walls of the gun in proportion to the caliber of the gun. It is the intention of the department not only not to have the thickness of the walls of the gun proportionate to the caliber, but to have them actually thinner than the walls of the present 12-inch gun. Under such conditions I am sure the proposed 14-inch gun will expand as much under the pressure necessary to give 2,000 f. s. as does the bore of the present 12-inch gun under the pressure necessary to give 2,500 f. s., and therefore score as much or more and be even shorter-lived.

From a careful study of the star-gaging reports of the two 6-inch wire guns recently tested at Sandy Hook, I am convinced that with proper banding and uniform twist of rifling the life of the gun can be materially increased without reducing the present service velocities. I am positive it is possible so greatly to reduce the scoring as to render it unnecessary to reduce velocities and to permit even of increasing them.

I regret and deplore the expenditure of so much money to build guns which, once it is proved that scoring can be materially reduced, will be so much scrap steel. Why not build 12-inch guns on the lines of the two 6-inch wire guns recently tested at Sandy Hook? Such guns would give the required 2,500 f. s. with pressures far below 30,000 pounds, and with proper banding and uniform twist of rifling would have a life of fully 300 rounds. They would have the additional advantage, once it is proved that scoring can be materially reduced, of having a service velocity of fully 3,500 f. s. and still have a life of fully 300 rounds. J. H. BROWN.

Gyroscopic Action of Electric Locomotives on Curves.

To the Editor of the SCIENTIFIC AMERICAN:

A note by Mr. C. H. Kennison in the SCIENTIFIC AMERICAN of March 16, 1907, upon the possible importance of the gyroscopic action of electric motors in cars upon curves, gives rise to an interesting line of thought. Practically, it is scarcely probable that the effect would be appreciable, although we must admit the existence of some such action. It may be of interest to look a little more in detail into just what various forces are concerned.

At the outset it is necessary to call attention to one very common misapprehension as regards gyroscopic force. It is commonly said that a wheel rotating in a given plane offers a resistance to any force tending to change the plane of rotation. This statement is not strictly true. If the axis of rotation of a rotating wheel is moved angularly in a given plane, the gyroscopic force thus developed does not directly act to oppose the motion, but acts in a plane at right angles to that in which the axis moves, tending to deviate it one way or the other. This can be plainly seen by holding a rotating gyroscope in the hands, and attempting to move backward or forward one end of the axis, when it will be found that no immediate and direct opposition exists to the motion in the horizontal plane, but only a force tending to raise or lower the end of the axis. The fact that the gyroscopic force always acts at right angles to the plane of change of direction of the axis cannot be too strongly impressed upon the mind. What is commonly spoken of as the resistance of the wheel to a change in its plane of rotation is only a secondary effect of the gyroscopic force, and is very prettily illustrated in the ordinary gyroscope.

In the common form of gyroscope, the axis when first released falls vertically. The gyroscopic force, or couple, as it really is, does not act in any way to oppose this fall, but simply to deviate the direction of motion from the vertical. The axis therefore takes an inclined path. As the path becomes more and more inclined, the gyroscopic force, always at right angles to the plane of motion of the axis, is directed more and more upward, gradually destroying the fall and deviating this motion into the horizontal direction. The gyroscopic force is now directed upward, opposing the attraction of gravitation. The gyroscopic force begins now to deviate the axis upward at the same time, becoming itself more and more directed backward. The path of the axis hence gradually curves upward until finally the axis comes to rest at the same level as before, but pointing in a different direction. Another loop is described in a similar manner, and so on and on a succession of minute arcs. Hence we see, generally speaking, that the gyroscopic force supports the apparatus, not by direct opposition to the falling, but secondarily by its ability to deviate the motion of the end of the axis into the series of little arcs referred to. A special case arises however when, by a rather common combination of circumstances, the axis attains a certain uniform horizontal velocity, which produces a gyroscopic force just sufficient to support the weight of the apparatus. In this case nevertheless the gyroscopic force, directly opposed to the attraction of gravitation, in no wise opposes the motion of the axis in the horizontal plane.

