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About aerial ropeways and their latest application for passenger transportation.

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I take it for granted that on the whole you are informed about the principles of Aerial Ropeways, let me begin by telling you about the Aerial Ropeways history.

It can be traced back as far as about 1500 years, when a kind of ropeway was used in China for crossing rivers; about the material forming the carrying organ we are not informed. Heusinger von Waldeck detected in an old book of the Vienna library a description of a ropeway constructed in the year 1411. Thomas Beck reproduces in his work: "Historical Essays on the construction of machines" a ropeway constructed by Marianus Jacobus Taceola. This ropeway most probably was doing service for a fortress, as a kind of mortar (big gun) was transported by it (See Fig. 1). The system was a very simple one. The mortars had to be brought across the moat of the fortress. Between a tree on one side and a peg fixed in the ground on the other side a rope was stretched, to this rope a mortar was hung by means of a ring. To the tree a block with a roll has been fixed, over this roll passes the pulling rope; one end of the latter is tied to the ring carrying the mortar, to the other end of a rope, which also runs over the moat, horses or oxen are harnessed. As the animals go further inland, they draw the mortar over the moat, as the ring, by which the mortar is suspended, slides over the stretched (carrying) rope.

It seems that this means ot transportation was chiefly used in the construction of fortresses for carrying building materials; for Buonacinta Lorini gives a description in his book: About Fortresses, which appeared in Venice in 1597. Ten years later appears in the same city a book of Faustus Verantius, who describes an aerial ropeway for transporting persons as follows:

To a thick rope a trough or basket (See Fig. 2) shall be suspended by rolls, a thin rope is stretched alongside, and the latter, when it is strained, draws those, who are inside the basket, across without any danger.

In the year 1644 the Dutch engineer Adam Wybe constructed what was then the most perfect ropeway for the building of the fortifications of Danzig. This plant must be considered the beginning of the present SINGLE ROPE SYSTEM. By means of a

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horse-capstan the put into motion an endless hemprope, to which were fixed the buckets. The rope ran over rolls fastened to strong wooden piles; on that side, on which the full buckets were drawn, a greater number of piles was provided.

Of course all these plants were of a very primitive nature and as only hemprope s were used, they could only serve temporarily. Not until the Mining Director ALBERT invented the wire rope, could the aerial ropeways enter into a new phase of development.

Still several decades had to pass before the value of the wirerope as hauling cable and carrying cable for aerial ropeways was recognised.

At first single wires and iron rods were used, mostly in the mountains, for transporting lumber, minerals etc. down hill. The load was attached to a saddle, sliding along the wire. As a hauling cable did not exist, the load rushed downward finally at a terrific speed. To take up the shock buffers were constructed mostly made of faggots.

As saddle natural wooden forks cut from the trees served. They could stand only one ride, in many cases they were destroyed already during the journey. Until the present day such plants can be found occasionally.

In the year 1861 Mining Director Baron of Duecker constructed the first aerial rope-way using one wirerope as carrier and one as hauling cable, in 1867 an Englishman Hodgson built several plants in England according to the system invented by the Dutchman WYBE mentioned before and took out a patent for this SINGLE ROPE SYSTEM.

The Duecker System was adopted henceforth by several other parties, in Germany in the first place by the two engineers Bleichert and Otto, to whom credit is due for the further development of aerial ropeways. They created new models and principles, which proved so good that some of them are existing up to the present day. In 1876 those two engineers separated, Bleichert started an office of his own at Leipzig, Otto at Skeuditz. Later Otto associated himself with the engineer Pohlig of Cologne. Also these two gentlemen separated again after some time, at the present time these three firms work independently from each other. In England Hodgson had a continuously growing success, his system was improved in 1890 by Roe, for Roe used special saddles for fixing the buckets to the carrying rope, (See Fig. 3) whereas hitherto the buckets had been fixed rigidly to the hauling rope. The principle was similar to the wooden saddles mentioned above. Roe provided however the inner surfaces of the saddles with a notch, which entered tightly into the space formed by the single strands of the wirerope. (See Fig. 4)

In America at first exclusively aerial ropeways according to the Hodgson System were built by Halledy, however the three rope system having become afterwards perfected for transporting large loads, nowadays only this system is applied.

France used exclusively only the three rope system. A single rope system invented by the Parisian Etcheverry did not turn out well, under this system the cars could be detached, but the rope was gripped all round by clamps. (See Fig. 5)

Spain used the single rope system besides the 3 rope system for the reason, that on account of special climatic conditions no ice is formed upon the rope; else a safe working is not altogether sure, as the cars can slip.

At the time, when ropeways were in a state of development in other countries as shown before, Italy's industry was suffering from the after effects of the formation of a united kingdom after many battles, but even in this time there were men, who clearly recognised the immense importance of this new contrivance for transportation especially in a country rich with mines like Italy. At first the engineers followed the track of the old masters, but little by little they developed their own ideas and produced new and independent inventions.

In the eighties the Italian Engineer BELLANI constructed a single ropeway, which he perfected into a special system with the assistance of Ceretti & Tanfani. Soon however it was found out that this system as well as all other single rope systems was not suitable for the steep Italian mountains, especially as in winter the ice and snow produced ice on the rope and made work an impossibility. It was decided to create a hauling organ and a carrying organ. For the traction stranded ropes were used, just as to-day, but the manufacture of the heavier carrying ropes was not yet so advanced and besides very expensive. A solution was found by using simple round iron, which was annealed soft iron. For clutching the rope mostly a screw clamp was used, which had to be opened and closed by hand. For putting in, or taking out a bucket or carriage, every time the whole plant had to be stopped. The usually quite light carriage had to be lifted by hand from the one carrying rope, put on again to the other carrying rope, coupled to the hauling rope and then it returned to the loading terminal. During this time the same operation had to be done with the carriages passing the loading terminal. Therefore distances between the single carriages had to be exactly the same. It is evident that such plants are of a small capacity only. After a shorter or longer interval the round iron got torn so that the whole plant or a greater part of it was always laying on the ground. By and by the economical conditions of the mining concerns improved, a larger capital was at disposal and then existed here and there a demand for a more perfect although more expensive system. In Germany in the mean-time matters had developed to such an extent that one actually could speak of a wire-ropeway. The round iron had been replaced by a suspended carrying wire-rope. However the Coupling Apparatus was not quite perfect yet, as the coupling had to be effected by the hands of a very skilful workman. Inclinations above 30° could hardly be overcome.

Here Ellingen first constructed "Knot-rope-device" following the idea of a simple quarry master. (See Fig. 6) Steel knots were either twisted into or pressed upon the hauling rope in distances suitable for the distances of carriages. In this way any high gradients could be taken, also the coupling of the carriages was more or less automatic, but the knots fixed to the hauling rope destroyed it in a comparatively short time. The shocks when coupling the carriages and the passage of the knots around the sheaves impaired the strands in the immediate neighbourhood of the knots so severely that the position of the knots had to be altered every fortnight. Therefore this system was used only at those places, where people were forced to adopt it in consequence of very steep gradients.

In the meantime the Engineer Obach of Vienna, constructor of ropeways for transportting lumber in Hungary, found a new apparatus the so called UNIVERSAL GRIPPING APPARATUS, which did away with most of the existing disadvantages. By means of his apparatus inclinations up to 45° could be taken without danger. The coupling and uncoupling of the carriages was effected nearly automatically, the operator pushed forward the carriage at the coupling station and then the gripping apparatus caught hold of the hauling rope and closed automatically, at the uncoupling station it opened by itself, released the hauling rope and the operator received the carriage. This picture shows a traverse section of a coupling apparatus simplified by the engineers Ceretti and Tanfani, Milan, and representing their "Standard" coupling which is cheaper than the Obach apparatus.

"e" and "h" are the two grip-cheeks "e" remains always fixed and "h" is movable. (See Fig. 7). "e" "o" "i" is a lever, which is wedged upon the spindle "a", at the end of which is fixed a counterweight, producing the gripping force. The spindle "a" possesses two threads, a small angle A and a sharp angle B. The lever turns 120°, the sketch shows the apparatus in opened state. If the lever "o" is turned, two movements are administered to the loose cheek "h" in the same direction towards the fixed cheek "e", a slow one by the thread "b" and a quick one by the collar "lc" The latter is provided with two inclined surfaces A-B, upon which are sliding the corresponding inclined surfaces of the cheek "h".

The loose cheek is prevented from revolving by two pinions, which connect it with the fixed cheek. On each of these pinions a roll is placed, which serves to keep the rope in the proper position. As the cheek cannot revolve, it must shift its position sideways. The collar "l" - "e" is forced to turn by a square of the spindle "a". The gradient of the inclined surfaces is so great that the loose cheek moves to the rope. This is effected by the turning round of the lever by only 30 degrees. Then the small angle thread B alone operates and the cheek "h" presses the rope tightly, whilst the lever turns through the other 90 degrees. For uncoupling the lever is turned in the opposite direction, the cheek goes back by the pressure of the spring "g" and the rope becomes free.

