RAILROADS IN THE UNITED STATES IN 1889.

THE year 1888 is notable for the reason that it marks the beginning of the second century of our existence as a nation. When Washington was inaugurated one hundred years ago, our population was less than 4,000,000: to-day it is estimated at 65,000,000. Enormous as has been this increase in the population of the country within the short period of one hundred years, the increase in wealth and material prosperity resulting from the rapid development of the country's wonderful resources has been in even greater ratio; has, in fact, no parallel in the history of the world.

That these wonderful results are due chiefly to the rapid expansion of our railroad system, none will gainsay. What our condition would be without railroads, it is impossible to conceive: what it is, having them, is universally known.

Of the total railroad mileage of the world, the United States now possess nearly one-half. At the end of 1888 the aggregate length of all lines in the country, according to "Poor's Manual for 1889," to advance sheets of which we are indebted for our facts, was 156,082 miles, all built in sixty years, the average mileage constructed per year being nearly 2,600 miles; but this record of sixty years, wonderful as it is, fades into insignificance when compared with the achievements of the past twenty-three years, — since the close of the civil war.

The total mileage of our railroads at the close of 1865 was 35,085 miles. In the twenty-three years since then, there have been constructed 121,000 miles of new road, — an average of 5,260 miles per annum, twice the annual average of the whole period of sixty years, and 5.3 times the annual average of the first period of thirty-five years. During these twenty-three years the country has experienced three great waves of railroad construction, which were checked only by extraordinary financial revulsions.

The first of these great construction waves occurred within the eight years intervening between the close of the war and the panic of 1873. In that time the mileage increased more than 100 per cent, or from 35,085 miles in 1865, to 70,268 miles in 1873. Within this period was completed the first Pacific Railroad line, and construction on a second line to the Pacific was well under way. The cash cost of the 35,000 miles of road constructed in these eight years must have exceeded $1,400,000,000; and the panic, which began in the fall of 1873, was largely the result of the transformation — following so close in the wake of a great civil war — of this vast sum from floating into fixed capital.

In New England, during this period, railroad mileage increased nearly 2,500 miles; in the Middle States the increase was 6,070 miles, about 75 per cent; in the South it increased 4,000 miles, 44 per cent; and in the Pacific States the increase was from 166 miles to 2,193 miles. But the great increase of this period was in the Western and South-western States.

At the close of 1873 the total capital investment in all the railroads of the United States was $3,784,543,034, represented by share capital to the amount of $1,947,638,584, and bonded debts to the amount of $1,836,904,450. This vast aggregate represented also the cost of 70,651 miles of railroad then in operation, the average cost per mile for the whole country at that time equalling $60,057. In New England the average cost was $47,850 per mile; in the Middle States, $67,737 per mile; in the Western States, $52,125 per mile; in the Southern States, $36,994 per mile; and in the Pacific States, $95,590 per mile. The maximum cost per mile was in New Jersey, where it averaged $115,829; the minimum was in Florida, where the average was only $18,445 per mile.

The increase of mileage from 1871 to 1873 had been 21,623 miles, and the increase of the cost of the roads $1,119,915,389, nominally. One cause for the excessive mileage built within a few years was the extraordinary effort to complete roads, in order to save from lapsing the vast grants of land made by Congress, on condition that the roads should be built within a certain time. But the increase was far beyond the possibility of speedy returns for the capital invested. That much land could be found unoccupied near the line of a railroad implied a sparse population; and, although prairie soil could quickly be brought into cultivation, it would be long before there could be sufficient traffic to pay the interest on the cost of the roads. Excessive competition and speculation in railroad building and railroad bonds and stocks ensued, until, in September, 1873, the great financial storm which has since passed into history as the "panic of 1873" burst upon the country.

The depression which followed extended through the years 1874–78. During 1879 matters began to improve throughout the country, and this feeling soon became reflected through the railroads. In that year construction increased nearly 100 per cent over the preceding year.

