STORY OF THE CABLE.

Moving a Population with Strings of Steel.

A WONDER OF THE TIMES.

A Study of the Cable Roads of New York City.

Secrets of the Conduits and the Power Houses—Ingenious Devices on the Brooklyn Bridge Cable—Composition, Cost, Size, and Term of Life of a Cable—The Power Needed to Move the Cables in Broadway and in the Third Avenue—An Explanation of the Gripman's Duties.

Few persons in this town, or who have ever been here since the starting of the first cable road on 125th street and Tenth avenue, but have wondered what was going on beneath the mysterious slot that is the only evidence above ground of the car-propelling power. Since work first began on the Broadway and Third avenue lines down town the evidences of this public curiosity have been innumerable. Crowds watched the opening of the ground for the conduit, the carting and placing of the yokes which support it in the earth, the putting together of the many parts which go to the making of one of these modern marvels of street tramways, and afterward the carting of the great reels of cable and the stringing of this big wire rope through the length of the streets. Since the roads began running cars nothing which has occurred upon them the least out of the ordinary has been without interest. In the winter when their great snow sweepers go whizzing down the tracks they are a marvel to behold. Curious accidents, too, have happened upon the cable roads which never would have been bethought in the simpler days when we were all more than satisfied—even proud—of the progress made in substituting common horse cars for the slow and cumbrous stages of a bygone age. Runaway cable cars have gone sweeping with resistless force down our streets, overturning and crushing big trucks and filling everybody nearby with terror.

In the first days when the cars driven by this new motive power began moving upon our streets, even New Yorkers, who are little given to wasting money-making time in idle speculation, would stop and stare at the long lines of them moving in procession seemingly without an actuating force. Knowing as well as we did what in a general way was going on down in the conduit where the cable ran, and in the power houses where it was driven, still we experienced something of that feeling which an untutored man must have when he first comes face to face with the wonders of civilization. Our country cousins when they visit us still find the cable roads one of the novelties and mysteries of the great city.

And are these roads not truly a source of legitimate wonder? Is it not really wonderful that a man with scarcely an effort, by the mere turn of a wheel or the throwing of a lever, should be able to control to a nicety the movements of a car weighing tons and full of passengers, sending it now bounding along at running speed, and again making it crawl along slowly as the walk of a tired horse? Who has not watched the cable car gripman and wondered at the confidence with which he will run his car right up to the tail of a truck, follow it through all the intricacies of its movements in a crowded thoroughfare, and yet never touch it?

Who has not been upon these cars, too, at a time when the one he was riding in and all of its companion cars came to a stop; when the hum of the cable ceased, and the whole line was dead for the time? At such times the busy man, the man who wants to catch a train, or the simply impatient man asks nothing more than to know when the car will start again, but the more curious mind wonders what the matter is and how in the world any one along that whole line, outside of the power houses, is going to find out any more than he knows about the trouble. When things are running all right the ordinary person is content to get aboard, pay his nickel, and jump out at his destination. Like the traveller in a steam car, who knows in an indefinite way that there is a locomotive ahead of him, the street car rider is aware that there is a cable under him and that it will probably pull his car to his destination. Many who are more curious get seats in the forward end of the cars or stand by the doors and watch the gripman. If they are upon the Broadway line they see the gripman standing behind a standard with two horizontal wheels upon it. One of these wheels is bigger than the other, and the gripman seems constantly busy turning these wheels around in directions opposite to one another. Now there is a "clang," "clang," "clang" as a truck gets in the way, as persons cross the street in front of the car, or as the car meets another, and the gripman's left foot is seen to be working up and down upon a big iron button, the stem of which runs through the platform. As the car approaches certain places upon the road the gripman whirls his wheels rapidly, and you feel a jar from underneath and realize, perhaps, that the cable that was drawing the car has slipped away and the car is running along of its own momentum. These are the shifting places, where one cable or one part of a cable is dropped, and where further along another will be picked up.

WHAT THE GRIPMAN DOES.

Suppose that you were upon the Third avenue road on its up-town extension. You would see the gripman handling a couple of levers instead of wheels. He, too, has the knob of an infernal gong under one foot, and makes as much and as many noises with it as does his Broadway competitor. Some one signals to him from the roadway to stop. He grips the lever that his right hand rests upon, loosens a catch that holds it in place, and lets it go forward toward the dashboard of the car, and at the same time draws the other lever toward him with his left hand. A shiver runs through the car and you know that the brake is on. The two levers, like the two wheels of the Broadway car, connect, respectively, the one with the grip and the other with the brake. That much almost everybody knows. On the Third avenue cars the old-fashioned crank brake that grew familiar in the horse car days is also left, and is frequently used instead of the lever brake. It is a gentler one in its action. It would not be possible with that to bring one of these heavy cars to a full standstill from a speed of nine and a half miles an hour within the space of six feet, as can be done with the lever brake; that is, upon a dry track.

Now, however, you are nearing one of the throw-off points; one of the places where the one cable is to be dropped and another picked up, and the Third avenue gripman goes through some mysterious movements, which his brother upon the Broadway line is a stranger to. First he loosens his grip lever. Then probably for the first time the man who is watching him notices that low down beside the other levers is a third one which all the time the car was running before was depressed. This has a telescopic handle bar. The gripman pulls out this handle bar and raises it up. You feel something give away, and presently, as the car draws near to a warning green signal, the cable slips away, the gripman draws the grip brake freely toward him, and an inspector on the roadway peers in at the levers to make sure that the grip has been thrown wide open and the cable released. Now the car runs along to a red signal and is brought to a stop. The gripman stoops down, seizes a ring under his footing, and, raising a square trap door in the platform, looks inquiringly into the opened place. Usually he is satisfied at once and closes the trap door. Sometimes he has to fix something down there. Under that trap door is an ingenious contrivance, the invention of Superintendent Robertson, to insure the release of the cable. This and all the other mysteries of the cable will presently be described. The gripman has found this all right, we will assume. He draws up the telescopic handle of the third lever again, forces the lever down, and rings a signal back to the conductor that everything is all ready to go ahead. He has caught the new cable and closed his grip upon it, until it needs but the fraction of an inch more to make the grip catch and move the car. How did he do it?

THE CABLE ON THE BRIDGE.