With Obach's System the spindle "a" is provided with a steep thread in analogy with "b", thus the backwards movement is effected by this thread. The spring is thus abolished. The disadvantage against the C. & T. construction is that this latter thread as well as that of the spindle and that of cheek had to be milled. In the course of time the diameter of the hauling rope becomes smaller in consequence of wear especially in the beginning and the apparatus must be regulated accordingly, viz. the loose jaw "h" must be moved nearer to the hauling rope otherwise the turning angle of the lever of 120 degrees would become greater. This however is not permissible as the lever would go too far down and eventually the discoupling operation could not be effected, which again might be the cause of a serious accident. With C. & T's apparatus the regulation is done simply by filing off at the sides and thus elongating the square "c" of the spindle, then the nuts "m" and "n" are tightened.

The POHLIG Apparatus also adopted the Obach System, however the pushing forward motion is effected by a threaded adjusting ring placed before the loose cheek. These two apparatus work very well if carefully attended to. Its disadvantage is that it needs adjusting as mentioned before. Besides the hauling rope is sometimes of smaller diameter at the splicing place, therefore when the coupling is done at these places an accident can happen by putting the lever too far down, thus eventually preventing the uncoupling. Therefore the manufacturers of the three rope system have endeavoured to find another apparatus. Mr. Spitzeck, a fitter of the firm of Bleichert, was the one, who transferred from the single ropeway to the three rope system the principle used by Bellani, Roe, Beddington and Etcheverry to exerce a pressure on the rope by the load's own weight. However Mr. Spitzeck did not possess sufficient theoretical knowledge to perfect his idea and profit by it. For pressure he used the load's own weight without applying any further mechanical contrivance to multiply the gripping force. With the Spitzeck construction only very small inclinations could be overcome. Bleichert used and perfected Spitzeck's invention as the first in the field, he constructed the loose cheek as the double armed lever, its shorter arm produced the pressure upon the rope and the other longer arm was acted upon by the weight of the load. Thus the gripping or closing force became a multiple of the loads weight. Thus the greatest inclinations could be overcome without danger. It must be mentioned however that at greater inclinations the longer arm of the lever becomes unproportionally long. Some years later C. &. T., Milan, invented their so-called IDEAL APPARATUS, which also is based on the principle of using the loads weight for pressing. In the following I shall give you a description and point out its special and undoubted advantages against the apparatus operating with levers.

The principle involved is again that of grip on the hauling rope by means of jaws, one jaw rigid, the other movable, the coupling comprises four essential parts: (See Fig. 8.)

the wedge A;
the jaws B;
the frame C;
the rollers D;

The gripping is accomplished by means of the wedge, which is forced vertically downwards by the weight of the carrier itself, the release is effected by the upward motion when the carrier is transferred to the suspended rail on entering a station; the wedge A consists of two integral parts, lower and upper, the former has four sliding surfaces, which correspond with grooves in the frame, and a socket for the hanger pivot; the latter has a slot, in which revolves a small wheel, which engages the movable jaw in such a manner as to propel it towards the rigid jaw and so grip the cable, when the wedge falls, and to recede from the other jaw, so releasing the grip, when the wedge rises.

The movable jaw B embodies the slot, in which the wheel is set.

The frame C has four grooves acting as guides f r the wedge A and another slot or horizontal guide for the fork of the movable jaw B, also two openings to permit of the upward or downward movement of the pivot d. (See Fig. 9).

The rollers D are mounted on the hanger spindle d, and at the moment of coupling or uncoupling, they engage the rails set for the purpose and also cause the raising or lowering of the carrier.

Sometimes the pressure of the jaw B is transmitted by a lever.

Our device acts in the following manner:

To couple the carrier to the hauling rope, all that is necessary is to mount the runners D on the lower rails built with angle irons in such a way that the frame of the wheeled car is held by the reversible counter rail, preventing the uprising of the car.

The wedge A rises with the runners D, thus causing the revolution of the wheel and consequently the propulsion of the movable jaw at the same moment the hauling rope comes, by means of the upper part of the wedge, between the jaws; then as the rail curves almost against the bottom, the fall of the pivot and of the wedge A is brought about, and, the movable jaw, approaching the rigid jaw, grips the cable.

Uncoupling is accomplished likewise by means of rails.

The important advantages of the Ideal Appıraratus are: at first the parallel shifting of the loose cheek. In the use of the angle lever such shifting is not the case, the lower part of the rope is squeezed more tightly than the upper part. Therefore a deformation of the pressed parts takes place easily. Yon can form a good idea of this by comparing the advantages of the parallel vices against the old screw-vices. Another very great advantage is that the IDEAL APPARATUS is self-locking, which means that even by applying an immense force, it would not be possible to open the apparatus except by lifting directly the sliding piece, to which the load is suspended. Tne inclination of the fork is chosen so that the angle formed by the direction of the hauling and the perpendicular drawn from the centre of the rollers upon the sliding surface is smaller than the friction. If therefore the weight of the carriage is reduced by any outward cause or neutralised entirely, with the angle-lever apparatus the pressure of the cheeks ceases; the apparatus does not grip the rope any more and the coupling slides along. Such a thing is impossible with the IDEAL APPARATUS, as the pressure invariably remains the same, as long as the roll "a" is not lifted directly. A discharge of the sliding piece is possible in certain cases. If the carriage f. i. is to be unloaded on the line by contact, when heaps of rock or ore are to be formed outside cf the mines, by unloading the carriage also the carrying rope will be freed suddenly from pressure, the carrying rope will jerk upwards quickly and intermittently. By such a jerk the effect of the loads own weight upon the gripping apparatus will be diminished and in some cases can be neutralised entirely.

In the use of the angle-lever apparatus cases have actually happened that the rope jumped out assisted too by the wedge shape of the clamp. Also when passing horizontal curves, where the rope is often drawn somewhat out of the guide pulley, it may happen that with empty cars such a pressure is produced that the clutching jaw opens itself, if the apparatus is not provided with automatic closing device.

I should like to mention here that this disadvantage exists also with the screw clamp used by some firms. This screw clamp is also acted upon by the carriage-weight, but its thread cannot be made selflocking as otherwise the movable clamp cannot be shifted sufficiently.

A natural advantage is, that with the IDEAL APPARATUS the rope is always pressed at the same degree, whether the carriage is passing a great or a small inclination. It would be the most practical thing if pressure were to become stronger at a great inclination and less strong at a small inclination. With the angle-lever apparatus just the contrary is the case.

Now kindly inspect this model of the "IDEAL APPARATUS" here. If the carriage is suspended perpendicularly, it means, the apparatus is running on a horizontal track, and the pressure upon the sliding piece will be the greatest, viz. will be equal to the load. At an inclination only the component acts in the direction of this pressurestamp as pressure force, whereas the other component is taken up by the guide. The first mentioned component becomes the smaller, the greater the inclination is. As the IDEAL APPARATUS is selflocking and as the coupling to the hauling rope is done in the station, which means at a time when the carriage is in perpendicular position, the result is that the pressing force remains always at its maximùm value at any point of the ropeway line. But with the angle-lever Apparatus the proportion of the lever arms must be such a one that the pressure of the jaw is of such a degree that it prevents a sliding of the carriage even on the steepest inclinations. At an inclination of 45 degrees the proportion of the leverarms has to be as much as 1: 6 or 1: 7, which means the long leverarm has to be very long and the pressure upon the rope is very considerable at less inclined points. On the other hand the IDEAL APPARATUS keeps at all inclinations the same outer and compact shape gets easily and with absolute safety over any existing inclination, grips the rope easily and evenly and in no case loses the grip of the hauling rope. There is no need to regulate the apparatus from time to time.

The gripping apparatus may well be called the main part of a ropeway, as in the first place the satisfactory working of the ropeway depends on its good working. Of course all other parts have to be constructed also correctly and by an expert. Secondly the layout is of greatest importance for the satisfactory working of the line and its upkeep.

The drawing, which you see here, represents the profile of the AERIAL ROPEWAY on the KOYASAN; this ropeway is erected on the CERETTI & TANFANI principle.

The ropeline is composed of concave and convex curves, sometimes the line is also straight. One must endeavour to maintain a constant pressure of the ropes upon the posts as far as possible, further to keep the bends in the convex curve within a certain limit. The rope-pressure is produced by the rope's own weight, the tension and by the car's loads weight.. In concave curves the posts may be placed at a great distance between each other as in consequence of the rope's natural suspension the pressure is smaller than in convex curves.

Naturally also the car-load and the sag caused by it need to be considered. The car-load and consequently the sag of the rope between two posts influence also the length of the rope suspension shoe. Thus 3 coefficients determine the lap out of the line and the length of the suspension shoe. Generally one constructs in convex curves the angles upon the posts, when the rope is unloaded, not larger than 5%, this means, the trigonometrical tangent of the angle formed by the linear tangents of 2 rope spans at the supporting point must not exceed 0.05.