During these fifteen years there were built 85,814 miles of new railroad, an increase of over 122 per cent; that is, in the last fifteen years we built 15,546 miles of railroad more than we built in the preceding forty-five years. The first five of these fifteen comprised a period of depression; the next four years were years of unexampled activity; while the three years of 1883, 1884, and 1885 were years of hesitancy, in which no new railroad enterprise of great magnitude was begun, as was natural, after the completion in a single year (1882) of 11,600 miles of road. In 1886 there were built 8,128 miles, and in 1887, 12,984 miles, the latter surpassing the record of any previous year; and in 1888, 7,028 miles. In the three years the new construction aggregated 28,140 miles, or within 58 miles of the extraordinary record of the three years 1881–83.

The increase in mileage during the ten years from 1840 to 1850 was 6,202 miles, or 220 per cent. The average mileage constructed per year in this decade equalled 620.3 miles. In the succeeding decade, 1850 to 1860, 21,605 miles were added, an average of 2,160.5 miles per year, the increase equalling nearly 240 per cent. The next ten years, 1860 to 1870, showed an increase of only 73 per cent, or 22,296 miles, the falling-off from previous records being due to the outbreak of the war. Between 1870 and 1880, 45,375 miles were added, an increase of nearly 86 per cent. Since 1880, 57,786 miles have been built.

Since the revival of railroad construction in 1879 there have been completed three additional through transcontinental railroads, — the Northern Pacific, the Atlantic and Pacific, and the Southern Pacific; while the Union Pacific by the construction of its Oregon Short Line north-west to a connection with a branch of the Oregon Railway and Navigation Company's system, the Atchison by the construction of its line to a connection with the Southern Pacific, and the Chicago, Burlington, and Quincy by the construction of its Denver extension, have added three other important routes to the Pacific. At least three of the great Western railroad systems are now stretching westward, with the evident intention of speedily reaching the same ocean.

A striking feature of the last decade of railroad building is the large number of speculative and parallel lines which were put under way, and many of them completed, notably the West Shore Railroad, which parallels the New York Central line for its whole length from New York to Buffalo; the "Nickel-Plate" line, which parallels the Lake Shore in like manner from Buffalo to Chicago; and the South Pennsylvania, paralleling the Pennsylvania Railroad between Philadelphia and Pittsburgh, upon which a vast sum was expended, but which has not been completed. In some instances such lines were perhaps undertaken with a view to forcing their subsequent purchase by the older companies whose lines they sought to parallel; and in the case of the two roads first mentioned these plans met with eminent success. But their fulfilment was in the main the cause of the depression which existed during the years 1885, 1886, and 1887.

The chief feature of railroad construction of the "wave" of 1886–88 has been the extraordinary activity displayed by the older and more powerful corporations of the North-west and South-west in the extension of their lines, with the apparent purpose of securing a firm foothold upon every available foot of territory contiguous to their several systems, or within reach thereof. The result of this policy has proved in many instances unwise, if not disastrous, as an examination of the facts herein set forth will show.

The most important lines which have been constructed during that period are here briefly summarized: North and north-west of Chicago there have been completed the Duluth, South Shore, and Atlantic Railway, forming a new short route between Duluth and

Sault Ste. Marie, where connection is made with the Canadian Pacific Railroad, under whose control the Duluth line has passed. The Minneapolis, St. Paul, and Sault Ste. Marie has completed an equally important line between Minneapolis and St. Paul and the "Soo," and has also constructed an extension north-west of Minneapolis to within a short distance of Bismarck, Dak. Between Chicago and St. Paul two important new routes have been opened, — the Chicago, Burlington, and Northern, and the Chicago, St. Paul, and Kansas City. The latter company also extended its line south-west to Kansas City, to which point the most important extension of the Chicago, Milwaukee, and St. Paul Railroad within the three years was built. Running far west to Helena and Butte, Mont., the St. Paul, Minneapolis, and Manitoba Railway Company completed a line which is the most northerly east-and-west line of importance in the United States.

The total number of miles of railroad in the United States at the close of 1888 was 156,082, of which 7,028 miles were constructed during the year, the rate of increase being 4.7 per cent. The mileage of lines making returns of their share capital and funded and floating debts equalled 154,276, against 147,999 for 1887, the increase being 6,277, the rate of increase being 4.24 per cent.