Let us consider now from a purely theoretical standpoint the question raised by the communication above referred to. Assume the armature of the motor to be directly applied to the axle of the wheels. So long as the track remains straight, the plane of rotation remains unchanged, and no gyroscopic effect results. When the car strikes a curve however, the plane of rotation is forced to change one way or the other, the axis of rotation changing direction in a horizontal plane. The result is the production of a force at right angles to this plane, tending to raise one end of the axis and lower the other. An analysis of the relative motions concerned will show that the gyroscopic force acts in such a direction as to raise the end of the axis nearest the center of curvature of the track, that is, that it tends to overturn the car. The result is the same, no matter which way the track curves. This observation can be easily verified by experiment with the gyroscope held in the hands.

If on the other hand we assume the motor to be geared to the axle so that the armature rotates in the opposite direction to the car wheels, then the tendency of the gyroscopic force is to prevent overturning as the car rounds the curve.

In either case, however, if it is granted that the car does not overturn, it is obvious that the gyroscopic force, being always directed in a vertical plane, can offer no opposition whatever to the change of direction of the car. C. M. BROOMALL.

The Delaware County Institute of Science,
Media, Pa., March 18, 1907.

To the Editor of the SCIENTIFIC AMERICAN:

If you will allow me, I will correct the impression of your recent correspondents, who think the gyrostatic effect of the rotors of an electric locomotive resists the angular movement of the locomotive in going round a curve. A rotating body does not resist a change of plane unless it is free to gyrate, or turn on another axis normal to its axis of rotation. For instance, a gyroscope does not resist the effect of gravity unless it is free to turn in a horizontal plane. In the case of the rotors, being held rigidly as they are in their bearings, the effect of gyrostatic action would be to simply lift on one bearing and bear down on the other, depending on the direction of rotation.

Niles, Mich., March 26, 1907. W. G. BLISH.

The Current Supplement.

The current SUPPLEMENT, No. 1632, opens with a most interesting and exhaustive article on liquid crystals and theories of life. In this article Prof. Lehmann's experiments with liquid crystals are instructively reviewed. The article is elaborately illustrated. Mr. Arthur P. Davis's discussion of the inundation of the Salton Sink is concluded. An excellent paper is that by Mr. William North Rice on the permanence of continents. Those of our readers who desire to learn how half-tone engravings for the SCIENTIFIC AMERICAN and other publications are made should read the article in the SUPPLEMENT entitled "The Making of a Half-Tone Engraving." The chemical composition of tool steel and the more important characteristics of high-speed tools are considered by F. W. Taylor. In winding small induction coils, that is, those giving sparks up to and including two inches in length, the secondary may be formed of bare copper wire wound in layers on the primary helix instead of using insulated wire. How thus to construct small induction coils with bare wire is very clearly explained by Mr. A. Frederick Collins. So clear is his text, and so elucidating the illustrations which accompany it, that any one should be able to construct a bare wire coil by the mere reading of the article. Dimensions are given. Mr. W. H. Wakeman writes on pumping devices for open tank service. The shortly expected return of Halley's comet renders particularly timely Mr. F. W. Henkel's article on the subject.

Official Meteorological Summary, New York, N. Y., March, 1907.

Atmospheric pressure: Highest, 30.57; lowest, 29.55; mean, 30.07. Temperature: Highest, 75; date, 23d; lowest, 16; date, 7th; mean of warmest day, 64; date, 29th; coolest day, 24; date, 7th; mean of maximum for the month, 47.9; mean of minimum, 33.6; absolute mean, 40.8; normal, 37.6; excess compared with mean of 37 years, +3.2. Warmest mean temperature of March, 48, in 1903. Coldest mean, 29, in 1872. Absolute maximum and minimum of this month for 37 years, 75 and 3. Average daily deficiency since January 1, —0.2. Precipitation, 3.80; greatest in 24 hours, 1.03; date, 19th; average of this month for 37 years, 4.08. Deficiency, —0.28. Accumulated deficiency since January 1, —2.00. Greatest precipitation, 7.90, in 1876; least, 1.19, in 1885. Snowfall, 13.8. Wind: Prevailing direction, N. W.; total movement, 8,813 miles; average hourly velocity, 11.8; maximum velocity, 58 miles per hour. Weather: Clear days, 10; cloudy, 10; partly cloudy, 11. Fog, 13th, 14th. Sleet, 12th. Thunderstorms, 19th.