The manufacturer must endeavour that at a convex point the pressure upon the single posts within this curve must be the same as far as possible and then it is necessary that the supporting points for the rope are situated in a parabola - this necessitates that the distance between the posts is the same.

In the concave curves, the so-called "valley" curves, one is forced to make use of great spans as otherwise the standards on these places become very high. The greatest span constructed by the firm of Ceretti & Tanfani amounts to 1600 meters, as far as I know the greatest span ever constructed in a regular ropeway. The plant in question is built in Northern Italy and serves to transport lumber. As I mentioned before, the carrying ropes are tightened by counter-weights, thus the tension should even under the greatest spans not exceed that of the counter-weight itself. If however the carrying rope has to change from its normal position (without carrying cars) into its working position (carrying cars), it has to overcome the frictions of the supporting shoes, not only of those placed on the posts forming beginning and end of the single span, but also of all those, from the post in question to the tightening station. As now especially with great spans the pressures on the supporting points are rather considerable, the tension is considerably augmented.

A further addition consists in the tension caused by the dead-weight, when differences of level are to be overcome. Therefore it is necessary that for greater spans a special control calculation must be made. It is obvious that the outer posts must be of especially strong designs, if the spans are great.

The places marked A and B are intermediate stations constructed only on account of the carrying rope. About every 2000 meters the carrying ropes should be tightened again. The ropes of the KOYA SAN ROPEWAY are anchored on the upper LOADING station. These ropes are tightened at A. Here are also anchored the new carrying ropes which commence here, and these are tightened again at B. In order to construct the Unloading station at Hidemachi as simple and short as possible the last sections of the ropes are tightened at B and anchored in the Unloading station. The tightened-counter weights here have now also to counteract the ropes' own weight and therefore have to be heavier than the weights of the other sections where the tightening hauling strain coincides with the direction of the ropes' own weight.

The diameter of the carrying rope, on which the goods are brought downwards, amounts to 25 mm, whereas that of the other rope (carrying rope) for "hauling upwards" amounts to only 21 mm. The safety factor of the carrying rope is abt. 5 and of the hauling rope 8. Under these conditions, provided that the carrying rope does not leave the post, the hauling rope can never pass over the carrying rope. The hauling rope is driven from the loading station by a 36 H. P. Suction Gas Plant. 30 H. P. are required only, if loaded cars are exclusively to be transported to the top and if nothing is to be transported downwards. However usually the bulk of cargo will go downwards and to a certain degree the ropeway will work automatically, or eventually the power has to be braked. A brake is provided for this purpose on the mainshaft. Later on an accumulator battery will be provided and the surplus power of the suction gas plant will be used for illumination purposes. The hauling rope will be tightened at Hidemachi in the unloading station, by means of a counterweight. In consequence of the great spans a great allowance for tightening length was required, it amounts to 8 meters. The slide-car of the tightening device sometimes moves as much as 4 meters during operation, the other 13 meters are necessary for the natural extension of the hauling rope respectively for elongation caused by differences in temperature.

On every station are sidetracks for spare carriages or for carriages, which are to be repaired: Both terminal stations are executed in wooden structure, whereas all parts on the track, as posts and tightening stations are made of iron. The height of the largest post amounts to 28 meters. As carriages the ordinary buckets are used, for heavier loads or trunks of lumber tandem platform carriers will be used.

Generally the ropeway will carry provisions and materials required for the villagers on top of the Koyasan, luggage of the pilgrims etc., downwards it will transport charocal, koyadofu, trunks of lumber, cut timber and cut boards, luggage of the pilgrims. There is no doubt that the undertaking will prove successful as at present over 50 horses and over 200 coolies are continuously occupied in transporting the goods; by using the ropeway the transportation rates will be considerably cheaper and the provisions therefore cheaper too.

There is also a plan to transport passengers by this ropeway; this is technically possible. Some plants combining the transportation of goods with the transportation of passengers do exist, f. i. in North America for crossing the KLONDYKE PASS in ALASKA and in South-America the Chilecite Ropeway. The firm of C. & T. has built among others a number of ropeways for transporting materials to the top of mountains, where fortresses are to be built, and military officials make use of this conveyance in especially constructed cars. As far as my knowledge goes there has never been an accident.

Of course for the transportation of the public at large such plants are not sufficient, for this purpose one used until recent years funicular railways, rack railways, which latter are executed in Switzerland to the number of hundreds. These installations were very costly and in many cases did not yield a sufficient income. Since the invention of the car-brake and special rails the funicular railways had however been simplified by Bucher Düker so that the costs of construction became much cheaper. Untill B. D.s invention the funicular railways consisted of two cars, the one of which was hauled upwards, the other one simultaneously downwards, but now the whole track is made single-railed and in the middle a double track station to serve as crossing station. Thus the permanent way as well as the groundward are considerably simplified. Consequently in a few years the number of funicular railways has increased considerably and even smaller undertakings, which transported per year only 30,000 persons yielded a profit, provided that the natural conditions of the place did not present any special difficulties for the ground-work. For most of the places, in which a comfortable means of communication was desired, the building of funicular railways was impossible on account of difficult local conditions. We have in Europe and certainly also in Japan places secluded in the mountains, to which only under the greatest difficulties provisions and materials can be brought and which the inhabitants perhaps only leave once in a years time in order to come again into touch with the rest of the world. Here was a field for the aerial ropeways, whose cost of construction besides was cheaper by 1/3 to 1/2 against the expenses connected with the funicular railways. And here it was the firm of C. & T. who first of all were enterprising and courageous enough to undertake the construction of aerial ropeways for the transportation of persons. There was a sort of ropeway however already under construction invented by a German Engineer Feldmann and brought into execution by Swiss Engineers. This was on the Wetterhorn in Switzerland, but the ropeway consisted only in one single span, connecting the highest with the lowest point, posts were missing entirely.

In 1907 Messrs. C. & T. handed to the Bernese authorities the first application for an aerial ropeway to transport persons according to a new construction invented by them. The place was the Monte-Bré near Lugano.

This system contained all safety-devices prescribed for funicular railways. To these safety devices I shall revert later on The Officials of the Swiss Department for Communications refused at first to give a concession for this plant as so far a sufficient number of working results had not been obtained.

Messrs. C.& T. did not become discouraged, for in the meantime many other projects for the same purpose had made their appearance. Those with the greatest prospects for realisation were (1) the LANA-VIGILJOCH ROPEWAY in TIROL in Austria and (2) the MONTBLANC ROPEWAY near CHAMONIX in France. It will interest you to hear that these two projects as well as two others have actually come to be executed by Messrs. Ceretti & Tanfani.

The Austrian and French authorities studied the system proposed by C. & T. thoroughly, an experimental ropeway was built, and most extensive tests were made mainly with regard to safetybrakes, but also for oscillations of the cars under the influence of strong winds, for the reaction of the coupling under sudden shocks etc.; the final result was that the authorities in both countries gave the required concessions without restriction.

I would like first to explain the system itself and then I shall give a description of the two ropeway projects.

Let me mention here, that Ceretti & Tanfani had for years been constructors of funicular railways and thus from these well tried plants could derive a great practical benefit with regard to hauling safety and braking devices, which could be applied for the new ropeways for transporting persons. Now for the description of the system, 2 carrying ropes, one on each side are stretched between the two starting points of the ropeway. These ropes are also supported by the shoes bedded on supports. Over the ropes two cars run, one on each side, so that the traffic is an alternate one. The cars are drawn by a hauling rope, which passes over the power sheave on top of the mountain and around the stretching sheave at the foot of the mountain. The rope is therefore endless in opposition to the funicular railways, where two ends of the rope are fixed to the two cars; the former arrangement has the advantage that the cars are conducted in a much better way and further that the driving sheave requires less grooves, as the rope's own weight is balanced on both sides. Besides the hauling and the carrying rope we have the so-called brake-rope, which holds up the car in case the traction rope breaks. This brakerope also runs around rope sheaves in the upper part of the plant, these rope sheaves can be connected with the main driving gear by means of toothed wheels. In the lower station the brakerope passes over an expanding disc operated by spindle. In ordinary cases the brakerope is firmly anchored in front of the expanding disc by means of large clamps, so that the rope can be moved only within the limits of its elasticity, which are determined by the material and the tension. The brakerope is supported by the posts and is placed not on rolls as the hauling rope, but on shoes. However every shoe is provided in its middle with a small roll of 3cm ϕ. If the brakerope is in a tightened state it is exclusively supported by this small roll, in the ordinary state it rests on the whole length of the shoe. The brakerope is further supported by the car as it runs over two rolls fixed underneath each large roll of the carriage. These rolls are fitted with leather and can be adjusted by a screw. Between the rolls the safety brake has been placed. I shall describe the construction of this later on.