The share capital of the mileage completed at the end of 1888 equalled $4,438,411,342, against $4,191,562,029 in 1887, the increase equalling $246,849,313, the rate of increase being about 5.9 per cent.

The funded debts of all the lines at the close of the year aggregated $4,624,035,023, a sum $437,091,907 in excess of the total of 1887 ($4,186,943,116), an increase of nearly 9.5 per cent. The other forms of indebtedness of the several companies at the close of the year equalled $306,952,589, against $294,682,071 for 1887, the increase being $12,270,518. The total share capital and indebtedness of all kinds of all the roads making returns equalled at the close of the year $9,369,398,954, an increase in the year of $696,211,738 over the total of 1887 ($8,673,187,216) the rate of increase for the year being about 8 per cent. The cost per mile of all the roads making return as measured by the amount of their stocks and indebtedness equalled very nearly $60,732, against $58,603 for 1887.

The gross earnings or receipts of all the lines (including elevated railroad) from which returns were received for the year equalled $960,256,270, of which $251,356,167 were received from transportation of passengers; $639,200,723 from transportation of freight; and $69,699,380 from the transportation of mails and express matter, profits of leased lines, and other miscellaneous sources of revenue. In the latter sum are included the gross earnings of elevated railroads. The gross earnings of all the lines for the year ending Dec. 31, 1887, equalled $940,150,702; the increase for the year 1888 equalling $20,105,568, or 2.14 per cent. The earnings in 1887 from transportation of passengers equalled $240,542,876; from freight, $636,666,223; from transportation of mails and express matter, etc., $62,941,603, against $69,699,380 for 1888. The earnings per mile from which full returns were received in 1888 equalled $6.540, against $6,861 for 1887, the decrease equalling $321 per mile. The net earnings of all the lines for 1888 equalled $301,631,051, against $334,989,119 for 1887, the falling-off equalling $33,358,068, the rate of decrease being about 10 per cent.

The amount of interest paid in 1888 equalled $207,124,288, against $203,790,352 in 1887, the increase being $3,333,936, the rate of increase equalling more than 1.63 per cent. The amount paid in dividends in 1888 equalled $80,243,041, against $91,573,458 in 1887, the falling-off equalling $11,330,417, the rate of decrease being about 12.4 per cent.

The number of persons transported in 1888 by all the lines was 451,353,655, against 428,225,513 for 1887, the increase for the year being 23,128,142, the rate of increase equalling 5.4 per cent. The number of passengers carried one mile in 1888 equalled 11,190,613,679, against 10,570,306,710 for 1887, the increase equalling 620,306,969 persons carried one mile, the rate of increase equalling very nearly 6 per cent. The distance travelled by each passenger in 1888 equalled 24.78 miles; in 1887, 24.68 miles. The amount received per passenger per mile equalled 2.246 cents in 1888, against 2.276 cents in 1887. Had the passenger rates for 1887 been maintained for 1888, the earnings from this source would have equalled $255,034,086, a sum $14,491,210 greater than that received.

The number of tons of freight transported on our railroads in 1888 equalled 589,398,317, against 552,074,752 tons in 1887, the increase equalling 37,323,565 tons, the rate of increase being about 6¾ per cent. The value of the tonnage moved in 1888, estimating its value at $25 the ton, equalled $14,633,957,925. The number of tons transported one mile in 1888 equalled 70,423,005,988, against 61,561,069,996 tons moved one mile in 1887, the increase of service performed for the year equalling 8,861,635,992 tons moved one mile, the rate of increase being about 14.4 per cent.

When "Poor's Manual for 1888" was published, it recorded the greatest amounts, in the aggregate, ever earned, either gross or net, by the railroads of the country. In the midsummer of 1888 the situation presented many hopeful aspects, and it was widely believed that the period or depression had passed. The volume of business throughout the country was larger than ever in its history, and an improvement in earnings was therefore confidently looked for. But unfortunately, while the traffic was large and of increasing proportions, the rates received for its transportation, owing to the fierce and unbridled competition in the West, drooped continually.