If you want to form a clear idea of how some of these details in cable railroading are carried on, there is no better place to study them than upon the Brooklyn Bridge. Go to the Brooklyn end of it and walk in upon the footway. You will not be able to see the power house, for that is under your feet, but you can see the big steel cable where it comes in on its return trip from New York, drops at a slant from the south track, turns to the west again around two 10-foot sheaves, and then takes a dive over another of these big wheels into the engine room beneath. Look through a window in the house where this last sheave is and you will see the cable come up again a few feet further on, turn over still another of these great wheels, and ascend at a slant to the north track. Now move a hundred feet or more along the footway toward New York. The footway has risen until your eyes are about upon a level with the rails, just beyond the end of the outgoing passenger platform.

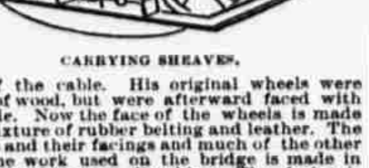
The cable is in plain sight, for it has risen upon a slant until it is now running over a lot of wheels which carry it up a foot, perhaps, above the rails. Stand there until an outgoing train is pushed along and see what happens. A Western man who had walked across the bridge the other day, and who watched the cars take the cable at this point for many minutes, turned finally to a bystander and said: "I have been pretty nearly all over the country, and I saw the World's Fair in Chicago, but I have never before seen anything so wonderful as all of these sights around New York."

The taking of the cable was not the least interesting of these things that he had seen. Before a train came he noticed that the wheels that the cable ran over were about six feet apart and that they were double wheels. The larger part of each wheel was that which contained the cable groove. Beside that was a smaller part with a flat face. Had he gone to the passenger platform he would have seen that each of these wheels ran in a frame, and that these frames were held up by spiral springs, strong enough altogether to hold the cable up with them. Now watch the train which is being pushed forward by one of the little bridge engines. As each car comes over the raised portion of the cable you see the cable caught between four wheels which form part of a curious structure under the centre of each car. You see the brakemen screwing up the grip brakes on the cars, you hear the click of the pawls in the brake ratchets, and you see the wheels that have grasped the cable begin to spin around with the cable. The cars gain speed, and as they do these wheels turn slower and slower until, when the train is going at the cable's speed, the wheels cease to move. Then perhaps you realize that the solid framework of the grip hung lower down than were the wheels that carried the cable where the grip caught it.

Wait for another train and you will see how ingeniously any collision between them is avoided. Running along below each grip is a steel shoe like a double-ended sleigh runner. As the grip approaches each cable sheave, this shoe strikes upon the flat part of the cable sheave and presses the whole wheel and its bearing safely down out of the way. The under part of the shoe is faced with rubber to prevent unnecessary noise. The shoe only presses down one wheel at a time, and the wheels are so close together that the cable between does not sag out of the line of the groove in the grip wheels.

THE BRIDGE GRIP.

The grip used upon the bridge is perhaps the best one in the world for the purpose. It is the outgrowth of an original designed by Col. Paine, and has been perfected by the present chief engineer and Superintendent Martin. There seems to be little doubt that it has saved many thousands of dollars to the two cities in wear and tear of cables, prolonging their life under heavy work to one and one-half or two times the life of cables on street railway work. It is, however, only suitable to the operation of an open road. It would take a slot about two feet wide in the street to admit it, and it would not begin to run in the width of a cable conduit. Col. Paine's purpose was to make a grip which should hold a cable securely while dragging full sized 25-ton railroad cars without having any sliding friction upon the



CARRYING SHEAVES.

face of the cable. His original wheels were made of wood, but were afterward faced with rawhide. Now the face of the wheels is made of a mixture of rubber belting and leather. The wheels and their facings and much of the other machine work used on the bridge is made in the bridge shops in Brooklyn. The facing is built up of alternate layers consisting of two thicknesses of rubber belting and one of leather, all nailed together with long wire nails. The leather is bevelled, and this serves to shape the facing to fit the wheels. An ingenious machine compresses the facing while it is clamped into the wheel. When you have watched the grip take the cable you wonder why the wheels don't go right on revolving and let the car stand still. Each wheel is hollow, and against its inner surface is a brake shoe of wood. It is upon these brake shoes that the pressure is applied which draws the wheels together upon the cables, and this is where the friction is which carries the car, instead of upon the cable itself, as it is in the street railway grips, which will be described later. The latest improvement in the grip device is one which makes it self-adjusting in taking its hold upon the cable. The frames which carry the brake shoes are drawn together by a toggle-jointed lever worked by chains and rods from the brake wheels on the car platforms. These frames are adjusted by means of a screw. When the face of the grip wheel wears down so that the frames need to come closer together it lets the toggle lever move further and further. At a certain point this lever touches another one, which, bit by bit as the brake is applied, turns the adjusting screw and keeps it always at the right place.

Now walk further along the footpath of the bridge until you can look all along the car tracks. Every thirty-five feet or so you see a carrying sheave or wheel upon which the cable runs, except under the cars, where it is held above them by the grip. This is the simplest form of a cable railroad. In street cable railroads all the devices which you have seen so far must be duplicated in their purpose, but many clever changes have been made to accomplish these purposes in the out-of-sight, confined space of a narrow conduit.

DIFFICULTIES IN STREET CABLES.

Another complication in street service arises also from the necessity of having in the conduit, and always ready for use, a duplicate cable. On the bridge, and in other open constructions of short distances, this duplicate cable may lie at one side and be lifted upon the sheaves by a suitable traveller when it is wanted, but this will not do for general purposes. The two cables must lie close together, too, in the conduit, not further apart than the width of the middle portion of the grip, and directly under the grip. Therefore everything pertaining to the traction arrangements of the road must be duplicated. In the Third avenue road, from the Bayard street station down to the Post Office and back a third cable was also placed in the conduit. This was one which ran at a slow rate and was used during the hours when trucks crowded Park row and the streets which crossed it, to enable the cars to crawl through without letting the cable slip through the grip, as would be necessary often with the faster one. The mechanical complications which the use of this involved led to many interruptions of traffic, and the use of the slow cable has recently been discontinued.

The conduit through which the cable does its work is an interesting structure, and it will be well to bear its general character in mind. As to details of construction there are almost as many kinds of conduits as there are of important cable roads, but all are alike in general features. The opening through which the cable runs is in all a horseshoe shaped steel tube open at the smaller section, where the heel calks of the shoe would come, and this is placed at the top. The sections of this tube are supported by cast-iron yokes, and these yokes also carry upon their outer edges the rails upon which the cars run, and other rails at the centre which protect the three-quarter inch wide grip slot. At intervals of 35 feet square pits of masonry are constructed in which the carrying pulleys are placed. It is over the entrances to these pits that you will see square iron plates placed along the line of every cable road. Each of these pits has a connection with the sewer to carry off the rain water that finds its way through the grip slots. They have other and important uses

POST OFFICE LOOP, THIRD AVENUE LINE.

besides. At night particularly you will see lights flaring about these manholes and down in them, and men working around and in them. Sometimes these men are the oilers, going from hole to hole, oiling the bearings of the two pulleys that are in each. On the long lines of the Third avenue road it keeps thirty-five men busy constantly doing nothing but oil these and the other line pulleys, and they use up about a barrel of oil a day.