In the upper station the brakerope is not anchored by means of clamps as in the lower station, the reason being that, if the brake has to act suddenly, the shock is much less, due to the elasticity of the rope itself, as it is possible to use the elongation of the rope from the other side. The driving pulley and the shaft are of such large dimensions that they can take up any possible shock with safety. The carrying ropes are firmly anchored in the upper station by means of steel sockets fixed to a tension frame. Before this anchoring device clamps are fixed to the rope; these are kept sideways by two anchors, which are also attached to the above mentioned tension frame. Therefore the anchoring of the carrying rope is a double one, each calculated for 10fold security. In the lower station the carrying ropes are also fixed by means of socket to Multi-link Chains, which run over chain wheels and are fixed to the other end of the stretching weight. Also here a double fastening is provided, as sideways from the chain two flexible steel ropes are running which are fixed to the carrying rope before the chain also by means of screw clamps in the same way as safety rods in the upper station. On the other side they run around the stretching weight. Each part is also constructed for a 10fold security. The pull of the carrying ropes is taken up in the lower station by an iron stand. The construction of the ropes is the so-called HERCULES construction. It is a so-called spiral rope with strands, instead of the single wires of an ordinary carrying rope, strands of 7 wires each are here provided. The material is best crucible cast steel of 165 kg. breaking strength per sq. m.m. The diameter of the carrying rope for the MONTBLANC Ropeway is 65mm. and for the VIGIL-JOCH Ropeway 60mm. The Hercules construction had been chosen as by this means the rope could be made in one continuous length without any sockets, for the latter never really give any guarantee for absolute safety. Eventually the so-called lock coil rope could have been used, which would have had the advantage of an absolutely smooth surface. But the lock coil ropes breaking strength does not at present exceed 120 kg. per sq.m. m. Further the mounted ropeways have always to overcome a certain height and therefore the rope's own weight is of great importance and the loss of resistance is therefore greater by one third with the locked coil rope than with ordinary round wire rope. Besides it is very difficult to detect a breakage of wire in the locked coil rope as there is very little free play between the broken wires and this space can be made invisible by the lubricating material. The broken wire of the Hercules rope however will protrude in a certain length and the faulty end can be cut off if disturbing the passage of the car. As the carriage is provided with double and very large carriage rollers even with the Hercules rope a perfectly smooth running is obtained. The locked coil-rope was said at one time to be proof against rain, but also this is not true, as one can see on examining a section.

All ropes have to be lubricated regularly with special lubricating fat or oil, which enters the spaces between the strands and then hardens. The single strands of the Hercules rope are varnished and the intermediate spaces are filled up with tar. The locked coil is by 50% more expensive than the HERCULES ROPE.

The hauling rope and the braking rope are executed in the ALBERT-LAY, this means that the wires are wormed in the same direction as the strands (contrary to the so-called cross-lay). The durability of ropes executed in the ALBERT-LAY is greater, but they get somewhat untwisted, if suspended; however this point needs to be considered only during the setting of the ropeway. Nowadays an Austrian Company, ST. EGYDYER EISEN & STAHLINDUSTRIE GESELLSCHAFT, WIEN, the same which manufactures the Hercules ropes, has developed a new process for making ropes in the Albert-Lay without any spiral twist. These are the ropes C. & T. have chosen for the MONTBLANC and the VIGILJOCH Ropeway. The diameters of the hauling and braking rope are 30mm and 32mm respectively. The standards of these ropeways are of iron and executed in the so-called obelisk shape. (See Fig. 10) The head carries on both sides the shoes for the carrying rope, underneath are placed the shoes for the braking rope, and still further down on special brackets the rolls for the hauling rope. The posts are fixed into concrete foundations by means of 8 foundation screws. At a wind-pressure of 250 kg, per sq. m. for an unloaded line and 125 kg. for loaded line the stability is calculated with a twofold factor of safety. Calculating the dimensions the materials will stand a pressure of 1500 kg. per sq. m. at 250 kg. wind pressure, and at a wind pressure of 12·5 kg. they will stand a pressure of 1200 per sq. m. In both plants the height of posts varies from 6.5 meters. to 23 meters.

The upper station generally consists of the station platform, the engine room and the waiting room. According to the electrical power used a room for the transformators or a room for the accumulators battery etc. must be added as required. The station building itself can be constructed of wood or wood and plaster or, and this is to be most recommended, entirely of bricks or stones.

The lower station consists of the platform, the room for the rope stretching device and the waiting room for the passengers. Mostly the lower stations contain also a cashier's room and a small restaurant in the waiting room.

In the intermediate stations an upper and a lower station are combined. These are arranged in such a way that the changing of cars for the passengers is very easy. i. e. without special stairways. At a certain length of the track it is absolutely necessary to provide intermediate stations as on account of the great difference of height such big dimensioned ropes would have to be used that it would be impossible to mount them. The main reason is however to double the efficiency of the line. Besides, for many passengers it is necessary to stay a little while at the intermediate stations on account of the lessening density of air in greater attitudes. Besides all Swiss funicular railways, where the track exceeds 1.5 km. are provided with intermediate stations. The MONT-BLANC Ropeway, which has a length of more than 3 miles, possesses 4 intermediate stations, the VIGILJOCH Ropeway one. Long tracks, where the inclination is not so great, may be suitably divided by so-called stretching stations, where only the carrying ropes are interrupted, whereas hauling and braking rope are continued. In the stretching stations the carrying ropes coming from down below are firmly anchored, whereas those proceeding to the top are stretched. Montblanc Ropeway has two stretching stations for the first two sections. If the local conditions permit that these stretching stations are placed in the middle of the line, the stretching stations can suitably be built as stopping places for the cars. The two cars meet exactly in the stretching station, which is constructed entirely of iron. The MONTBLANC Ropeway has two such stations, which are at the same time combined stretching and stopping stations.

I now beg to describe the arrangements in the stations and have chosen those of the Lambana Fai Ropeway, which is one of the simplest type, but the system of which is the same as that of the Montblanc and Vigiljoch Ropeways.

Construction at the lower station. (See Fig 11) Here the track is solid and firm as the carrying rope is supported by the straight steel shoes, which rest upon iron frame work. Therefore no vertical up and down oscillations are possible, when the passengers enter or leave the car. The lateral oscillations are prevented by special devices which can be shifted off and on. The staircases of the platform are abt 6 feet wide, their inclination is parallel to the carrying rope so that the difference in height between the bottom of the car and the staircase remains unaltered, no matter on which place of the platform the car stops. The stopping place of the car can differ considerably on account of the alteration in the length of the hauling rope due to the effects of the varying temperature. As I mentioned before, the ropes are stretched at the lower station. The carrying ropes are connected with the end sockets made of best crucible cast steel. The stretching weight for the carrying rope amounts to 20000 kg. The breaking strength of the chain amounts to 200000 kg which means 10fold security.-The same security is given all other parts in connection with the carrying rope. The other end of the chain is connected with a rope carrying the counter weight. The counter weights consist of single plates of reinforced concrete reaching into an excavation, which is also made of reinforced concrete. Between two such excavations, which are 18 feet deep, is a connecting passage, from which the stretching weight can be always observed. The pull on the ropes is taken up in the foundations by means of a great iron frame work, which carries stretching weights and also carries all the sheaves for the hauling and braking rope. The safety of the foundation is double. The stretching device for the hauling rope consists of three great horizontal sheaves, the first two are guide sheaves, the third a return pulley. The hauling rope is stretched by stretching weight, the return pulley is guided by a slide and slide guide. The sheaves are of considerable diameter.

The stretching device of the braking rope is placed above the device for the hauling rope. The arrangement of the sheaves is the same, only they are smaller as the braking rope will scarcely be moved. The braking rope is stretched by means of a stretching spindle, giving to the braking rope a tension of abt. 2000 kg at the beginning. As mentioned before, the braking rope is intercepted by clamps fixed on both sides. These are inclined on an iron frame and the shocks, produced by the sudden intercepting of the car, can never be transferred to the sheaves. The room containing the tightening device is perfectly closed, so that the general public can see nothing of it but the ropes leaving the room. The entrance and the exit are of very broad dimensions. Sufficiently large room is provided before the car-stand for natural extension of the rope and for bringing the car into working position. The station buildings of the VIGILJOCH ropeway are executed in Tyrolian style and those of the MONTBLANC ropeway are executed in very simple style. Besides the waiting room with restaurant, a terrace and a W.C. are provided. Entrance and exit are separated, the arriving passengers leave first and those, who wish to travel, are admitted afterwards.

The upper station. (See Fig. 12) The platform is constructed in the same way as at the lower station, only that there are as many stairs as the length of the car requires, as the car always stops at exactly the same place of the lower station. However also here is provided an empty space of abt. 10 ft. in order to be able to brake the car automatically in case the driver is careless. The ropes are here also bedded on shoes resting upon an iron frame work.