It appears that in the seven years 1882–88 the tonnage increased 228,907,942 tons, or 63 per cent. In the same period the mileage of lines in operation increased 49,588.91 miles, or 51 per cent. Computed on the basis of tonnage per mile of road, the traffic of 1882 was 3,650.5 tons per mile; of 1883, 3,744.7 tons per mile; of 1884, 3,526.2 tons per mile; of 1885, 3,578.6 tons per mile; of 1886, 3,853.4 tons per mile; of 1887, 4,030.1 tons per mile; and of 1888, 4,055.2 tons per mile. It thus becomes apparent that the traffic of the past two years was the largest ever carried by the railroads of the country. During 1888 the volume of freight traffic was exceptionally large; and, with an increase of eight miles in the average length of haul per ton, the earnings from this source should have been, had fairly remunerative rates prevailed, sufficient to insure a continuance of dividends by the great trunk lines rather than their suspension, as has been the case in so many instances.

The tonnage-mileage of 1887 was 61,561,069,996, for transporting which the railroads received an average rate of 1.034 cents per ton per mile, producing a revenue of $636,666,223. In 1888 the tonnage-mileage was 70,423,005,988, which produced an average revenue per ton per mile of .907 of a cent, or, in the aggregate, $639,200,723. Had the rates received in 1887 prevailed in 1888, the difference of about 1¼ mills per ton per mile would have given the railroads an increased revenue of $89,189,819, sufficient to pay more than 2 per cent upon the total amount of capital stock outstanding at the end of 1888, upon all of the roads contributing toward this grand aggregate.

The causes which led to this unlooked-for result are now thoroughly understood. The sentiment is unanimously expressed that the chief elements of disturbance in the railroad situation in the West have been, first, the unprecedented activity with which the railroad systems of that section have been extended, as a result of the desire to secure entrance to the newly developed lands in the West and South-west; second, the partial failure of the crops, and the consequent loss of a large proportion of the traffic which had been calculated upon; third, the complications resulting from the application of a new and radical law, — the Interstate Commerce Act; and, fourth, the spirit of hostility and repression evinced by the legislatures of some of the Western States.

To these several causes, which were in themselves sufficient to demoralize the business of even so powerful a system as that of the railroads, might be added a fifth and perhaps most potent cause of all; that is, the very mightiness of the contestants and the magnitude of the interests involved. In no period of the world's history has there been such vast aggregations of capital engaged in commercial enterprises as are now to be found in this country. Nor is there any country in which competition in business is freer and sharper than in ours. In this general competition the railroads of the country have taken active part. The construction of new lines has been encouraged in every part of this country, in no section more strongly than in those which are now displaying the most

violent antagonism toward them. Nowhere were greater inducements held out to capital to supply railroad facilities than west of the Mississippi, between the close of the war and the early seventies; yet in those very States, which owe their present prosperity and development to no cause more than to railroads, we see the most rampant hostility displayed toward the creators of their wealth.

In the early days of railroads in this country, their profits reached very respectable proportions. In some instances, where the lines were especially favored in respect to location and physical surroundings, these returns were so large as to excite the cupidity of capital to such an extent that, at several periods of the country's history, the eagerness displayed by railroad constructors in pushing their lines beyond the requirements of the territory resulted in plunging the country into financial crises having far-reaching effects. But the days of large profits appear to have passed. A railroad which in the future can pay regular dividends of 5 per cent per annum, will be regarded in much the same light as those which formerly paid 8 and 10 per cent for years without intermission.

In the Manual are three tables, showing the decline in freight rates upon various railroads of the United States. Table No. 1 includes seven leading Eastern trunk lines, running between Chicago and the seaboard, and covers the twenty-four years, 1865 to 1888 inclusive. Upon these roads the rates received for transportation of freight declined from 2.9 cents per ton per mile in 1865, to .609 of a cent per ton per mile, — a reduction of 79 per cent within the period covered by the statement: in other words, the railroads comprised in that statement received, in 1888, $21 for the performance of a service for which in 1865 they received $100. What other business can show a corresponding decrease in returns?

Table No. 2 gives like statistics for six leading Western trunk lines running west, north-west, and south-west of Chicago, and embracing the same period, 1865 to 1888. Upon these lines the reduction equalled 73 per cent in the twenty-four years, or from 3.642 cents per ton per mile in 1865 to .934 cent in 1888.