MAINTAINING THE CABLE.

Other men will be cleaners. Small as the grip slot appears, it is remarkable what an amount of dirt will accumulate in the conduit through it. A considerable amount of the dirt that falls through this slot gets upon the cable and helps to destroy that costly part of the plant. Much of this dirt is afterward removed when the cable gets into the power house, as will be told later. The removal of the rest, which falls to the bottom of the conduit, is a tedious job. No contrivance can be attached to the cable to do this work because of the wheels which it would have to pass over. The only way that has yet been devised, is to scrape this dirt along with little hoes, like children's garden hoes, worked by hand through the slot above. Twenty-six men are employed in this work alone on the Third avenue road. The men begin at one wheel pit and work to the next one, always scraping in the direction in which the cable is running. The dirt falls into the wheel pits and is taken out of them in buckets. Where the tracks run close together the manholes opening into these pits are between the two tracks, and each one opens into a wheel pit upon either side, but where the tracks run far apart, as upon the Bowery, separate manholes are connected with each set of pits.

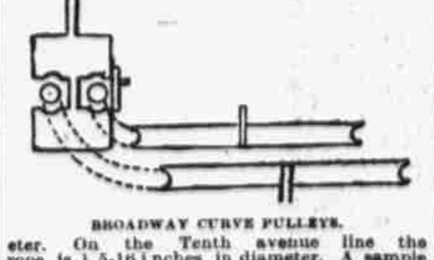
In the comparatively dull hours of the night you will see along the road other gangs of men at work by the light of flaring naphtha torches. Some of these are the "iron gang" making repairs to the metal work of the track at places where other roads cross the line, or at switches. Under the light cars of the horse traction days this special work, as it is called, used to last almost indefinitely. Now it is pounded out so rapidly that the Third avenue road is already beginning to replace some of their line, although the road has been running only a year. Other men are making general repairs to paving or replacing worn wheels in the conduit. These wheels last only about a year where a road runs its cables, as the Third avenue does, nearly twenty-four hours a day. One hundred and twenty men altogether are kept busy in these branches of work under the road master on the Third avenue road.

Every cable road, no matter how long it might be, must be divided into sections each not longer than can be operated with one endless rope. The two longest sections in this city are those of the Third avenue line, which reach, the one from Sixty-fifth street to Sixth street, and the other from Sixty-fifth street to 129th street. Each section is a complete cable road in itself. It must have its boilers, its engines, and its cables, with all their attending men and contrivances. The power stations may of course be duplicated, as they are at Sixty-fifth street and at 125th street and Tenth avenue, to work two separate cables, the one running each way. The two cables from the Sixty-fifth street power house are each about 36,800 feet long.

The Broadway line has until recently been operated in two much shorter sections, the one cable being run from the Houston street power house and the other from the house at Fifty-first street and Seventh avenue. About three weeks ago these two cables were spliced into one of 34,500 feet in length, and this is being operated from the Houston street plant. This was done to have the up-town power house free for alterations needed to fit it for operating the new Columbus avenue cable line belonging to the same company. This line will require a cable almost as long as the present Broadway single loop.

HOW THE CABLE IS MADE.

Now we come to the cable. Nearly all roads use one style in cables. They vary only as to size. This standard cable is built up like any other round rope of seven strands—six strands twisted about a central one. The cables used on the Broadway and Third avenue lines are each 1½ inches in diam-



BROADWAY CURVE PULLEYS.

eter. On the Tenth avenue line the rope is 1 5-16 inches in diameter. A sample section of this 1½-inch rope lies in one of the cable road offices. Examine it. In its centre the strand is made of manila. Around this and pressed closely into it are six strands, each made of nineteen steel wires. To vary the size of the rope the size of these initial wires is changed. The sample section is about eighteen inches long. Put it over your knee and try to bend it. It seems as stiff as a crowbar. Yet this rope of steel has got to go winding around drums and bending over pulleys, and twisting around curves. The manila centre strand helps it to do this by furnishing an elastic centre into which the steel strands can bed themselves, but the internal friction and the constant bending often destroy a cable faster than does the outer friction, and it is not an infrequent occurrence for the splicers to have a fair-looking rope fall to pieces in the centre when the strands are opened to make a splice.

This cable is one of the most expensive parts of the wearing equipment of a road. It weighs 3 6-10 pounds a foot, and costs about twelve cents a pound. A new cable for the Broadway road would, therefore, cost about $15,000, and about $16,000 would be the cost of each of the two longest sections of the Third avenue line. They wear very unevenly. On the Brooklyn Bridge, where six cables have been worn out, the greatest mileage has been got of them. Mr. Martin attributes this greatly to the superiority of the bridge grip. The bridge cable runs at higher speed than either of the street road cables, making 10½ miles an hour, and at the busy part of the day carries six 100-ton trains and their passengers over the heavy grades of the bridge. One of its cables lasted 1,140 days, and one only 350 days. The average life of the bridge cables has been about 550 days, with a mileage of about 160,000. Each cable carries about 50,000,000 passengers across the bridge before it is worn out, and the average load upon it is 220 tons.

The life of a cable upon the Broadway road and upon the upper part of the Third avenue's routes is equal to about 65,000 miles. Some have run 90,000 miles. On the lower section of the Third avenue route from Sixth street to the Post Office, over and around the many grades and curves there, 30,000 miles is an average life.

It will also be interesting to note the loads these cables have to pull besides their own weight. At the busy time of day on the Third avenue route there will be upon each of its long cables forty-six cars and trailers, making a load of nearly 700 tons, and on the Broadway line 105 cars with their passengers, making a load of about 735 tons. The power required to move the cable with these loads is about equal to 650 horse power on each cable. On the bridge, where the grip is released entirely when the cars are not in motion, and where the grip has roller jaws, the cable requires no surface lubrication. If a cable were run like that in a street road it would pretty soon heat the grip red hot and cut itself and everything it touched to pieces.

PREPARING THE CABLE FOR USE.