The carrying ropes are first lead over cast steel shoes along the framework horizontally and are anchored tightly at the other end of the station by means of sockets to a double stretching frame. The stretching frame transfers the whole pull on to the foundations, which are built with double security against any lifting or shifting. Before the anchoring again heavy steel rope clamps are mounted, from which extend laterally two tie bars, also anchored to the stretching frame. If the socket by any outer reason allowed the rope to free itself, then still always the clamps would remain in their position; for instance the lightning might melt the composition of the sockets and bring about this condition. The hauling rope is conducted at first over two large vertical sheaves and passes from here to the large horizontal main driving sheave and the return sheave. The latter two are fitted with leather, in order to spare the rope as well as to add to the friction. The diameters are 1500 x diameter of the wire. The driving toothwheel is fixed directly to the sheaves rim so that the shaft is not subject to torsional stress. All tooth wheels have cut teeth. The vertical main driving shaft is driven firstly by countershaft, on the foot of which is placed the large con'cal driving cone wheel of cast steel. The second horizontal countershaft is driven by the motor, through a pair of double helical wheels made of cast steel and cut according to the system Wuest. The gearing ratio of these wheels is 1:5. The direct current shunt wound motor of VIGILJOCH rope-way makes 650 rev. p. m. and gives 51 HP. normal, but is built to stand an overload of 25% for half an hour and for a few seconds even to 100%, According to the calculation the greatest capacity required will be 68 HP, the normal capacity 35 HP. A flexible coupling has been inserted between the motor and first tooth gear, in order to meet irregular load and smaller shocks. On the motorshaft a chainwheel is placed, corresponding with the chain wheel of a handwinch.

By means of this handwinch the cars can be brought into the station, if the electrical plant should be out of order or the current fails. The current is direct current of 550 V. tension. (The current is conducted from the valley to the top as threephase current of 2000 V. by a cable and is transformed into direct current. As the consumption of current is calculated according to the maximum required, an accumulator buffer battery has been provided for.) The drive of the braking rope is the same as of the hauling rope. Motor, horizontal and vertical countershaft serve also for driving the braking rope. For this purpose a clutch coupling is provided on the vertical countershaft, this clutch coupling gets into action as soon as the braking rope comes into use. Between the main pulley of the braking rope and vertical countershaft is inserted a further vertical toothwheel. The large driving toothwheel is fixed directly to the rim of the main driving pulley in the same way as mentioned in the description of the hauling ropes driving gear. Driving pulley and return pulley have only 5ft. diam. as the driving gear will be hardly used for anything else than the pulling upwards of the carrying ropes during the erection of the plant. The normal speed of the braking rope is abt. 2 ft. and of the hauling rope 7 ft. per sec. All horizontal sheaves are placed on the iron frame work in such a way that a free space remains between floor and frame

Very important parts of the driving gear are the BRAKES. Altogether 4 brakes are provided, the two mainbrakes are placed on the main counter shaft, which revolves at a speed of 130 r.p.m. There are two block-brakes. One of these is automatic, the other one has to serve during the operating of the plant and is put into action from the engineers stand by means of spindle and handwheel. The automatic brake is worked by a counterweight. It becomes engaged (1) as soon as the normal speed increases from 7 ft. to 8 ft. per sec. (2) if the cars in the upper station are passing beyond their normal final position in consequence of the drivers carelessness (3) this automatic brake can also be operated by the engineer himself. Its effect is so strong that the cars under full speed can be braked on a distance of 7 ft. to 9 ft. On the horizontal shaft above the brake-pulley a spring-regulator is placed, which at a speed of 8 ft. on its peripherie drives a pin outward so much that it touches a lever; by this device the counterweight of the brake becomes disengaged and the brake is engaged.–The same operation is effected if the cars proceed beyond the extreme point of their stopping place, a lever is touched and its movement is transferred by guide rod and rope. Finally the brake can be engaged from the engineers stand by means of lever in connection with pull rod.

The third brake is a handbrake, placed on the vertical main driving shaft. This brake is put into action by hand, using handwheel and spindle. The handwheel is placed quite near to the engineers stand. The purpose of this brake is to brake the hauling rope and thus also the cars, in case a toothwheel has been broken between the horizontal countershaft and the vertical mainshaft.

The fourth brake is an electro-magnetic brake, placed upon the motorshaft. It acts, if the current is interrupted by the controller or any other cause. Its power only goes as far as to brake the whole hauling rope driving gear with safety although requiring a greater distance to pull up the car. It also serves to assist the engineer, and keeps the driving gear braked, if during a stoppage of the plant the handbrake should be disengaged.

Further instruments are: an indicator, to indicate the position of the cars, a tachometer to measure the speed of the hauling ropes, and an amperemeter. The instruments are placed near the engineers stand, other electrical instruments are placed on a switchboard. The intermediate station consists, as mentioned already, of a lower and an upper part; the stations are placed besides each other so that the crossing can be done easily. The current for driving the intermediate station of the Lana Vigiljoch Ropeway is conducted by means of cable from the upper station to the lower station.

THE CARS: (See Fig. 13) The car consists of three parts: the carriage, the hangers and the compartment. The carriage is mostly made of cast steel, the carriage running wheels are carried by a special frame of profile iron. They are guided in slides in vertical direction to the rope and are controlled by springs, which are compressed by the cars weight. If a wheel by any reason tends to lift itself from the rope, the spring acts at once and presses the wheel so long against the rope until the nave of the wheel has reached the lowest position of the slide. (See Fig. 14) Underneath the rope, counter-rolls are placed so much below at a normal position of the carriage that they pass easily underneath the ropeshoe fixed to the posts. If a running wheel eventually gets lifted, the roll approaches the carrying rope until the running wheel has reached its lowest position in the slide. The distance between rope and counterroll then has become such a small one that the rope cannot slip through sideways any more. The most important part of the carriage is the safety brake.

It is placed inside the carriage frame. It is a double brake, this means on a breakage of the hauling rope the braking rope is gripped by two clamps. The brake is put into action by the cars own weight.

The lower part of the brake consists of a lever gear. On the left it is connected with the braking rope, and on the right with the hauling rope, between these two points is a gear composed of various levers and connecting parts. In point "o2" of this mechanism, the car is suspended. The mainpiece of the gear is a double lever "a", which turns around "o1". By means of the connecting piece "e" and the double armed lever "f", turning around "o3", with its left side the counterrope G is connected, with its right side the hauling rope Z is connected, by means of the connecting piece "l", the levers "k" and "i" turning around "o4" and the connecting piece "h". (See Fig 15) To the third end of the lever "a" a pulling rod is connected, which transfers the weight of the car upwards to the braking jaws as soon as the traction rope breaks, because then the lever "a" falls down on account of the weight of the car and the traction of the counterrope. The rod does not transmit any load as long as the traction rope is sound and keeps the lever "a" in an elevated position. In order to actuate the braking device in cases of danger also by hand, on the upper end of the lever "k" a pawl "m" is fixed, which fits to a nose in lever "i" and is kept here by the two armed lever "p", which supports the pawl by spring-pression and to the lower end of which is fixed a rope with handle. If this rope is pulled, the lever "p" is turned and the pawl "m" loses its support, slides out of the nose and now lever "k" and with it lever "a" can move downwards so that the pulling rod connected with the braking gear gets the necessary pull. Beside this automatic brake a handbrake is provided, worked by the driver by means of a pulling rope. The construction of this brake is identically the same as that already described.

The compartment of the cars of the Lambana Fai Ropeway holds 10, of the LANA VIGILJOCH Ropeway holds 16 passengers, that of the MONTBLANC Ropeway 24. Both types are provided with platforms at both ends and besides the driver 5 persons, two of these standing, can be placed here. The seats on the platforms can be turned up in order to give the necessary space for luggage or goods, if so desired. Between the platforms is the compartment proper. At the Montblanc Ropeway this compartment is divided into two. The doors are provided with locks but are kept closed besides during the trip by a system of bolts opened and closed from the drivers stand. Each car has a driver, whose duty it is to communicate with the engineer in the power station by bell signals or telephone in case of danger or accident. In case of immediate danger he must operate the automatic brake on the car and in the event of failure of this brake he must operate the handbrake. For communication with the engineer in the power driving station 2 wires are provided, one for signal bell and one for conversation. For this purpose a contact rod is provided, which conducts the current to the carrying rope as return circuit. The wires are fixed laterally to the posts and can be easily reached by the contact rod. The telephone is a field-mikrophone. The cars are illuminated by acetylene lamps, two are placed inside the car, two-provided with reflectors are placed outside on the roof of the car in order to illuminate the track.

Special instructions are issued for the service, which also give information how and within what space of time the controlling of the ropes has to be done. Every breakage of the rope strands is carefully noted. After a certain number of wires breaking in the rope or after a certain number of wires breaking on one meters length the rope must be exchanged. The duration of the hauling rope in these passenger ropeways is perhaps longer than that of ordinary ropeways, as it is always conducted in a straight line and has not to pass curvation-rolls, where it has to be subjected to bending. As the dead weight is smaller than that of funicular railways the hauling rope and consequently the thickness of wire becomes smaller and this ensures a longer life for a given diameter of pulley.