BRANCH RAILWAYS BY THE TELPHERAGE SYSTEM.

The building up of a vast railroad system like that of the United States is marked by two distinct periods: the first, that in which the main arteries of travel are pushed boldly out over the territory to be covered; and the second, that in which these main lines are made accessible for the outlying regions they traverse, by the construction of branch or feeder lines. The railroad system of this country has passed through the first phase, and it is not likely that many, if any more, great trunk lines will be projected. Also, in the East and Middle West, the main feeders to the trunk line have been so far constructed, that they will serve the needs of the country for many years to come. The 220,000 miles of track in the United States probably represent the sum total of trackage of the standard broad-gage type that would yield a profitable return on the investment, if it were worked with the full complement of rolling stock that it is capable of carrying.

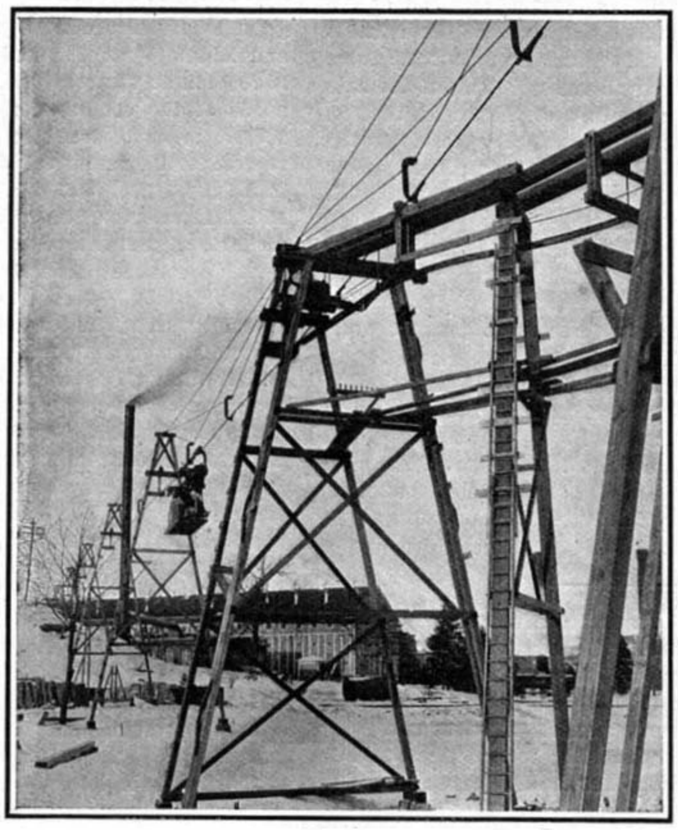
At the present time the railroad situation may be said to be face to face with yet another phase of development, which will consist, not in the construction of heavy, broad-gage track carrying heavy rolling stock of the standard type, but of light railways, either of the narrow-gage surface, or of the light overhead type, cheap to construct, cheap to operate, and having a capacity, at least in the case of overhead lines, far exceeding that of any known system of land transportation. Although the narrow-gage railway has met with considerable favor in some European colonies, it has failed to meet the conditions of traffic in this country, its capacity being too small for heavy traffic, and its cost too great for the needs of those sparsely-settled districts where, for the present at least, freight and passenger movements must necessarily be infrequent and small in quantity. Nevertheless, the demand for some inexpensive and easily-constructed railway system which would bring the vast farming districts of the West and Southwest into direct communication with the railroads is most imperative. Could some system of cheap feeder lines be devised, not only would the value of these farms be increased, but the settlement of the sparsely-settled districts would be greatly stimulated; for such a connection would rob the vast prairie lands of the West of those associations of loneliness and isolation which, doubtless, serve to prevent many would-be settlers from making their homes there.