The thirteen roads embraced in these two tables are typical of the entire railroad system. Upon the basis of the deductions here shown, it may be assumed that the average reduction throughout the whole country since the close of the civil war has been at least 70 per cent. To earn an amount equal, on the average, to that earned twenty-four years ago, the railroads are now required to perform a service nearly three times as great. Yet, notwithstanding this, the cost of operating the lines has not been decreased to any appreciable extent. Of the total cost of operating a railroad, fully 80 per cent is paid to labor in one way or another. Expenses of this nature cannot be materially reduced: in point of fact, the tendency is constantly toward an increase. The average rate of wages paid by railroads is to-day as large as in 1865, if not larger. It becomes plain, therefore, that the immense sums that have been annually lost to the railroads of the country by their voluntary reductions in rates have been a corresponding saving to the public at large. A calculation of the sums saved to the public by these reductions in rates during the past quarter-century would reach far up into the thousands of millions.

During all these years the railroads have met with most active competition from the waterways of the country, upon which freight can always be transported at about one-third of the cost of railroad transportation. It early became apparent to the railroad companies that to make their lines pay required an immense volume of traffic, which could only be secured by the development of their routes to a point where competition from waterways need not be feared. With this view, tracks have been doubled, trebled, and even in some cases quadrupled; roads have been almost entirely rebuilt with heavy steel rails; locomotives and cars of double or treble their former capacity have been constructed; and trains have been run with a frequency and at a rate of speed which were once considered to be among the impossibilities.

The effect of all this is seen in the wonderful development of all sections of the country, but particularly in the Western States, in which the progress recorded in a short quarter of a century is justly regarded as one of the marvels of the present age.

In proportion to population, the earnings of the railroads in the States of Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota, Dakota, Iowa, Nebraska, Missouri, and Kansas were considerably higher in 1888 than in 1870, being $18 per capita in the former year as against $12 in the latter, the increase being 50 per cent. But this increase of averages is a very deceptive one, as, calculated upon the basis of mileage, — the only true test, — the earnings in 1888 were but $5,728 per mile, as against $6,753 per mile in 1870. The falling-off of revenues in these States equalled more than $1,000 per mile, which for 1888 alone amounted to an aggregate of $73,000,000.

With these facts before us, it is difficult to understand the extraordinary antipathy to railroad corporations now prevalent in the West. The railroad mileage of the West has advanced in far greater ratio than the population, and the wealth and commerce of that section have kept pace with the railroad mileage. Were the railroads to be advanced only in ratio to the increase in population, the situation in the West and throughout the country would present an entirely different aspect, and public sentiment would experience a corresponding change.

The acreage of wheat and corn in Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota, Dakota, Iowa, Nebraska, Missouri, and Kansas in 1888 was 66,435,304 acres. No figures of acreage in 1870 are obtainable, but it was undoubtedly less than 30,000,000 acres in that year. Without railroads, the products of this immense territory would be to a large extent valueless; but such trifling matters as these are always dismissed from the consideration of demagogues when they strive to excite the public mind upon the rapacity and greed of railroad corporations.

In point of importance, the railroad interest now takes precedence of all other industries or enterprises. Its magnitude is greater than any other interest in the world, and it has become so thoroughly a part of the economic system of the Republic as to be second only to the government itself.

In order to show how closely interwoven are the interests of railroad stockholders and the working-classes of the country, a few calculations are herewith submitted.