Every one has perhaps read of the threading through the conduits of the original cables—how they came to the power houses either entire or in sections in big spools weighing 40 or 50 tons, and are hung upon trunnions, and the ends drawn out and pulled through the ducts by 40 or 50 horses. Once through, and spliced into an endless band, you would think the cable was ready for work, but it is far from it. It is passed slowly around its course at first, and as it goes out of the power house, barrels and barrels of hot and melted wood tar are dripped upon it. The tar sinks into the cable between every wire and strand and finally fills it all until, smoothed by the rollers and sheaves it passes through, the whole length of it becomes a round and shining coil, not unlike an immense stick of taffy candy. Now it is ready to run, and, as it goes, linseed oil drips constantly upon its surface to lubricate it where it slides through grips and around curves. From time to time the tar coating has to be renewed.

One particular corps of men has nothing to do but to watch the cables and keep them in order. In each power house is a boss splicer and his assistants. At the Sixty-fifth street house, where two cables are in constant operation, the splicer has six men. At each of the other stations there are the chief and four men. Never for an instant does a cable move, day or night, but there is a man who does nothing but watch it. He must keep an eye upon it even when he eats his lunch, and he never leaves his seat during his watch without getting some one to take his place. Except when some actual splicing is to be done this is the sole duty of the splicer's assistants. At the least sign of a break it would be their duty to have the engines stopped and the duplicate cable put into service. Once a day the chief splicer himself must go slowly over each service cable and examine it foot by foot. Every night this is done on the Broadway road during the long hours when the cable does not run. Late travellers about the City Hall will remember that every night about midnight or later half a dozen teams of horses appear there and haul the Third avenue cars around the loop from in front of the *Times* building and back. There the cars get a cable again. Many have wondered why this was done, and usually suspect that some accident has happened. Nothing has happened, except that only one of the cables that goes through this part of the line turns about the outer loop, and that one is being overhauled and inspected. It is that cable which runs all day, and as soon as it has been

THE THIRD AVENUE GYPSY SHEAVES.

looked over it will be set to running again. Meantime the cars are run by the duplicate cable, which makes a plain turn within the loop and not around it, and the horses have to be used.

Even with cables it takes a lot of horseflesh to keep such a road running. For trucking sand for the tracks, for wrecking wagons, switching, and such purposes the Third avenue line still keeps nearly 200 horses, and expects to need 150 right along.

THE GREAT CABLE PLANT.

Now let us look at the mechanism which has taken the place of the rest of the horses and that moves the cable and its loads. In each power house are long rows of boilers from which the power emanates. In the Sixty-fifth street house there are thirty-two of these, at Bayard street sixteen, and the Houston street plant of the Broadway line has twelve. In the Broadway power house there are four engines, each of 1,000 horse power. It is one of the boasts of their engineer that not only are the engines duplicated for the service, but that every part of each engine is in duplicate, so that sixteen combinations can be made to meet the emergencies of accident.

The greatest of all cable plants in the country is the one at Sixty-fifth street, where the Third avenue line has four 1,500 horse power engines. Every engine is kept either at work or ready for it. For overhauling cables for examination there are small engines. The cable drums are not driven directly by the engines. In the earlier plants the engines were connected to the driving drums by geared wheels, but these lacked elasticity, and now the plan in general use is to connect them by many endless belts of cotton rope, each belt working in a separate set of grooves in the pulleys.

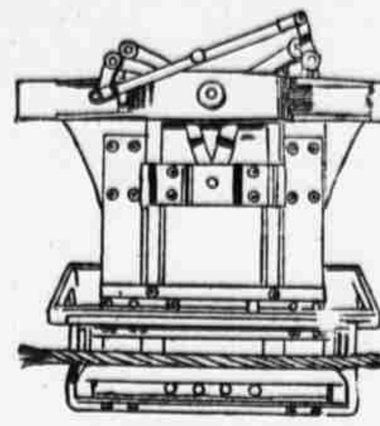
In each of these engine rooms in this city provision has been made also for the making of easy and rapid changes in the machinery. At the Sixty-fifth street power house this room is free from columns, and a great trussed crane travels the whole length of the room upon elevated tracks at either side. Across this truss travels a lifting carriage, which can pick up thirty tons of weight, and by means of the double motion of the truss and its own tracks move its load to or from any part of the room. Each engine and the cable-driving drums to which it is connected are set quite close together, and appear to the uninitiated to be but one machine, as it is in effect.

Extending beyond the side of this ponderous machinery, where it shall be easy to get at and to watch the cable, are the driving drums. There are two of these on each machine, and sometimes power is applied to both of them and sometimes only to the one nearest the street. They may also vary in size. At the Sixty-fifth street house, where the cables are to be driven through the conduit at a speed of nine miles an hour, each of these drums is sixteen feet in diameter. In the face of each of them is a series of V-shaped grooves, in which the cable runs. It is always the incoming side of the cable loop that runs directly to the drums, and this is wound about the two drums, going from one to the other to make each coil in three and a half or four complete turns. Except that the journals of the two drums may be braced together with a strut at the outer ends, there is no connection made between these drums except by the cable, and in order that the cable may pass from one to the other in concentric coils these wheels are not in the same plane, but the rear one is inclined just enough so that the cable, which has entered one of its grooves directly from a groove of the first wheel, shall be rendered at the other side into the next groove of the first drum. Between the drums where they run nearest to each other is a brass scraper which fits into each of the grooves in both wheels. This scrapes out and gets rid of a lot of the dirt which comes in on the cable.

THE TIGHTENER TAKES UP SLACK.

Now let us follow the cable as it leaves the drivers and see where it goes and what devices are necessary to guide it in its journey to the end of its section and back. As it leaves the drivers in the Sixty-fifth street house it starts in the direction of the street, but before it gets there it must pass over one of the most important bits of all the mechanism. This is a tightener. It consists of two great pulleys. One of these is simply an idler, but the other is mounted upon a carriage which is drawn back by great weights. The purpose of this device is so take up any slack length in the cable and to keep it at all times tight enough not to kink and leave its guiding pulleys. Solid and firm as a cable seems, when it is first put under strain it begins to stretch, and in about a week one of the 36,800-foot lengths of the Third avenue road will lengthen out about fifty feet. This is about the length of a splice, and if the first splice is not wearing well, this piece is cut out, but if the splice is good, this is not done where the traveller still has room to work. At Sixty-fifth street the traveller will take up 300 feet.