The leading railroad men of the day have been devoting much attention to the system of telpherage, which forms the subject of the accompanying illustrations, with a view to adapting it to the needs of railway service, and particularly to the demand, as above mentioned, for an inexpensive system of branch railways in sparsely-settled country. It is particularly suited to the conditions; for it is cheap to construct, inexpensive in operation, and possesses a flexibility as to capacity which is unequaled by any other method of transportation. The nature of the construction and the simplicity of operation of the Common Carrier Telpherage System, as it is called, are clearly shown in the accompanying drawing, which was made from a description furnished by Mr. John Brisben Walker, of this city, who is the owner of the common carrier rights for the United States, and all the telpherage rights for Canada. In this view, a typical telpherage line is shown starting from the siding of a broad-gage railway, crossing a river, and running into the country to be served, say for a distance of from 20 to 30 miles. The construction is of the most economical kind. It consists of two lines of 8-inch by 10-inch stringers with 20-pound rail, carried at the outer ends of a series of trestle bents consisting of 8-inch by 8-inch caps, spiked down upon posts, which may be of sawed lumber, or even of suitable lengths of common telegraph posts. The "trains" are made up generally of sets of four light corrugated-iron cars, circular in section, 4½ feet in diameter by 16 feet in length. Each car is supported by two light iron straps to two two-wheeled trucks. The forward truck of the motor car is provided with a motor and a short trolley pole engaging an overhead trolley wire. The crossing of rivers, canyons, or precipitous valleys is accomplished by supporting the cable or traveler wire from a series of suspender cables, passing over the tops of latticed towers, and guyed back to anchorages on either bank; the suspender wires forming a modified catenary, from which the traveler cable is supported at stated intervals, as shown in the engraving. A notable advanta[illegible] of the system is that the method of support or sus[illegible] sion of the track or cable is capable of wide vari[illegible] to suit the topographical difficulties of the cou[illegible] be traversed. Tunneling is unnecessary, since [illegible] may be so developed as to cross the loftiest mountains, without exceeding the maximum grade of four [illegible]ent; or, where rocky bluffs are encountered, it may be supported on iron brackets attached at intervals to the sides of the bluff, as shown in the a[illegible]ompanying engraving.

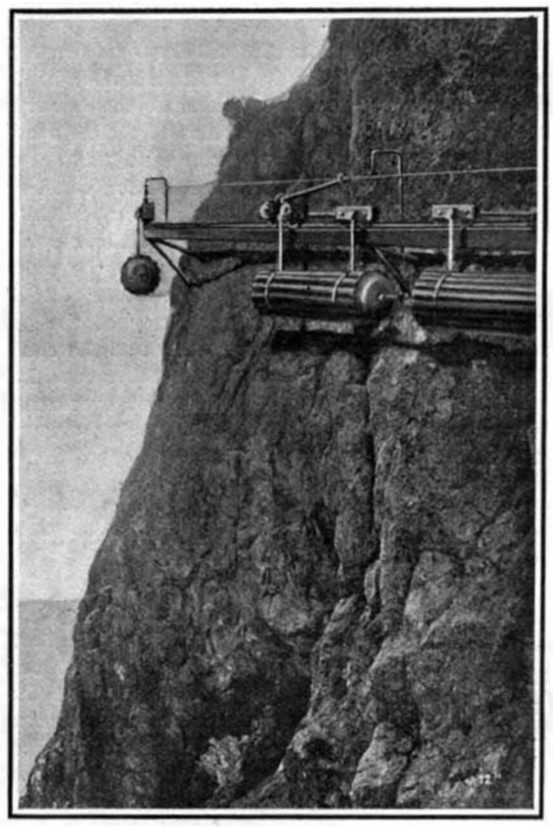
In no character of country does the telpherage system show to better advantage than for transportation through the mountains. A railr[illegible] in the West, which has recently been completed, is said to include twenty tunnels in 20 miles of road—and any engineer who is familiar with the extraordinarily broken character of some of the western canyons, will understand that this is quite a possibility. When building a broad-gage mountain railroad through a precipitous canyon the road must often be carried continuously either on trestle, in tunnel, or on a ledge of road-bed which has to be blasted out of almost perpendicular cliffs, the side slope of the cut reaching, sometimes, several hundred feet up the mountain side. It will be seen from our engravings that by the use either of light trestles, suspended cables, or brackets and cantilevers anchored into the rocky walls, it would be possible to carry a telpher line, costing a few thousand dollars per mile, through a canyon in which the construction of a standard-gage steam track would run up in cost to $100,000 per mile and over.