According to experience we can safely assume that the life of the hauling ropes of the VIGILJOCH and the MONTBLANC Ropeway will be from 6-8 years.

Nothing definite can be said with regard to the life of the carrying ropes. The carrying ropes of ropeways for transporting goods under similar conditions have lasted for more than 10 years. Now the proportion between carload and section of rope is much more favourable in these two ropeways for passengers. However the authorities insist upon a factor of safety of 10 after having taken into account all possible requirements. Thus the bends of the ropes caused by the running of the car become larger than with the ordinary goods-ropeways, where the ropes have only a factor of safety of 5 or 6. It would be more correct to tighten the ropes for passenger transport with a factor of safety of 6-8. With regard to the safety of the public no doubt need be entertained. The famous constructor of mountain railways, the late Mr. STRUB of Switzerland, states that of all transporting systems a correctly constructed aerial ropeway is the safest, including the ordinary railway. As I mentioned before, on a suspended ropeway the hauling rope is not strained so much as on funicular ropeways. Only a very small number of breakages of the hauling ropes has happened amongst the hundreds of installations existing, if I remember rightly, only two or three. And here also no accident happened, as the brakes did their duty perfectly.

According to experience with the hauling rope the inside strands as well as the outer strands can break. The inner strands cannot be controlled. Of the carrying rope however the inner wires never break, the outer wires can be always controlled. In case all outer wires should be broken the safety would be reduced from 10 to 4 or 5, and this is a safety at which all bridges and iron structures are designed,

Therefore it is of no use to provide a second or third carrying rope of equal strength. To presume the security is increased by such a proceeding is a great mistake. If such a rope breaks, which would have a three-or four fold security, the consequences will be as disastrous as a breakage of all the carrying organs, on account of the immense power of the suddenly discharged rope and of the car which would be precipitated downwards anyhow to a certain degree.

Finally some general details about the two ropeways. TheVIGILJOCH Ropeways total length is 2. 2 km., the total differences of height 1153 m.; the single horizontal lengths are 900 and 970 m, the respective heights 520 and 633 m. The speed of the hauling rope is 2 m per sec. on the longer track and 1,75 m.p.s. on the shorter, so that time of trans-portation is for both parts the same,-abt. 11 minutes; allowing for the stopping time 4 minutes, 60 passengers will be transported per hour. Price of the returnticket amounts to 3 Kronen 50 Heller or Yen 1,40. The view from the Vigiljoch is magnificent. Before us extends the charming valley of the river Etsch, with the famous and picturesque health resort MERAN, to the right we see the well known DOLOMITE mountains, to the left the beautiful Vinschgau valley. The costs of construction amounted to abt. 240,000.- Yen, a great portion of these expenses the Company has regained already by the rise in price of the adjoining ground. A profit of at least 7% may be safely calculated.

The MONTBLANC Ropeway is divided into 5 sections. (See Fig. 16) The first two sections now under construction are provided with intermediate posts, the last three are suspended between posts without intermediate posts. First section: extends from the village LES PELERINS to LA PARA the horizontal length is 1870 m, difference in height 750 m. Second section: extends from LA PARA to the station GLACIER DES BOIS-SONS. This station is situated immediately beside the gigantic glacier; horizontal length: 1190 m, height 750 m. Third section: extends from the GLACIER DES BOISSONS to the GLACIER DES PELERINS.

Fourth section: extends from the GLACIER DES PELERINS to the GLACIER DES ROIS PERCES. Fifth section: extends from the ROIS PERCES to the AIGUILLE DU MIDI the last three sections have a total length of 2630 m and a difference of height 1250 m. The total difference in height between the first and the last station is therefore 2750 m. The AIGUILLE DU MIDI has a height of 3850 m. and is 160 m or 450 ft. higher than the Fuji no yama. The survey of the last two sections has not been finished yet, it is further not yet decided, whether the final point of the ropeway will be the Aiguille du midi or the Col du midi, which is situated 200 m lower down. From the Col du midi the famous Vallée Blanche or white valley commences, a vast snowfield, where "skiing" during summertime is possible. The third section passes straight over the ice of the GLACIER DES BOISSONS. The stations are built on protruding rocks and situated in such a way that they can not be reached by avalanches. Only the first section passes over an avalanche track, but is protected by extensive constructions making it safe against all possible danger. The connection between the lowest station LES PELERINS and CHAMONIX will be effected by automobiles.

The total expense will amount to 3-4 Millions Frcs., but the profits will be larger than those of the VIGILJOCH Ropeway, as the traffic of foreign tourists is enormous. The ticket to the Aiguille du midi will amount to Frs. 20.-- or abt. 7. 70 yen.

On Mr. Fuehles' lecture the following remarks were stated by Mr. Masayuki Otagawa, Member of the Society.

"I took a great interest in Mr. Fuehles' lecture, the Furukawa Mining Company I am connected with being the greatest user of ropeways in Japan.

"The Roe and Beddington systems mentioned by the author were used in Ashio Copper Mines twenty-two years ago, being the first installation in this country.

"The author has treated the subject very thoroughly, commencing from the early history of the ropeways to the latest improvement. A primitive rope-way system was seen from time immemorial in Japanese mountain districts such as Kai and Shinano, where, in order to cross deep gorges, wistaria ropes and baskets were used.

"As in common with other things, the ropeways had their origin in the Orient, and then were developed in the Occident- thus from the East they came to Europe and America, and again returned to the East. The return of this improved ropeway to Koyasan, one of the most sacred mountains in Japan, is welcomed and the author's work in the interest of Koyasan is to be commemorated by the ropeway world.

"The first steel wirerope used in Japan was produced in the first year of the present Meiji era, i.e. forty-four years ago. This was done by my friend Mr. K. Fujikura, Member of the Society and formerly Director of the Imperial Lighthouse Department, for conveying materials in building a lighthouse at Satano Misaki, a cape in the province of Hyuga. Dr. Ishibashi, Chairman, will be perhaps familiar with the fact, as he had devoted a great deal of his work to lighthouse construction with Mr. Fujikura, who is now an authority for steel rope manufacture in Japan, being connected with the Tokio Seiko K. K. (Tokio Rope Manufacturing Company.)

"While I was in Ashio Mines, Mr. Y. Tamamura was with me in the Engineering Department, and there Mr. Tamamura made several important improvements in wire ropeways. He took later patents on his system of ropeways at both home and abroad. He is now an expert on the subject. He unites me in expressing gratitude for the author's visit and work in Japan."

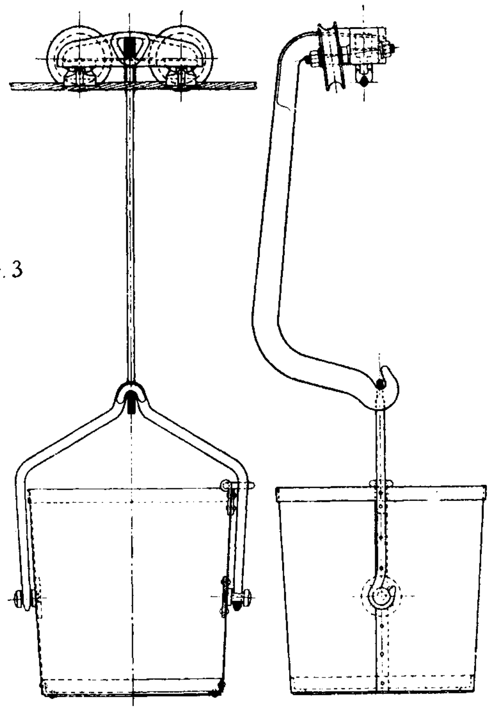


Fig. 3

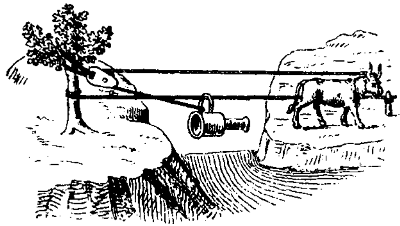


Fig. 1.ª

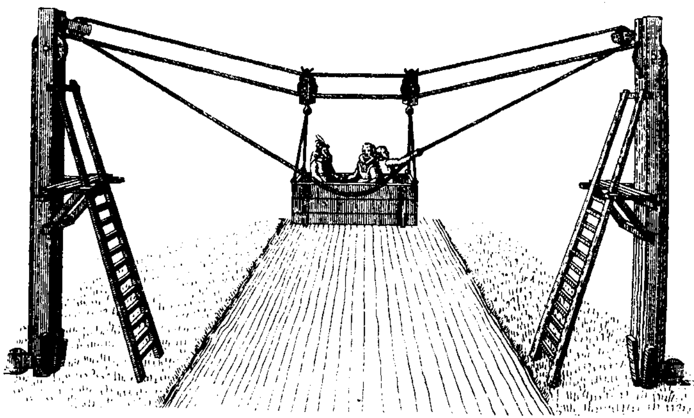


Fig. 2.