Another purpose of the traveller is to give and take under the inequalities of the loads and the changes in the length of the cable due to differences of temperature. Only one coil of cable goes over the traveller, and from there it goes



THIRD AVENUE GRIP.

to the big sheaves under the street which turn it into the conduit. These wheels are in great vaults under the street, and at night are lighted, and one can peep down into them through the grip slot and see the wheels go around. These wheels being below the grade of the conduit are set at an angle and from them the cable rises just as we have seen that it does on the bridge, to a height above the regular carrying wheels, and high enough for the car grip to take it.

The wheels over which it turns at this point and the similar ones at the end of its route and again where it is about to go to the drivers again are called gypsies. These will be described after we have examined the grip and its action. Meantime we will follow the cable. It goes merrily along on its journey, now riding over the wheels in the pits along the conduit and singing with the hum of a great hive of bees. If it is to encounter no curves nor crossings, it meets with nothing else until it comes to another set of gypsies and dives into another big vault. This is the end of its section. Here it turns around a wheel, usually as big in diameter as the distance between the grip slots in the up and down tracks, and goes over an exactly similar route in the return conduit. If this be not at the end of the road, but between sections, as at Sixth street, on the Third avenue road, the vault under the street will contain four of these great wheels, which in this vault are fifteen feet in diameter. Two of these turn the pair of cables which work from Sixty-fifth street down, and the other two those which operate the road from the Post Office up, working from Bayard street. On the up-town cable, at 125th street, provision has to be made to cross the cable road on that street. At such crossings one cable must go clear under the other road. The Third avenue cable does so here by means of four wheels, as shown in one of the cuts. At such places the car must release the cable, of course, and run over the intervening space by its own momentum, and there are gypsy wheels on each side to enable it to release and take the cable again. Many devices have been made, such as sprocket chains and teeth on grips, to carry cars from the places where they must release one cable to where they can take another, but in practice it has been found in this city, at least, that none were needed. The cars can float over, and at most places this is helped by putting the changing places upon slight down grades.

The Broadway road used to use horses to carry their cars over this gap at Houston street, but have found that even in Broadway a little care would enable them to float the cars over.

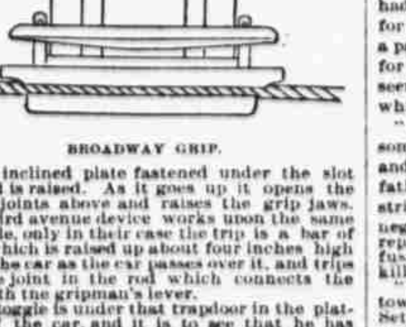
DIFFICULTY AT CURVES.

Curves are the curse of cable engineers. At every bend in a cable road, no matter how slight, you will see the iron covers of vaults on the inside of the curve within the tracks, and these cover sets of horizontal wheels which must be placed not more than five feet apart from centre to centre the whole length of the curve. Clear around Bowling Green, on the Broadway line, these wheels extend, and the Third avenue loop at the City Hall has got wheels in an almost continuous row from in front of the *Times* building, down and back. These curves will be spoken of later.

We are ready now to examine the grip—the thing of mystery, which, actuated by a wheel or lever, connects or releases us from that constantly running cable beneath the street.

There are many kinds of grips in use, but those of the Broadway and Third avenue lines are representative types of the best for double-cable roads. These two grips differ not at all in principal and but little in detail. Each has a cable clasp upon either side, where it grips the wire rope between smooth jaws of hard steel. When the jaws are not closed and the car is not being hauled, the cable is simply sliding over the lower jaw of the grip. Spool rollers have been used in a hope of reducing this wearing friction, but have been found of little use. From one set of these jaws flat steel plates, a little less in thickness than the width of the grip slot, go up and are bolted into a frame fast to the truck of the car. Another set of these plates carries the moveable jaws, and is connected at the top with a lever or a set of levers which move them up and down. A third set of these plates moves a pair of A shaped pieces which raise up and force the cable out of the jaws. In the Third avenue grip it is the lower set of jaws which moves. In the Broadway grip the upper set moves.

There are slight grooves in the jaws of the grips, and when a car is merely stopping along the road it is only necessary to open the grip jaws a little bit to let the cable slip along in these, while at the same time the grooves prevent a chance of its jumping out. When it becomes necessary to release the cable entirely, the jaws must be opened wide. A failure to do this has cut a cable right in two more than once, and in any case it will make a kink that is sure to break soon, besides wrecking the grip. To avoid this chance each of our roads has an automatic grip opener. That on the Broadway line includes a part of the grip. Just above the movable jaw is another piece of metal with tapered ends. It is hung upon the jaw's supports and moves up and down with it. Two plates are connected to it, which run up to the upper part of the grip, where by levers they are connected with toggle joints in the arms of the movable grip jaws. If the gripman opens the jaws in time this plate goes up with the jaws, but if he does not, it runs upon a



BROADWAY GRIP.

similar inclined plate fastened under the slot rail and is raised. As it goes up it opens the toggle joints above and raises the grip jaws. The Third avenue device works upon the same principle, only in their case the trip is a bar of steel, which is raised up about four inches high under the car as the car passes over it, and trips a toggle joint in the rod which connects the grip with the gripman's lever.

This toggle is under that trapdoor in the platform of the car, and it is to see that he has safely passed the trip that the gripman raises that door. There is also another toggle joint in the grip rod. This is worked by the sliding armed lever which we have seen the gripman use at the cable-shifting points. The lever which he uses for starting and stopping—the one in his right hand—only moves the grip jaws a fraction of an inch. The one in his left hand works a brake. When the cable is to be released is when we see the gripman lift the third lever, and he lets it remain lifted until he reaches a taking point again, when he presses it down to close the jaws of the grip until the cable is just held in the groove. On the Broadway line it is the bigger, lower wheel that the gripman works to move the grip jaws, and the upper one for the brake. He has only to work his wheel around more times to open the grip wide, but it takes more time than with the lever system. This is also true in stopping and starting. The wheel system is easier for the men, but slower. The Third avenue grip has two levers, either of which works the jaws, and these are connected directly to the levers by the rods in which the toggle joints are. The Broadway grip has but one lever, and the connection with the ends of the car is made by an endless band made of rods joined by chains. These chains run around sprocket wheels under the platforms, and the sprocket wheels are geared to smaller wheels on the end of the grip-wheel rods.

HOW THE GRIP TAKES THE CABLE.

Now, with our grip wide open, we are ready to run out a car and take the cable. The gypsy wheels which make this possible are as much alike upon our two roads as are the grips. There is, of course, one of them for each cable, the running cable and the dead cable.

