation of logwood, the total length of which is 12 miles. The tramway is divided into three sections, each of which constitutes a distinct line in itself, with independent power, the driving stations being located at points where bends occur. The cars at these stations are transferred in the usual way from one section to the next by means of shunt rails, so that no re-handling of material occurs. At the driving stations, sufficient power is provided not only to run the tramway, but also to operate pumps for purpose of irrigation. The entire structure is of iron.

A line at the United States Military Academy, West Point, N. Y., 1,640 feet in length and 37½ tons hourly capacity, replaced a system of



Length of line, 11,550 feet.

BLEICHERT TRAMWAY,

Of Lubimoff, Solvay & Co., Russia; showing guard-net.

Hourly capacity, 55 tons.

industrial railways in previous operation. The line is used for conveying coal from vessels, to bins at two storage houses, passing over one where the gas coal is stored, to the main bins at the upper terminal station. There is one support between the dock and the gas-coal bins. The coal is elevated at the dock 40 feet by an independent hoist (see illustration on the opposite page), the buckets holding each 750 pounds. When a loaded bucket reaches the desired height, it is dumped upon a chute terminating at a hopper at the lower end, from which the tramway buckets are filled. The gas coal is discharged while the cars are in motion, without detaching from the traction rope. The other coal passes to the upper terminal station, and is there dumped into special cars travelling in an endless circuit upon tracks above the bins, the cars holding each one ton of coal, and discharging from the rear ends, which are fitted with chutes that are opened by the operator at any desired point. These cars are moved by a ½-inch wire rope running continuously along the inside rail of the track at a speed of 132 feet per minute, which is driven by a grip-wheel 42 inches in diameter on the main shaft. The structural work is entirely of iron, excepting the station over the gas-coal bins, and the entire plant is operated by electric power, one motor running the tramway and distributing line at the upper terminal station, and an independent motor being used to operate the hoist at the dock.

A similar line, of 30 tons hourly capacity, was built for the Maine Insane Hospital, at Augusta, Me. The structural work in this case was of timber, and the dock hoist, a view of which is shown on the opposite page, has an inclined iron beam that projects out over the vessel and on the lower flanges of which the hoist-carriage runs, the beam being arranged so that it can be pulled back clear of the rigging of vessels when landing or departing. The bucket attached to a fall-block below the carriage is raised and lowered by means of a ½-inch wire rope operated by an independent engine. The carriage with the empty bucket runs out first to the lower end of the beam and then drops vertically into the hold of the vessel. After loading, it is hoisted until the fall-block comes up against the carriage, when the operator continuing to wind in the rope, the carriage with the loaded bucket is drawn up along the beam and back over the

Length of line, 1,640 feet. BLEICHERT TRAMWAY, Hourly capacity, 37½ tons.

Built by THE TRENTON IRON CO., Trenton, N. J.,

At the United States Military Academy, West Point, N. Y.
View of loading terminal and dock hoist.

Length of line, 1,050 feet. BLEICHERT TRAMWAY, Hourly capacity, 30 tons.

Built by THE TRENTON IRON CO., Trenton, N. J.,

At the Maine Insane Hospital, Augusta, Me. View showing
loading terminal and dock hoist.

hopper into which the bucket discharges automatically, and from which the tramway buckets are loaded.

The report of the hospital board for 1899 states that "the new tramway was constructed late in November, but in season to use for transporting coal from the vessel to the coal pocket, at a distance of 1,050 feet and an elevation of 150. The stevedores were formerly paid 29 cents for discharging the coal from the vessel and wheeling it on the wharf. We have been able by the use of the tramway to discharge the coal from the vessel directly into the pocket, at an expense not exceeding 25 cents per ton, thus doing away with the cost of shoveling it into carts and hauling it up the hill; the result has been a net saving of about 70 cents per ton."

A line built for the Cambria Steel Co., Johnstown, Pa., is interesting from the fact that it crosses the main tracks of the Pennsylvania Railroad. As a precaution against accidents, an iron bridge, 220-foot span, was built over the tracks, as shown in the view on the opposite page, the bottom and about three feet of each side being encased by sheet iron. Since an accident in crossing the Pennsylvania Railroad might result in loss of life, the structure is a much more elaborate and substantial affair than ordinarily constructed for such purposes. In most cases, a wire netting, supported by wire ropes attached to the supports, is sufficient, such as illustrated on page 25.