If we estimate that in the operation of our railways there are employed in prosperous times an average of six persons per mile of road, it would show a total, on the basis of our present mileage, of more than 936,000 persons regularly employed in connection with that single interest; and if to this number we add 780,000 — a number representing an average of five to the mile — as the number of persons employed in connection with all those industries which are directly affiliated with and dependent on our railway system, such as locomotive and car building establishments, rail-mills, etc., we have a total of nearly 1,716,000, or an average of 11 to the mile of railroad. Assuming that each of these would represent a family averaging five persons, we have an aggregate population of 8,580,000, — nearly one-seventh of the total for the country at large, — of which 90 per cent are actually dependent on the railway system for the sustenance of life. If we allow, as the average rate of wages of those employed in operating, say $450 per annum, and for those employed in locomotive building, etc., say $500 per annum, we have a total pay-roll of $911,200,000 per annum, of which at least $500,000,000 is directly chargeable to operating account, while the remainder is for account of betterments, improvements, and new construction. Add to this the amount paid to laborers engaged in construction in such a year as 1887. In that year there were built new roads whose aggregate length was 12,984 miles. If we take, as the average cost of labor in grading, track-laying, etc., for each mile of this total, say $10,000, and allow the average daily wages of laborers to be $1.50, with, say, 100 laborers of all classes to each mile, this would show the average time for the completion of a mile of railroad to be 67 days. On this basis, the construction of 12,984 miles of railroad would give steady employment for 300 days in the year to an army of 289,976 laborers, whose total earnings would be $129,840,000.

This gives a total of 2,006,000 persons, to which we will add 44,000 as the number whose labors are stimulated by the employment of the 289,976 last mentioned, making a total of 2,050,000, representing families numbering in the aggregate 12,250,000 persons. To maintain this number, there would be expended by railroads and others under the above calculations at least $1,040,000,000

per annum, or very nearly $3,000,000 for each day in the year. The regular expenditure of more than 90 per cent of this vast sum stimulates other industries, and in this manner the volume of general business is increased in progressive ratio.

In these calculations no account has been taken of the large number of people forming the proprietary interest of this vast aggregation of capital, which comprises people in all classes and in all occupations, and scattered throughout all parts of the country.

The New York Central Railroad Company has 10,000 stockholders, whose average holding is about $9,000. If we take that sum as representing the average holding of all stock and bondholders in the country, the total number of such would be over 1,000,000, representing more than 5,000,000 persons with important interests in the success of the railroad system.

From these deductions a general idea can be gathered of the magnitude of the railroad interest, and how vast and widespread is the interest of our people in that system.

From the tables in the Manual it appears that during the past ten years the following percentages of profit have been distributed to holders of the share capital of our railroads. In 1879 the dividends paid averaged 2.5 per cent of the total amount of capital stock outstanding; in 1880, 2.8 per cent was paid; in 1881, 2.9 per cent; in 1882, 2.91 per cent; in 1883, 2.75 per cent; in 1884, 2.48 per cent; in 1885, 2.02 per cent; in 1886, 2.04 per cent; in 1887, 2.18 per cent; and in 1888, 1.77 per cent.

BUHACH.

IN an article on the California insecticide known as buhach, which was mentioned in *Science* of May 24, the *Journal of the Society of Arts*, London, says this product is a fine powder made from the flowers of the *Pyrethrum cinerariæfolium*, largely used for the destruction of insects. This plant was originally a native of Persia, from whence it was introduced to Dalmatia and adjoining States of Herzegovina and Montenegro, where it has been almost exclusively cultivated until a few years ago. The importance of this industry was considered so great in these countries that special efforts were made to prevent the export of seeds and plants by the governments. The plant was first introduced into California about twelve years ago by a Mr. Mileo, a native of Dalmatia, who succeeded, after some trouble, in obtaining seed from his country. After experimenting for some time, in order to find a suitable soil and climate, this gentleman finally succeeded in growing the plant on an extensive scale, and in 1880, associating himself with other capitalists, established the Buhach Producing and Manufacturing Company. At the present time the company have about 300 acres of this plant under cultivation at their farm near Atwater, Cal., and own mills for grinding the dried flowers to powder at Stockton. The cultivation of pyrethrum requires careful and intelligent supervision, and it cannot be grown successfully without irrigation. It requires three years from the time of sowing to grow plants capable of producing a paying crop of flowers, and then they will bear from four to five years longer. It is at its prime, however, in its fourth or fifth year. The plant grows about thirty inches high, and is set out in rows four feet apart, and from fifteen to twenty-four inches apart in the rows. The flowers are harvested towards the latter part of May. The stalks are cut just above the roots, and the flowers stripped from them by passing the plants through a kind of comb. The detached flowers fall into a box below, and are carried to the drying ground, where they are spread on sheets and exposed to the rays of the sun during the day, being repeatedly turned over in the meantime. They are covered during the night to prevent their absorbing moisture, as the perfect drying of the flowers is most important in order to retain the volatile oil which gives the powder its insecticide properties. It is also very necessary that this operation should be done quickly, and that the flowers during the drying process should be protected from moisture. A slight dew falling upon the flowers at this time will injure their color, and reduce their strength as an insect destroyer. In this respect the California-grown flowers are better cured, and, consequently, more valuable than those produced in Dalmatia, it being acknowledged by experts that the particular conditions of soil and climate in California are extremely favorable to the growth and curing of plants rich in the essential oil which renders them so destructive to insect life. Like many other products, insect powders are liable to adulteration, and last year a large quantity made from the flowers of the Hungarian daisy, mixed with a small proportion of pyrethrum, was placed upon the market by unscrupulous dealers. Inferior powders are also manufactured from the stems and leaves of the plant, which possess, to a certain extent, the properties of buhach.