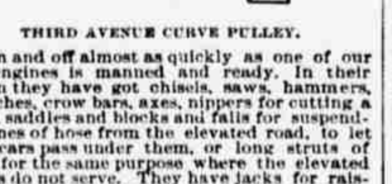
Here in outline are those of the Third avenue system, with all the detail of actuating machinery and bearings left out. Each wheel is carried in a binnacle bearing. In their normal position it will be seen that the wheels are inclined toward each other until the two cables which they carry almost touch. In use one would be blocked back to where the dotted lines are. Here it would be out of the way of the grip, and, of course, the cable it carries would be to one side, too. Now for the other. It is held in place by a weight, and the cable is at the height of the grip opening. Before the grip can get to the cable to start, it must pass the gypsy. Almost at the moment when the grip would be against the gypsy, a flange of the car wheel has run over a movable tongue in the rail slot and forced this down, and a lever connected with that has tipped the gypsy back out of the way until there is a clear space of fourteen inches between it and its neighbor. The grip passes, the gypsy wheel falls over to its place and lays the rope nicely into the jaws, the gripman pulls his lever, and off we start.

In the Broadway road the gypsy wheel lies normally in the out-of-the-way position, and is forced into place by a lever which the side of the grip engages at the proper time.

Fixed, open gypsies take the cable out of the grips at the end of sections. The carrying of cables around curves, especially where a second cable has to be provided for in a single conduit, is the one problem which the cable-road engineers have not yet solved with satisfaction. Who does not know how the Broadway cars go whizzing around the double curves of the road at Fourteenth street and Union square. The curves are reversed here, and the gripmen have orders not to stop or loosen their grips, except for the most serious reasons. This is because of the danger of having the cable pulled out of the grip and of losing it. The Third avenue people have come nearer solving this problem, and any one who travels much on their road will remember that they stop or slow up on curves as well as on straight track, but they also seek to make clean runs upon these objectionable pieces of track. In the earlier times of the Broadway road they had lots of trouble with the live cable at curves getting in the wrong place and tearing across the dead cable. The difference between the roads at these curves does not seem to account for this. Each of them uses a plate around the whole face of the curves, against which the grip slides, and it is this plate which Superintendent Robertson of the Third avenue road says keeps the cable in its place, if it happens to be the inner one that is in use. The outer one of course would stay in anyway.

THE CABLE WRECKING WAGONS.

At various places along the lines of our cable roads we see big red wagons with teams harnessed and men in waiting. What are they waiting for? In the old horse car days it was a well-known and handy trick of a driver to jump his car off the track anywhere, drive it jolting over the pavement, and get around any obstruction. Fires, broken-down trucks, and all such matters could only hinder, but not stop him. Cable cars don't jump. Whatever obstructs their traks has got to be removed or they stop right there. These are the wrecking wagons, and they are waiting for the signal of trouble. Listen! A sharp-voiced gong is ringing in the office. We shall not tell you just what number it rings, but it means, fire! The men are on the



THIRD AVENUE CURVE PULLEY.

wagon and off almost as quickly as one of our fire engines is manned and ready. In their wagon they have got chisels, saws, hammers, wrenches, crow bars, axes, nippers for cutting a cable, saddles and blocks and falls for suspending lines of hose from the elevated road, to let their cars pass under them, or long struts of wood for the same purpose where the elevated tracks do not serve. They have jacks for raising broken-down trucks and a lot of other things. But one wonders how it was they got the signal that sent them away.

SIGNALLING FROM A CAR TO THE POWER HOUSE.

Walk along the tracks of the Third avenue road, and at the north side of every evenly numbered street, and at about the same distances apart down town, you will see beside one of the wheel-pit plates a small iron plate, oblong, and about 1 foot by 8 inches in area. Under every one of these is a signal instrument connected with the main office by electric wires. You will see a square nut sunk in the face of the lid of this box, and every gripman, when he gets his badge to begin work, gets a wrench with which to open this box. Both he and the conductor have books of rules which tell them just what to do in cases of emergency.

There is a signal to start the cable, go slow, all right, fire, send wrecking wagon, grip stuck, car wheel or axle broken, and pedestal or box broken. He finds a handle and pulls that up as many times as his signal requires. The gong rings out the number in the office as he pulls it, and when he turns down the handle to replace the cover the gong rings automatically the number of the box. There is another set of wires running from each of these boxes. These connect with a telephone in the office. If the wrecking wagon men find that they need help or instructions when they get to the scene of a call they open the box, screw on a connection, and talk to the office through a telephone, which forms part of every outfit.

This system was put in when the road was built. The Broadway road found the need of one when the runaway cable swept Broadway, and have since put in a signal system of about the same kind. This signal system alone cost $25,000 on the Third avenue road. Every wagon has its district to cover, and it is remarkable how quickly it will relieve a block upon a road. Broken-down trucks are the most frequent cause of trouble. Sometimes a lot of these getting into difficulties about the same time will cause a load of trouble.

Superintendent Robertson recalls a day when one car, with, of course, all those behind it, was delayed 1 hour and 20 minutes on a round trip. At Ninety-second street an ice wagon broke down in front of it, at Forty-second street a truck loaded with barrels got stuck under the elevated, in its way, and at Chatham square a five-ton coal truck broke in front of it on the track. At such times cars are switched over at the ends of sections, and local traffic is kept up by that means.

Perhaps the device which Mr. Robertson of the Third Avenue road is most proud of is the life saver recently illustrated and described in THE SUN. It is the only one of his inventions which is not patented, and since THE SUN's story of its good work Mr. Robertson says it would be worth at least $25,000 in the market. It has been in use too long to patent, and is open to the public. The principle which gives it value, Mr. Robertson says, is not so much in its form as in the fact that it lies back as far under the end of the car as possible, and thus gives the gripman a chance to check or stop his car before the fallen person is struck by anything which can crush him.

HIS CASE WAS AN EXCEPTION.

Too Worthless to Have the Benefit of an Unwritten Law of the South.

From the Chicago Daily Tribune.

"I was once detained for two weeks in a small town in middle Georgia," said a well-known Chicago drummer, "and while there witnessed an extraordinary trial. Old Seth Hawks, a character of the village, was one of the most ornery cusses that lived. Nobody ever saw him work, and it was more than suspected that all his harvesting was done in other people's fields while they slept. Still, he was too foxy to get caught. Most of his time was spent in saloons, and he had a knack for getting drinks without paying for them. He was a tall, lanky fellow, without a particle of spirit, as his neighbors supposed, for he was indifferent to kicks, and nothing seemed to trouble him except a shortage of whiskey.