In addition to the cheap nature of the construction of the line, which in prairie and rolling lands can be built for $3,500 per mile, there is an equal economy realized in the construction of the rolling stock. The standard type of car for use under ordinary conditions would be cylindrical, with semi-spherical ends, and, being built of corrugated steel, it would possess considerable strength for a very moderate dead weight. The two hangers would be of strap iron, and, because of the comparatively small size and weight of the cars, the overhead trucks would be also of light construction. Further economy would be found in the comparatively small amount of electric power that it would be necessary to install at the opening of a new line. As the speed of operation would only be about 12 miles per hour, a 20-mile line, such as would be built out from the steam railroad in order to tap one or two large wheat fields, say, on the level prairies of the northwestern country, could be operated with a plant of not to exceed 100 horse-power. This would suffice until the district had been developed, and a greater tonnage was available, when the smaller equipment could be used on some newly-opened line.

In addition to the cheapness of the line, the rolling stock, and the power plant, there would be a further economy in the character of the force required for operation. Since there would be no locomotives or heavy cars to handle, the train crew would be abolished at a stroke, and the operating force would be confined to one or two men at the power station. Even the switchmen would be unnecessary, for a train of cars could be automatically switched into a particular station, say 20 miles from the starting-point, by means of automatic trips, set to engage corresponding stops at the switch opening.



Method of Supporting Telpher Line from Overhead Cable Carried on Trestles.



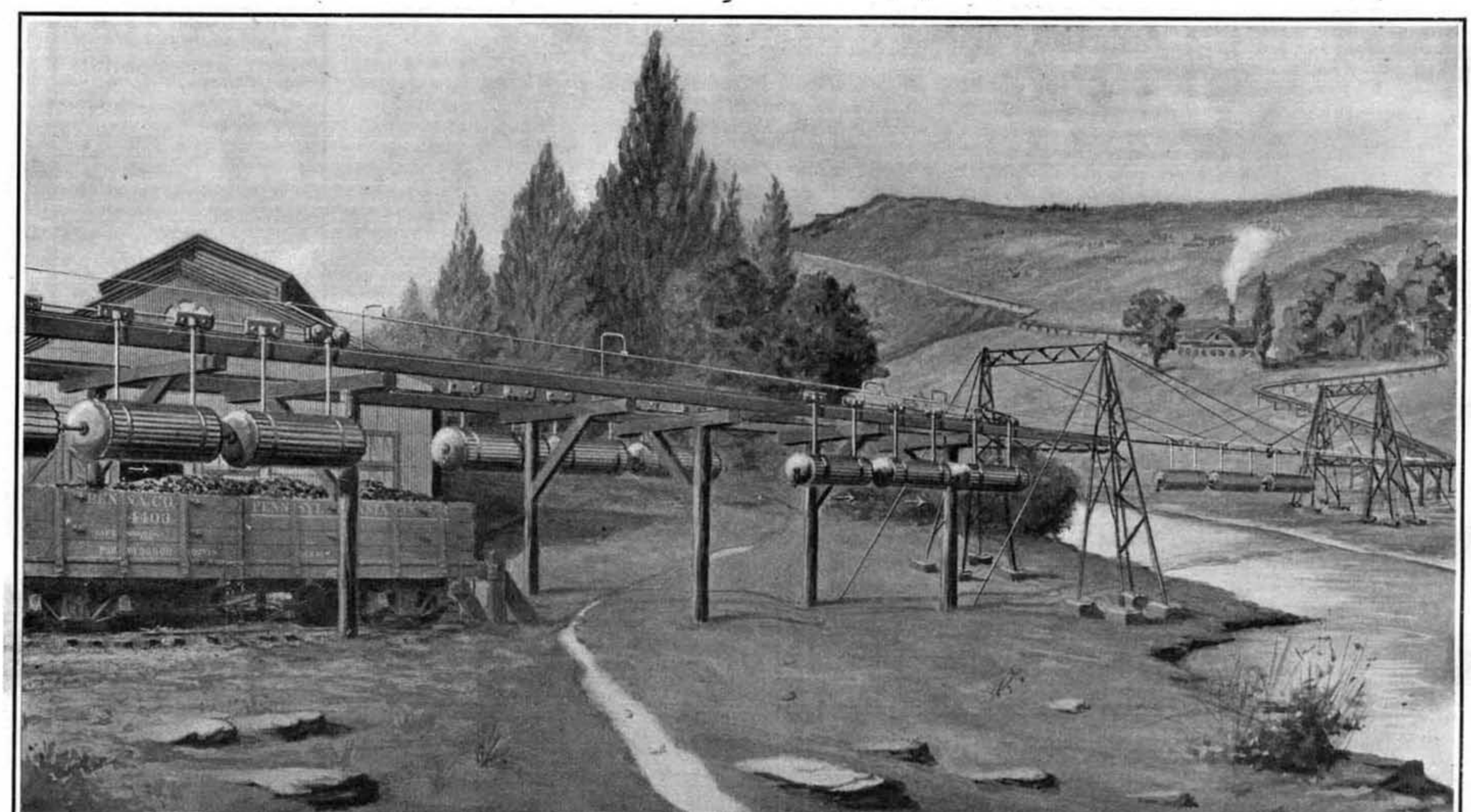
Tunnels Avoided by Carrying Line Around the Face of the Bluffs.