The line of the Plymouth Cordage Co., referred to on page 12, which is used for carrying baled hemp from a warehouse to their cordage factory, is interesting from the fact that it makes a right-angled bend at the end of the warehouse around which the cars pass without detaching from the traction rope (see illustration on the opposite page). Along the warehouse for a distance of 500 feet shunt rails extend so that cars can be loaded at numerous points, special apparatus being provided for releasing the traction rope while the cars are being loaded. Immediately after passing the angle station the loaded cars ascend an incline of about 40 per cent. and thence pass over a guard-bridge spanning the railroad to the factory on the opposite side. The satisfactory operation of this line now for several years has fully demonstrated the practicability of passing bends automatically, and marks an advance in the adaptabilities of this method of transportation.

Length of line, 3,260 feet. BLEICHERT TRAMWAY, Hourly capacity, 50 tons.

Built by THE TRENTON IRON CO., Trenton, N. J.,

For The Cambria Steel Co., Johnstown, Pa. View of guard-bridge across the Pennsylvania R. R.

Length of line, 1,150 feet. WIRE ROPE TRAMWAY, Hourly capacity, 7½ tons.

Built by THE TRENTON IRON CO., Trenton, N. J.,

For the Plymouth Cordage Co., Plymouth, Mass. View of angle station.

Length of line, 625 feet.

BLEICHERT TRAMWAY,

Of The Vivero Iron Ore Co., Spain.

Hourly capacity, 250 tons.

Testimonials.

From THE EAST RIDGE COAL COMPANY.

MINERSVILLE, Pa., October 29, 1902.

Mr. Charles E. Hewitt, General Manager, The Trenton Iron Co., Trenton, N. J.:

DEAR SIR—Referring to the Bleichert Tramway you built for us in 1901, which we use for carrying culm from the culm-bank to the washery, a distance of about 1,300 feet, with an elevation between the loading and discharge terminals of 190 feet, the discharge terminal being above the loading terminal, would say that during March, April and May, we carried on an average 700 tons per day, at a cost of $2\frac{7}{10}$ cents per ton for transportation and labor of handling at both terminals, which includes gripmen, dumpers, loaders, engineer and runners.

We started our tramway on October 23d, after five months' idleness caused by the strike; we carried 200 tons the first day, this output being small because the chutes in the breaker were rusty from being idle so long.

Our expenses for repairs on the tramway have been $36.00 since last January, which is about $\frac{1}{2}$ of a cent per ton.

It is run by a single engine of 100 H. P., which not only drives the tramway, but drives twelve shakers besides; therefore a 50 H. P. engine would run the tramway, which I consider is a remarkable saving over either cars and plane or conveyor lines.

In view of the foregoing facts, I can heartily recommend it for transporting culm either to or from the breakers. Yours respectfully, B. E. KINGSLEY, *General Manager.*

TRANSLATION.

MONTEREY, Mexico, Sept. 25, 1902.

Messrs. Van Voorhis & Sanford, Agents for The Trenton Iron Co., Monterey, N. L.:

DEAR SIRS—In reply to your favor of recent date relating to the Aerial wire rope Tramway, "Bleichert" system, which you sold us for the "Voladora" and adjoining mines, we take pleasure in communicating to you that ever since the completion of the line it has been in active service, working at a rate greatly in excess of the guaranteed capacity.

We are at present transporting over this line 6,000 metric tons of ore monthly, a distance of 14,000 feet, with a difference of elevation between terminals of 3,200 feet, at a cost not exceeding eighteen cents (Mexican currency) per ton.

We are very pleased to render you this information, for you to use in any way you may see fit, and to say that we are entirely satisfied with the tramway.

(Signed,) CIA. METALURGICA DE TORREON,
DONALD R. MORGAN, *Sup't.*

SALT LAKE CITY, Utah, Feb. 5, 1901.

Trenton Iron Co., Trenton, N. J.:

GENTLEMEN—Please ship to the Centennial-Eureka Mining Co., Eureka, Utah, a set —fourteen (14)—of new buckets for their tramway, furnished in December, 1899.