"Old Seth had a daughter, and a very handsome girl she was; but she was densely ignorant and fully as lazy and good for nothing as her father. Bill Stukes, a young man of the same stripe as Hawks, ran away with the girl and neglected to marry her. Seth insisted that he repair this omission, and upon the positive refusal of Bill to do so, borrowed a shotgun and killed him outright.

"This tragedy took place before I reached the town; but, as I have said, I attended the trial. Seth had no money to pay an attorney, and was so dratted worthless that no member of the bar felt like defending him for nothing. When the case was called the Judge assigned him counsel in the person of a bright young lawyer who did not deem it necessary to make much of a defence, as it is an unwritten law down that way that the nearest of male kin shall kill the violator of family honor. The Public Prosecutor made the tamest sort of a fight, because from time immemorial juries had acquitted offenders of this class. Every one looked for the prompt and honorable discharge of the prisoner, who throughout the trial, which lasted but a few hours, chatted merrily with his counsel. The Judge's charge was brief, but the most extraordinary one I ever heard. He said:

"'The prisoner at the bar only followed a well-established precedent, but I fail to find an instance where so worthless a rascal as he presumed to take the law in his own hands. While by no means denying the right of a father to vindicate the honor of his family, even to the taking of human life, I think it would be establishing a dangerous precedent to extend the duty and privilege to men like the prisoner. The dead wretch richly merited his fate, and had Hawks used a gun that shot aft as well as fore his memory might have been kept green by his fellow citizens. As it is, gentlemen of the jury, it is clearly your duty to bring the prisoner in guilty of murder in the first degree.'

"The jury did as it was bidden, and a week later old Seth was hung, the Judge allowing that an ornery fellow like him didn't need much time for preparation."

LEXOW SCENES AND FACES.

THE SETTING OFTEN AS INTERESTING AS THE INQUIRY ITSELF.

Mr. Goff Assisted By a Corps of Detectives and "Experts" in Crime—The Variety of Witnesses—Uncle Dan'l Bradley a Feature of the Inquiry—The Spectators.

The theatre in which the Lexow drama is produced is often as interesting as the drama itself; or, a better illustration, the supernumeraries are frequently as interesting as those who have speaking parts. The committee meets in a lofty court room sixty feet long by forty wide. The committee never sit on the Judge's bench, to the left of which and on the same level is the witness chair, and further to the left, as they sit, is a long reporters' table; also on the left are the raised and enclosed chairs provided for the jury, but which, in this investigation, are occupied by reporters and newspaper illustrators.

Directly in front of the bench a narrow space is railed off, which has for regular occupants the official stenographers and Father Ducey. Chairman Lexow's father frequently sits in there, and other distinguished visitors have chairs placed for them there. In front of this rail are two long tables, one end of which, that opposite the witness chair, is occupied by Mr. Goff and Mr. Moss, and the rest of the space is used by reporters. The latter, with their illustrators, number between thirty-five and forty. To the right of the bench is a square space within the rail which divides the bar from the bench, and here the female witnesses and personal friends of the committeemen sit.

Running the full length of the bar, between the counsel table and the spectators' seats, are two long rows of chairs where Mr. Goff's agents and detectives and male witnesses sit. Outside the bar the space is packed with a mixed crowd, friends of the witnesses, friends of the individual policemen who are being investigated, and curious idlers who, on one pretext or another, succeed in passing the doorkeepers. There are always many witnesses in attendance who are never called. If the cafés with girls are being inquired into, twenty, thirty, or perhaps more proprietors of such east side resorts are subpœnaed, although only half a dozen may be put on the witness stand. So it is with stoop line soda fountain keepers, with keepers of disorderly houses or inmates of such houses, with Bowery and Park row lodging house keepers, with policy shop keepers. When the clubbing policemen were being made a show of, ninety were called but less than a dozen questioned. So it is that whatever disorderly, and frequently criminal, class is supplying evidence the witness chairs hold from thirty to forty witnesses; but they are not all that go to make up the general "toughness" of that part of the crowd.

Mr. Goff has a number of expert witnesses and gatherers of evidence. These are green goods men, policy writers, police court sharks, bunco steerers, and men who "do the best they can," as they describe doing any petty criminal act that promises a profit. These men find a profit just now in selling this information to Mr. Goff, and using their special or "expert" knowledge of crime and criminals in assisting the counsel for the committee in preparing evidence. They are a decidedly unpleasant lot of instruments, but even Mr. Goff's enemies have not condemned him for using such tools as the work demands for accomplishing results.

"Young men eminent only in Sunday school work wouldn't put Mr. Goff onto much that is new about green goods, cafés with girls, or police court bail bonds," remarked one observer.

Into this crowd, chiefly foreign, generally criminal, mostly unwashed, and invariably unpleasant personally, are wedged now and then gentlemen—merchants, steamship agents, and others—who are so unfortunate as to possess information the committee wants. They look frightened first, then disgusted, and finally unutterably bored. They had so much rather read the newspaper accounts of the proceedings than hear them first hand, shouldered on one side by a man who keeps a seven-cent lodging house on Chatham square, and is bathing the carpet at his feet in tobacco juice, and on the other, perhaps, by a negro who is to go on the stand as a living picture of "What it looks like to be clubbed." Many of the witnesses can neither speak English nor understand it, yet their breathless interest seems never to wane. Except as to the women, these, the foreigners who cannot speak or understand English, sit in their allotted space sullen, solemn, silent, sometimes for day after day. They wait until they are called to testify, and then go to the witness stand much as if it were the fatal chair in Sing Sing, take the oath as it is interpreted to them, wonder vaguely, perhaps, what "By resolution of the Senate of the State of New York, with amendments thereto," can possibly have to do with their wretched lives, and then tell just so much as the ingenuity of counsel can corkscrew out of them, and no more.