SAWING STONE BY HELICOIDAL WIRE CORD.

A NEW plan of cutting stone by means of wire cord has been adopted in many European quarries. While retaining sand as the cutting agent, M. Panlin Gay, of Marseilles, has succeeded in applying it by mechanical means, and as continuously as the sand blast and band-saw, with both of which appliances his system — that of the "helicoidal wire cord" — has considerable analogy.

An engine puts in motion a continuous wire cord (varying from five to seven thirty-seconds of an inch in diameter, according to the work), composed of three mild steel wires twisted at a certain pitch, that found to give the best results in practice, at a speed of from fifteen to seventeen feet per second, the higher speed being adopted for the smaller diameter.

Instead of the stone being brought to the saw, the wire cord, which may be of indefinite length, is led to the stone, being guided by grooved pulleys, mounted on bearings with universal joint, which permits of their adapting themselves to any change of direction. The same cord, which is kept at uniform tension by a weighted truck on an inclined plane, may act upon any number of blocks, provided sufficient space be given between them to allow for cooling.

The pulleys are mounted in standards, and are fed down by endless screws rotated automatically if the stone be uniform, but preferably by hand if there is reason to suspect irregularities in its texture. Sand and water is allowed to flow freely into the cuts, the sand carried along by the cord in the spiral interstices between the wires causing a uniform attrition of the stone. The twist of the cord causes it, while travelling, to turn upon itself, and thus become worn evenly. A cord of 150 yards in length will cut about seventy feet deep in blocks fifteen feet long, or produce four hundred and ninety square feet of sawn surface before being worn out.

The sand must be sharp, and not used more than three times. The nature of the sand is determined by the hardness of the stone; thus, quartz sand will cut granite and porphyry, which it has hitherto been found impossible to saw, or indeed cut in any other way than by pick or chisel. An hourly advance of one inch in granite or porphyry and four inches in marble, is regularly obtained in blocks of fifteen or sixteen feet long. At the Brussels Exhibition of last year, where the system was awarded a prize, the same cord which cut marble also cut a block of concrete composed of quartz pebbles.

Not merely does the helicoidal cord saw blocks of stone, but it even cuts them out of the solid rock in the quarry. To do this, it is necessary to sink shafts of two or two and a half feet in diameter, in order to introduce the pulley-carriers. If there is a free side to start from one shaft is sufficient for a triangular block; but for a quadrangular one, which is preferable, two shafts are necessary. They are bored by a mechanical perforator, consisting of a hollow plate-iron cylinder, having at its lower end a slightly thicker collar which acts with sand and water in its latest development. The cylinder is made to revolve, at a speed of one hundred and forty revolutions a minute, by means of a tele-dynamic cable, advancing about an inch per hour in marble. An annular space is cut in the rock, leaving a core, which may be utilized as a column. The diameter of the shaftway depends upon the diameter of columns most in demand, provided a sufficient number be sunk, and the intervening angles broken down, so as to afford sufficient room for the pulley carrier.

In the case of stratified rocks, the shaft-cuts are carried down to a natural parting; but in unstratified rocks a nearly horizontal cut may be made with the cord, sufficient inclination being given to insure the flow of sand and water to the bottom of the cut.

Such is the method of working practised at the Traigneaux