* * * * * * * * *

You will be interested to know that the tramway continues to work perfectly satisfactorily; the superintendent said yesterday that the ropes show no signs of wear yet; line has been working a year and every day at more than its rated capacity.

They have put a large engine lubricator over the loaded rope, which feeds oil slowly on to a bunch of wicking, each outgoing car wipes off the oil on its wheels and so transfers it to the standing ropes, which seems to have conduced largely to their slight wear.

Yours respectfully, (Signed,) JONES & JACOBS.

From THE BUNKER HILL AND SULLIVAN MINING AND CONCENTRATING CO.

KELLOGG, Idaho, March 15, 1896.

The Trenton Iron Co., Trenton, N. J.:

GENTLEMEN—In reply to your favor of the 5th inst., regarding the operation of our Bleichert tramway, I am pleased to say that the line is working to our entire satisfaction.

The tramway to date has transported from our mine to our mill 450,000 tons of ore. On the larger portion of the line the original carrying cables are still in use, and are apparently good for considerable additional tonnage. The present traction rope has been in use in transporting 180,000 tons of ore, and apparently is still in good condition. During the last six months (September, 1895, to February, 1896, inclusive) the tramway has transported from mine to mill 236,806 buckets of ore in a total working time of 2,208 hours, of which 172 hours were lost, as follows:

28 hours changing lugs.

93 hours because of repairs (includes coupling in three new pieces of carrying cable at different times).

27 hours on account of accidents.

24 hours on account of telephone line and electric lights being out of order, and ore frozen in chutes, and other like causes.

In this period the tramway averaged $107\frac{25}{100}$ buckets of ore per hour of total time, or $116\frac{31}{100}$ buckets of ore per hour of actual time in operation. For the above period the average weight of ore carried by a bucket was 732 pounds. There are 127 buckets

(5 cubic feet capacity) on the line placed 140 feet apart. The tramway carries from the mill to the mine 10 to 12 cords of wood per day, and could carry more if we required it. The operation of the line develops some power which is used for hoisting purposes.

The total operating and repair crew is as follows:

1 foreman.
2 tramwaymen at mill.
1 brakeman at mine.
1 bucketman at mine.
4 tramwaymen at mine.

I hope the foregoing, together with the data you already have, will give you all the information you wish regarding our tramway. Yours truly, F. W. BRADLEY.

KELLOGG, Idaho, May 20, 1901.

H. N. Elmer, Esq., Trenton Iron Co., Chicago, Ills.:

DEAR SIR—I am sorry I did not see you in Spokane the other evening. When I received your letter you had already left the city. I am at a loss to know why anybody should be talking about the excessive cost of tramming Bunker Hill ore. As a matter of fact, it is about as cheap transportation as it is possible to obtain. Our average cost per ton of ore trammed, including repairs and maintenance, amounts in round numbers to ten cents. We have for the last year or more been running the tramway two shifts of ten hours and nine hours respectively, and have, within the last month, increased the time of operation to two twelve-hour shifts, with a view of handling a larger tonnage of ore. We have a total force of 17 men on the two shifts, which includes the foreman, brakeman, lineman, loaders, dumpers and repairmen. The total cost of labor is $62.50 per day, and we are tramming from 850 to 900 tons per day, making the labor cost of, say, 7 cents per ton. (3½ cents per ton per mile.)

Referring to your sketch of terminal rail; the total length of the loop is about 90 feet, and only two men are engaged on each shift at the lower terminal. One of these dumps the buckets, and the other grips the outgoing bucket. They change off with one another every hour. If any other information is desired, I shall be glad to send it.

Yours truly, (Signed,) FREDERICK BURBIDGE.

SILVERTON, Colo., Aug. 1st, 1900.

Trenton Iron Co., Trenton, N. J.:

GENTLEMEN—Yours of the 20th inst. at hand and contents noted.

In regard to the automatic scale, I possibly misunderstood Mr. Elmer, and as we are dropping buckets in so fast with our new tramway that it would be impossible to weigh them except automatically, you can cancel that part of the order.

I am very much pleased to say that our new line is running perfectly.

Very truly yours, GOLD KING CONSOLIDATED MINES CO.,
By W. Z. KINNEY, *Sup't.*

TELLURIDE, Col., December 14, 1896.