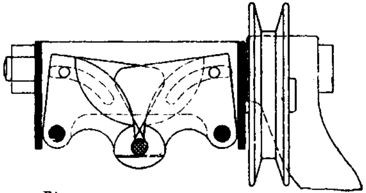


Fig. 5

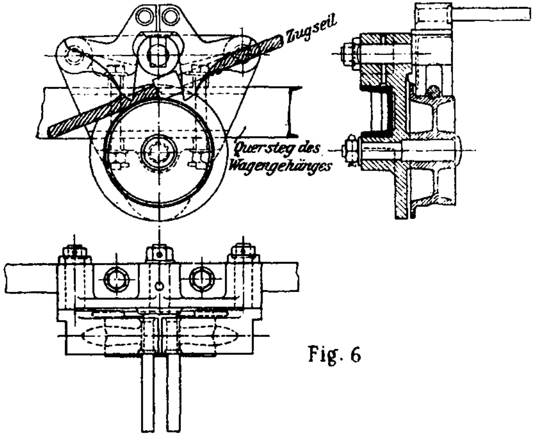


Fig. 6

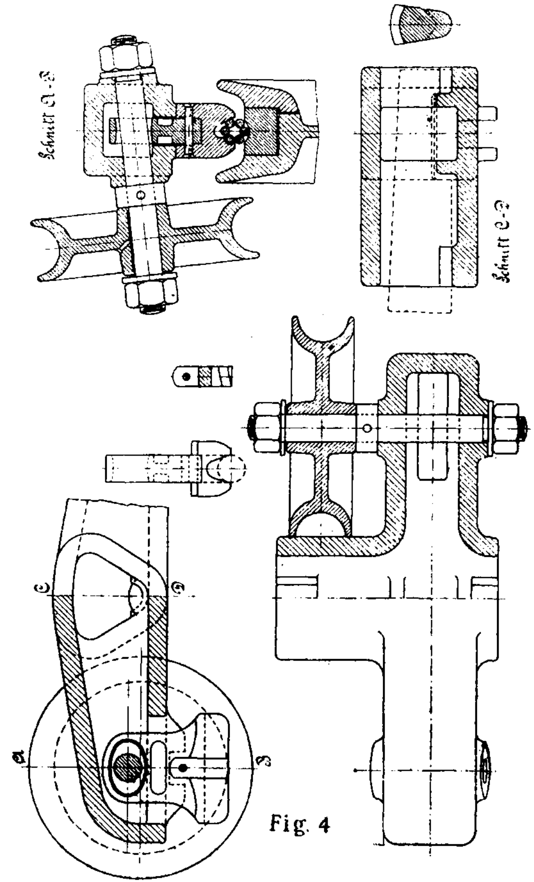
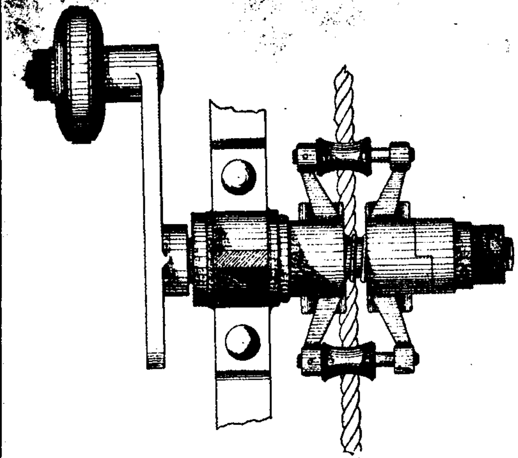
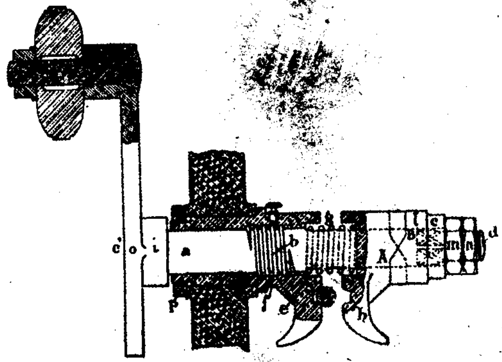


Fig. 4

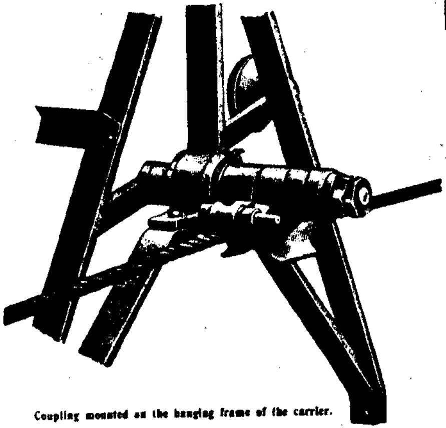
Fig. 7



— Plan view of the Coupling.



— Section of the Coupling.



Coupling mounted on the hanging frame of the carrier.

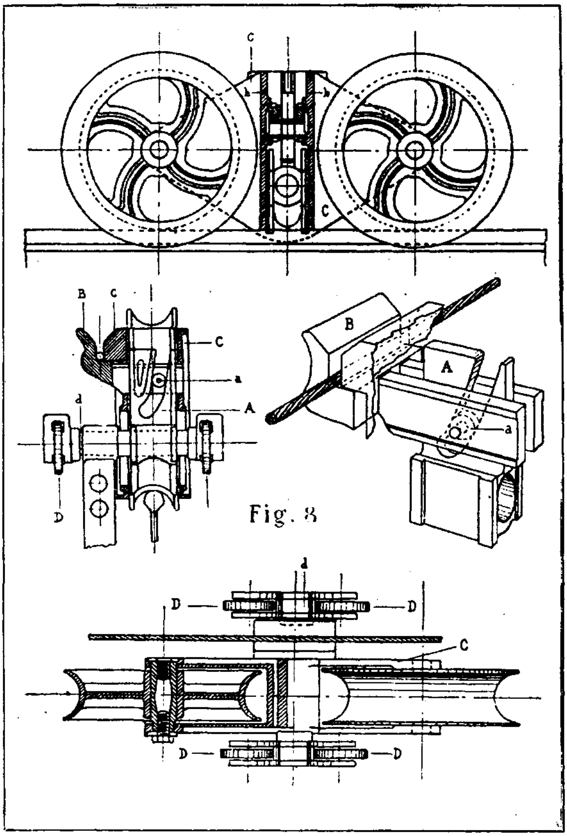


Fig. 8

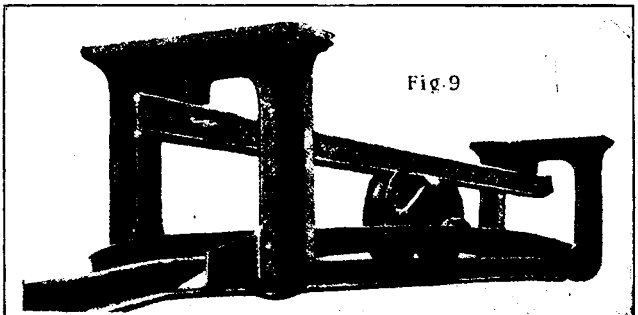


Fig. 9

Device for coupling and uncoupling the carriers provided with "Ideal" coupling.