The accumulated economies which are peculiar to the telpherage system, as outlined above, render this not only the cheapest system of transportation of freight, but the one having the greatest capacity. It is estimated that with a telpher line operating under favorable conditions, freight may be carried at a cost of one-twentieth of a cent per ton per mile. This would occur when the line was loaded to about one-fourth of its full capacity; that is to say, if 25 per cent of the telpher line were occupied by the telpher cars. The system would have a remarkable capacity for the carriage of ore, coal, or wheat in bulk; for if the line were occupied to one-fourth of its capacity with loaded cars, traveling at 12 miles per hour, we would have the equivalent of a 4½-foot pipe line delivering grain or similar substance at the rate of three miles per hour. The enormous tonnage which would be handled in this way can be readily understood.

While speaking of the character of the cars, reference should be made to an economy of no small importance, which would be due to the fact that these cars could be carried direct into coal mines, loaded at the headings, hauled to the telpher line, loaded bodily into delivery trucks at their destination, and dumped in the coal bin or cellar without breaking bulk.

The important question of right of way is greatly simplified by the fact that the construction of the telpher line involves a minimum of interference with the property over which it is carried; for the cars could traverse a field of wheat without in any way interfering with the cultivation of the same. Furthermore, the system affords an excellent solution of the problem of overcrowded freight lines, such as the Erie Railroad presents; since the capacity of such a road could be doubled by transferring the carriage of the coal to an elevated telpher line, built on the right of way on each side of the steam tracks, thus leaving the latter for the exclusive use of mixed freight and heavy passenger service.

The Bureau of Navigation at Washington reports that for the calendar year 1906 the vessels built in America and registered numbered 1,045 of 393,291 gross tons; for 1905, 1,054 of 306,563 gross tons; for 1904, 1,065, of 265,104 gross tons; for 1903, 1,159, of 361,970 gross tons; and for 1902, 1,262, of 429,327 gross tons.



Typical View Showing Telpher Line Acting as Feeder to a Steam Railroad.

BRANCH RAILWAYS BY THE TELPHERAGE SYSTEM.