Trenton Iron Co.:

GENTLEMEN—Your 1896 edition of wire rope transportation, etc., has been duly received, for which accept thanks.

Yours truly, TOMBOY GOLD MINES CO.,
Per A. H. BROWN.

P. S.—Our new tramway is giving splendid satisfaction.

From THE VERMONT MARBLE CO.

PROCTOR, Vt., April 2, 1896.

The Trenton Iron Co., Trenton, N. J.:

GENTLEMEN—We have used constantly the wire rope tramway which you installed here in June, 1894, and found it in every way very satisfactory. It conveys sand from a bank to our mill, a distance of about a quarter of a mile, carrying 100 to 150 tons per day. It runs easily, smoothly, without breakdowns, and the expense of repairing is very trifling. It has been a great saving to us, and we take great pleasure in speaking of it in the highest terms. It is in every way what you recommended it to be.

Yours very truly, FLETCHER D. PROCTOR, *President.*

NOTE.—This line has been extended to a length of 11,000 feet and adapted to a capacity of double that of the old line.

From THE TRINIDAD ASPHALT CO.

NEW YORK, March 9, 1896.

The Trenton Iron Co.:

GENTLEMEN—Replying to your inquiry of the 5th inst., we have to state that the plant for the loading of crude asphalt from the pitch lake, in Trinidad, has been in operation for the past eighteen (18) months and has given very satisfactory results. The asphalt is loaded in buckets at the pitch lake, and, by means of the Bleichert tramway erected by you, is transported to and deposited in the holds of vessels lying alongside the pier with only one handling. We are now transporting from 550 to 650 tons per day when running, and are putting the material on board vessel at a much less cost than under the old system, when the loading was done by means of carts and lighters. We have no hesitation in expressing our pleasure at the very satisfactory results which have been obtained. Very truly yours, A. L. BARBER, *President.*

From THE OLD DOMINION COPPER CO.

GLOBE, Arizona, April 24, 1892.

The Trenton Iron Company, Trenton, N. J.:

GENTLEMEN—I have your favor of the 13th inst. and note contents of same carefully. The Bleichert tramway procured from you last year was erected by us last fall, and put in operation on the 6th of January, 1892. Since that time it has been running daily.

The line is 1,224 feet long, and is used to convey copper ore and limestone from the rock-house at our mines to the smelting plant, the grade being sufficient to run the line automatically but not to develop any additional power. Over this tramway we are now conveying daily 110 tons of copper ore and 30 to 40 tons of limestone in nine hours' working time, at a cost of 8.9 cents per ton. We could easily increase the capacity greatly, as we have frequently run at the rate of 25 tons an hour, which would, of course, bring the cost down proportionately.

We had no trouble in the erection of the line, and have none in working it. Everything about it works so smoothly that no extra attention is needed and no trouble caused, as we are sure of the ore supply in any kind of weather. I am more than pleased with the working of this tramway, and can earnestly recommend it to those requiring a cheap and reliable method of transporting ore from one point to another.

Yours truly,

A. L. WALKER, *Superintendent.*

MONTREAL, Canada, November 27, 1889.

Messrs. Trenton Iron Company, Trenton, N. J.:

GENTLEMEN—With your tramway we are now handling fifty tons of pulp every ten hours. The tramway runs at the rate of two hundred and fifty feet per minute, only, and our experience so far shows that we could easily handle several times more pulp than this at same speed, without the slightest difficulty.