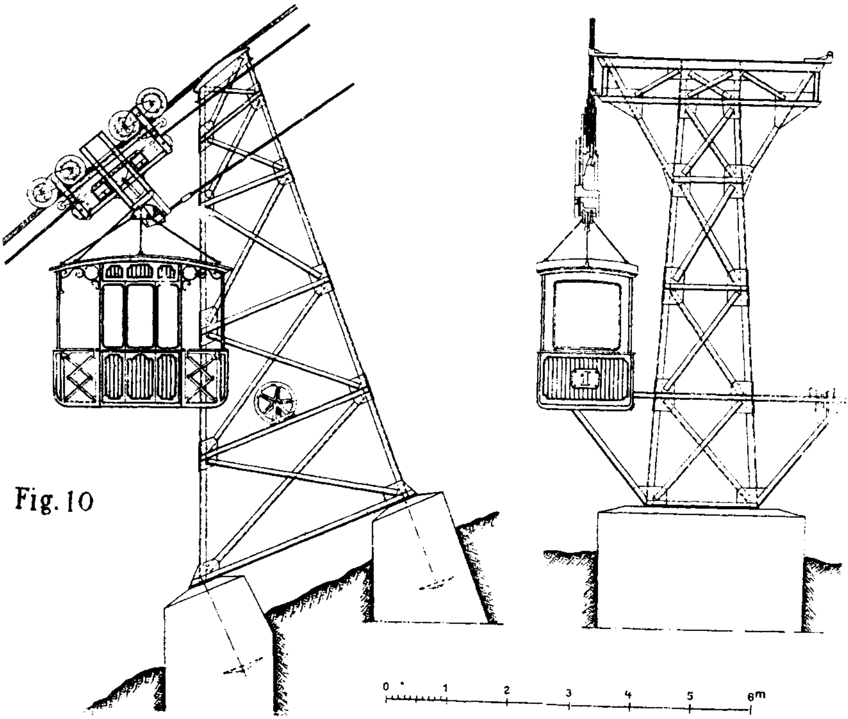


Fig. 10

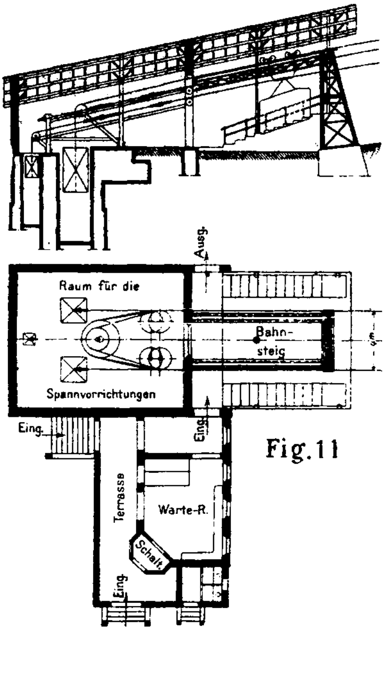


Fig. 11

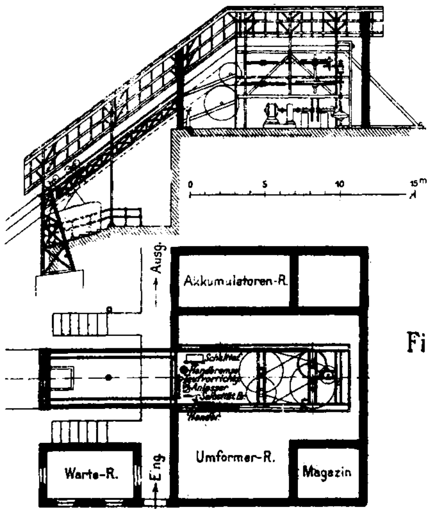


Fig. 12

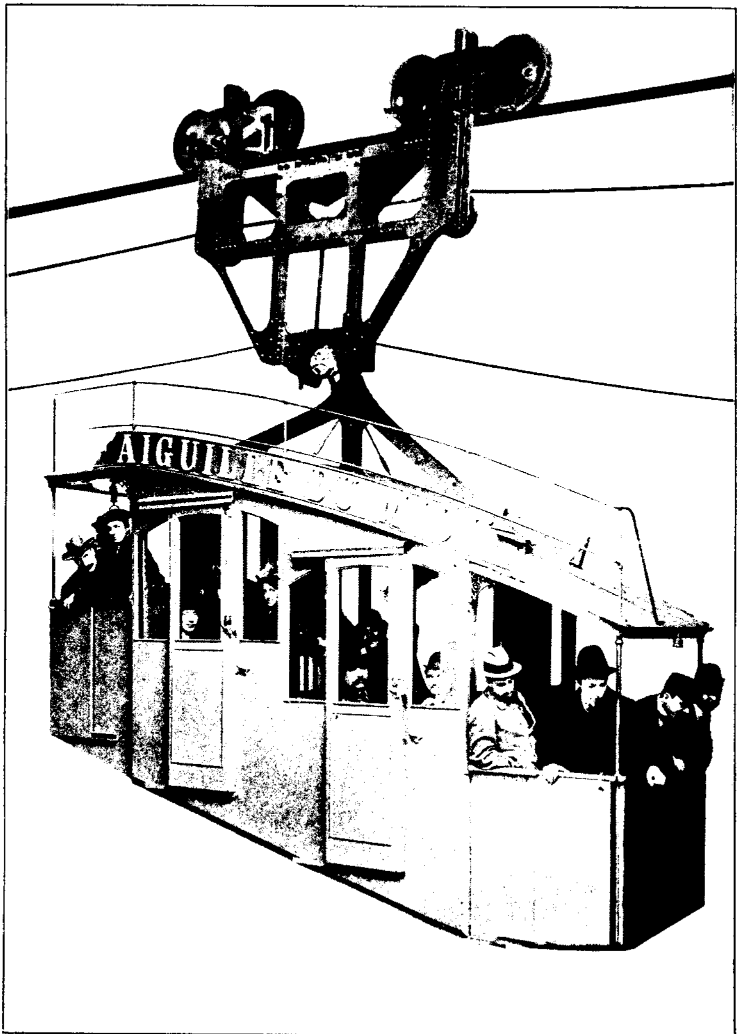
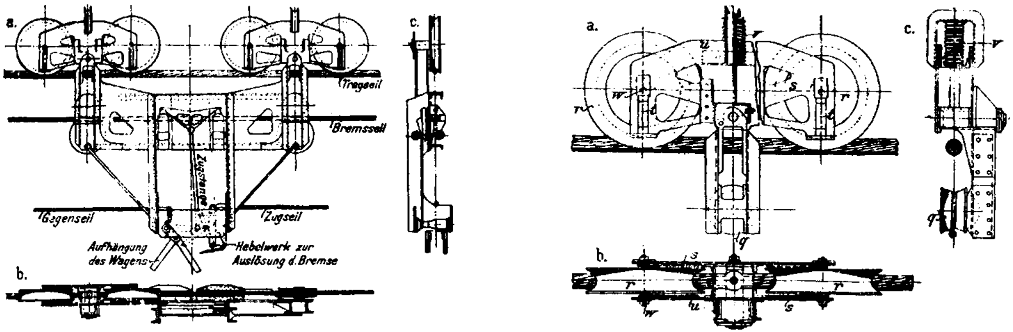
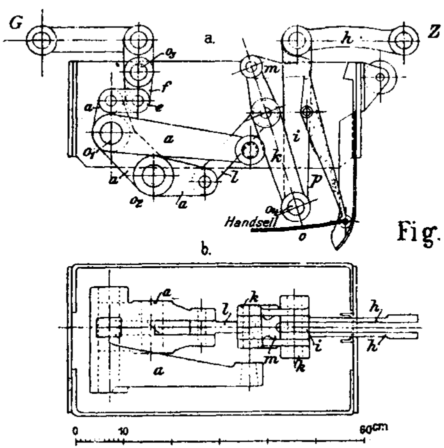


Fig. 13

Fig. 14



a.
c.
Tragseil
Bremsseil
Zugstange
Gegenseil
Zugseil
Aufhängung des Wagens
Hebelwerk zur Auslösung d. Bremse
b.
a.
c.
b.



G
Z
a.
h
Handseil
b.
0
10
60cm

Fig. 15

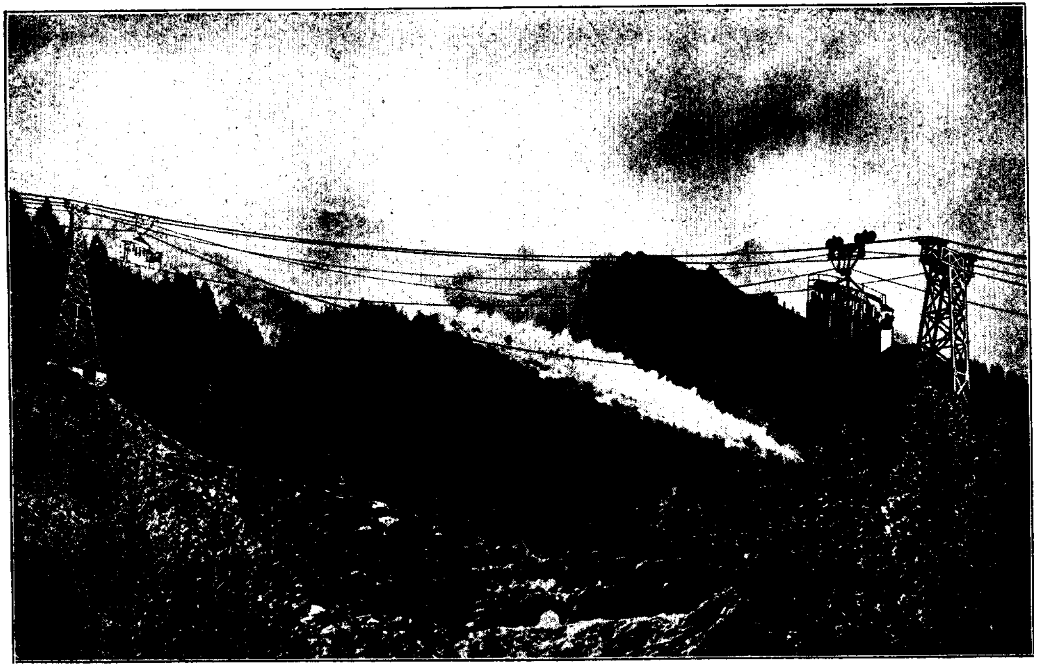


Fig. 16