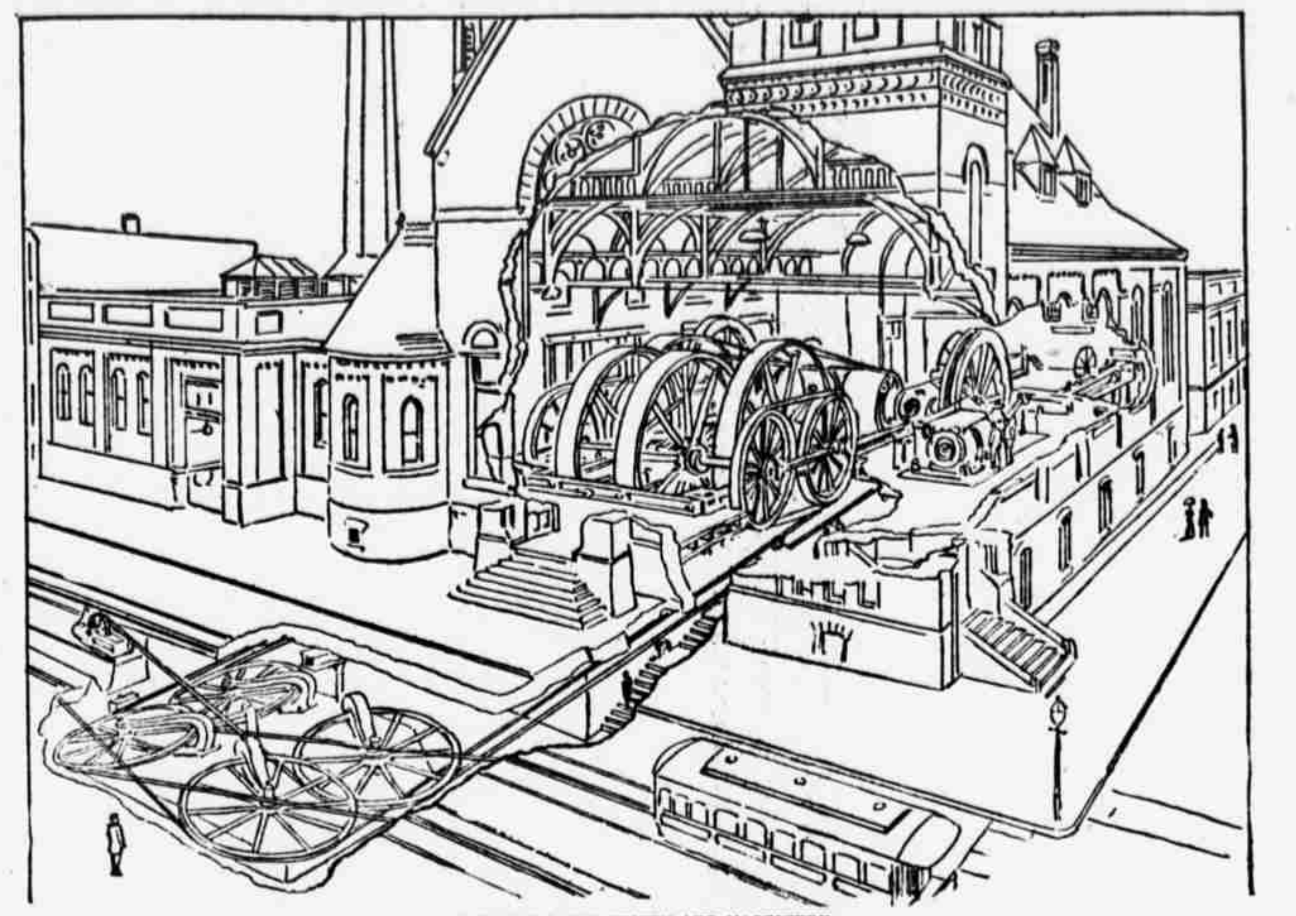
The oath is administered by Chairman Lexow, but it is a function in which Uncle Dan'l Bradley, whose chair is next to the witness, figures and shines to his satisfaction. He always handles the Bible. If the witness is a Jew, Uncle Dan'l opens the book at the Old Testament, calls the attention of the witness to that fact, and then says, "Kiss the Bible. Sit down." This *obiter dicta* seldom being interpreted, the witness usually regards Uncle Dan'l with alarm, but with no understanding. If the witness is a Catholic Uncle Dan'l produces a Bible with a cross on the cover, and he always regards with suspicion the witness who kiss their thumb, as it holds the book, instead of the book itself.

In examining a witness Mr. Goff is aided by the one of his detectives who has worked on the case under investigation. These detectives, as distinguished from the experts, are a cleanly and intelligent lot of young men. They in turn have been assisted in each case by one or two "experts," and it is plainly seen that the amount of detail thus gathered and placed at Mr. Goff's disposal is the means of inducing witnesses to speak candidly. They see that their examiner has much information, and he is clever in impressing them with the belief that he has much more than he actually has; so they decide that it is useless to attempt to conceal anything. Any one who likes to study comparative morality or, say, comparative backbone, as opposed in the sexes, will be interested in learning that it is the men, not the women, who soonest and most frequently weaken under Mr. Goff's familiar bluff of knowing it all, and wanting the admission of the witness for purposes of record only. An ignorant woman can prevaricate more cleverly, more consistently, more persistently, and with a better appearance than a well-educated man. It was a gentleman—that is, a well-educated, well-bathed man—who was first bluffed from his attempts at concealment by the production of a paper from which Mr. Goff pretended to base his questions. The paper happened to be a catalogue of new music which the counsel had been asked to procure by a member of his family.

The committeemen frequently take a hand in the examinations. Uncle Dan'l's methods in this respect would be excellently adapted to driving spikes through an oak knot, yet they frequently succeed. Uncle Dan'l probably knows the human natures he is dealing with better than any other Senator on the committee. Chairman Lexow is clever enough, but he is a bookish man and given to asking involved questions, with the predicate, German-wise, concealed at the end of tortuous clauses. If the witness speaks English he usually has no idea of what the question is all about, and if it is a foreign-speaking witness the interpreter is usually in the same unhappy case, and asks something in Turkish, Hebrew, jargon, and Slav, and answers "yes" or "no," as the spirit moves him.

Senator Pound has a good sense of proportion. He chafes when Mr. Goff is elaborating some unimportant point to tenuity, and sometimes breaks in with a pertinent question which discloses matters of importance which otherwise would remain hidden. Senator O'Connor contents himself with comments calculated to impress New York with its wickedness, and on the rare occasions when Senator Saxton is present his remarks illustrate his pious horror of everything he hears. Senator Cantor likes to puncture Senator Dixon's political bubbles as fast as they are blown from the Chairman's pipe. The Chairman does not know New York politics as well as Mr. Cantor, and sometimes aims a rap at Tammany which should be applied in another direction. Then Senator Cantor gently, firmly, sets him right, and smiles as he does so. Senator Robertson says nothing.

The crowd in the spectators' seats is made up of police court hangers-on, ex-policemen, small politicians, with a sprinkling of more decent material, men who have a reasonable curiosity to see the actual operation of so notable an investigation. Many of them stand five and six hours, their open mouths and staring eyes showing how deeply they are impressed by all they hear and see in the process of exposing the seamy side of life on Manhattan Island.



A SINGLE CABLE SYSTEM AND MACHINERY.