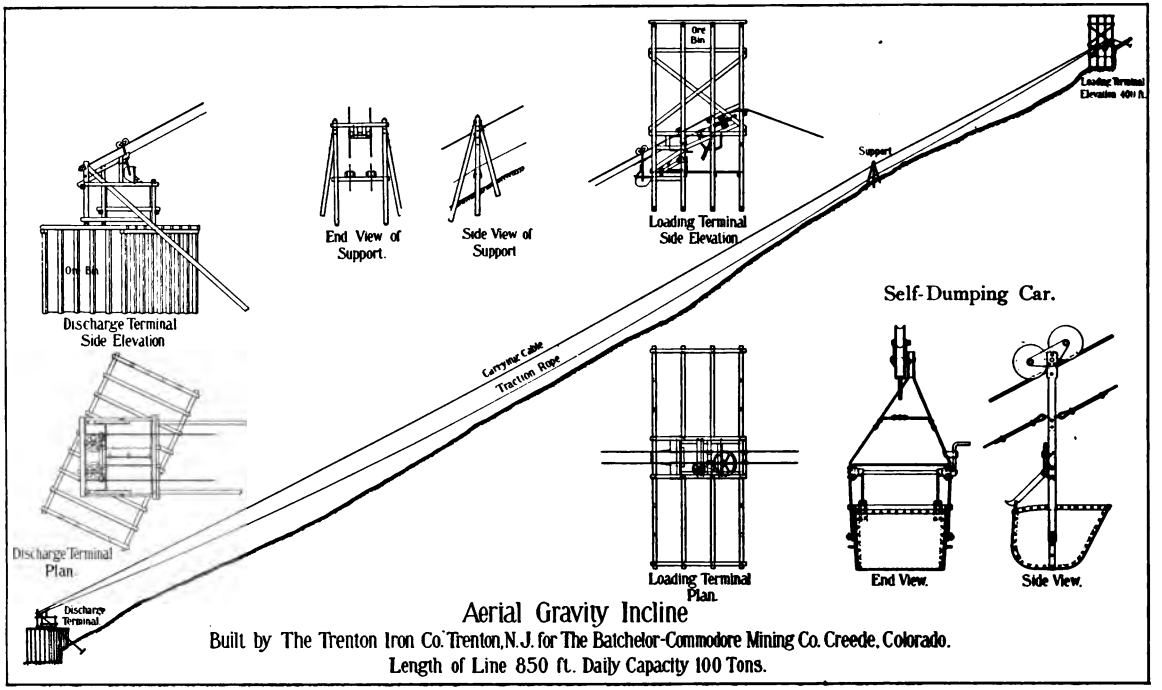
We feel sure, also, that the latter result would not be anywhere near the maximum capacity of the line, but we only speak from actual experience.

When we consider that this tramway takes our product from our wet presses in the mill, carries it across the three channels and intervening islands of the river St. Maurice, the third largest river in Canada, and delivers it 1,500 feet away, on the level of our railway siding, and that we do this with 3 to 5 horse-power, and the labor of only one additional man, at the very most, we are more than satisfied. If there is any other information you require, we shall be glad to give it. Meantime, we remain,

Yours respectfully,

THE LAURENTIDE PULP CO. (LIMITED),

JOHN FORMAN, *Secretary.*



Aerial Gravity Incline

Built by The Trenton Iron Co. Trenton, N.J. for The Batchelor-Commodore Mining Co. Creede, Colorado.
Length of Line 850 ft. Daily Capacity 100 Tons.

Reversible Wire Rope Tramways.

DOUBLE TRACK.

REVERSIBLE WIRE ROPE TRAMWAYS are so called from the fact that the traction rope is given a reciprocating motion, in contradistinction to the Bleichert and single-rope systems in which it is run continuously in one direction. Usually there are two carriers, which are so arranged that as one arrives at either terminal the other arrives simultaneously at the other terminal. This style of conveyor, of course, is limited to comparatively short lines of communication, such for instance, as the transferring of material across a river or ravine, or from one building to another.

The track cables may be either of the patent locked-coil or smooth-coil constructions as described on pages 8 and 9, and the traction rope, which works in an endless circuit about sheaves at each terminal, may be run at speeds from 400 to 800 feet per minute, according to the contour of the ground and the intervening supports.

If power is required, which may be applied at either end of the line, a reversing engine or electric motor may be used to drive, but if the loads travel on a descending inclination, with sufficient fall to run by gravity, the line is operated under control of brakes.

A gravity-acting reversible wire rope tramway, built for the Bachelor-Commodore Mining Co., Creede, Col., is illustrated on the opposite page.

The total length of the line is 850 feet, and difference in elevation of terminal points about 400 feet. The two carriages each travel on 1-inch steel cables, and are attached to a ½-inch traction rope, the movement of which is controlled by brakes at the upper terminal station. Loads

of 12 cwt. are carried, and the ore delivered to bins by self-dumping buckets, and thence to a longer wire rope tramway of the Bleichert system, which transports it to the Denver & Rio Grande railway. One hundred tons of ore per day are transported thus, at a very low cost.

A similar line, built for the Compania Metalurgica de Torreon, Coahuila, Mexico, is 1,453 feet long with a fall of 730 feet.

Reversible Wire Rope Tramways.

SINGLE TRACK.

ON THE following pages are illustrations of a cheap and economical reversible wire rope tramway with single-track cable, built for the St. Bernard Coal Co., of Earlington, Ky., for carrying refuse from their coal washer, and is specially designed for dumping at different points along the line.

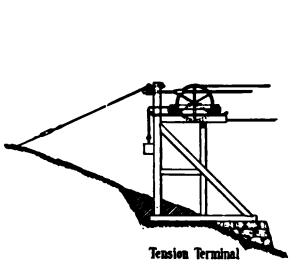
A single bucket holding half a ton, suspended from a carriage running on the track cable (1½ in. diam. smooth-coil), is moved by a ⅞-inch endless wire rope driven by a small reversing engine. Bars clamped to the track cable at the desired dumping points trip a latch on the bucket hanger, releasing the bucket which is so balanced as to discharge automatically. The construction of the latch is such that the loaded bucket passes the bars going out without lifting the latch, but trips in coming back. This arrangement permits the discharge of the bucket at the various dumping points without having to shift any of the bars. One man operates the line.

The bucket is permanently attached to the traction rope, and after dumping, the empty bucket is returned to the loading terminal upside down. If desired, however, a self-righting bucket can be used, and the hanger supporting this can be fitted with a grip, so that it can be detached at either terminal, and, by means of shunt rails, taken to points of loading or discharge as may be, not directly accessible by the cable line.

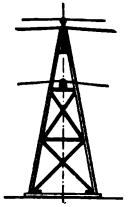
Where power can be taken from some convenient shaft, the traction rope may be operated from either end of the line by double friction clutch pulleys driven by straight and crossed belts, and the material transported in either direction.

Reversible Wire Rope Tramway with self-dumping Bucket

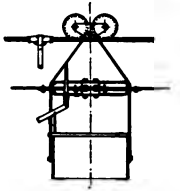
Manufactured by The Trenton Iron Co. Trenton, N.J.



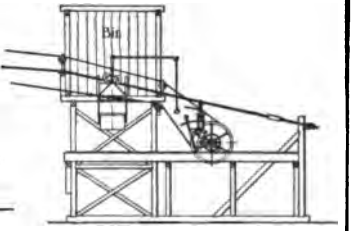
Tension Terminal



Support



Bucket



Power Terminal

Length of line, 600 feet.

REVERSIBLE WIRE ROPE TRAMWAY,

with Self-dumping Bucket.

Built by THE TRENTON IRON CO., Trenton, N. J.,

For the St. Bernard Coal Co., Earlington, Ky.

Hourly capacity, 10 tons.

The capacity is dependent of the length; the line at Earlington, which is about 600 feet long, having a capacity of 10 tons per hour.

The ground immediately under the line, at Earlington, having been filled in, the bucket is discharged into side-dump cars, by means of which the material is conveyed to the dump banks on either side of the cable line, and a large area thus covered.

The Trenton Iron Co.

TRENTON, N. J.

MANUFACTURERS OF

WIRE AND WIRE ROPE,

Wire Rope Tramways,

Cable Hoist-Conveyors,

Surface and Underground Haulage and Transmission of Power Equipments.

Suspension Bridges, Etc.

The Bleichert Wire Rope Tramway,

AND OTHER SYSTEMS OF AERIAL TRANSPORTATION.

Bleichert Tramway of the Bunker Hill and Sullivan Mining and Concentrating Company. Showing long span across the town of Wardner, Idaho.

MANUFACTURED BY

THE TRENTON IRON CO.

TRENTON, N. J.

Engineers and Contractors and Sole Licensees in North America for the Bleichert System. Also, Wire Rope Equipments for Surface and Underground Haulage, Etc.

NEW YORK OFFICE—Cooper, Hewitt & Co., 17 Burling Slip.
CHICAGO OFFICE—1114 Monadnock Building.

Illustrated book, describing the above, will be mailed upon application.

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