miles per hour without encountering the displeasure of some rural Dogberry anxious to earn his perquisite. Doubtless after the public shall become more familiar with mechanically-driven vehicles the present objections to them will disappear in great part; likewise better knowledge of the capacities and peculiarities of the machines themselves upon the part of their owners will enable them to avoid many of the present mishaps.

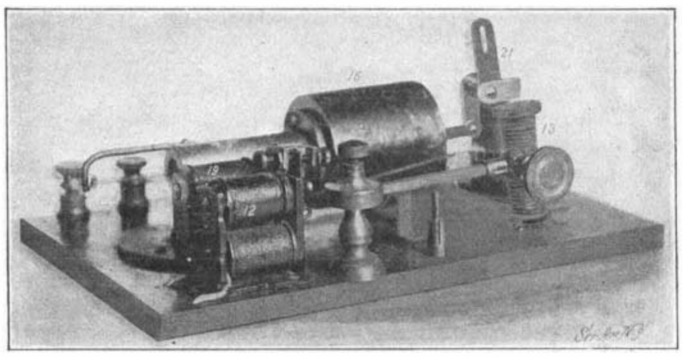
THE AUTOMATIC TRAIN CONTROLLER.

Despite the greatest precautions in the way of pneumatic and electric signals, serious railroad accidents are continually occurring. In devising these signals inventors do not take into account the personal element —the individuality of the engineer—which plays such an important part in many crises. We have read of engineers who, when suddenly confronted with danger, seem powerless to act, and rush on to destruction without making the slightest attempt to stop the train. In explaining the cause of a wreck which occurred in this vicinity, a railroad official of high standing said that it was probably due to that mad recklessness which sometimes overtakes an engineer, making him disregard all signals and risk his own life and that of the passengers. Obviously, then, the best perfected system of automatic signals, even though working perfectly, would be deficient in cases where the man at the throttle was blind to their warning or too dazed and bewildered to know just what to do. The only proper way to provide against all contingencies is to devise some suitable means, whereby the warning of danger would be immediately communicated to the engine, closing the throttle and applying the air brakes without the medium of human agency. In other words, since man is sometimes unreliable in critical situations, we must look for some trustworthy substitute which may be depended upon to act without fail in all emergencies.

A substitute of this character may be found in the system which is herewith illustrated. This system, which has been developed by the Automatic Train Controller Company, of 25 Broad Street, New York, is very simple, and the apparatus employed is very compact, being arranged to occupy not more than a cubic foot of space and, with the exception of the electrical mechanism which acts directly on the throttle and air-brake valve lever, the parts may be stowed away in any convenient corner of the engine cab. A complete understanding of the electrical action may be had by a glance at the diagram. The track is laid out in block sections of any desired length, the rails 5 at one side being electrically disconnected at the end of each section, and the opposite rails being electrically connected throughout the length of the track. At the end of each section, preferably between the rails, is a contact rail 7, which is electrically connected with the rails 5 of the section immediately ahead. Arranged upon the forward end of the locomotive, and preferably on the pilot, is a contact lever 8 designed to engage with the contact rails. This lever is pivoted on a shaft 9, from which the contact finger 10 extends upward and is adapted to normally engage the contact piece 11 carried by the pilot. The contact finger 10 is electrically connected to one pole of a battery, or other source of electrical power, conveniently located on the locomotive, while from the other pole a wire extends to an electro-magnet 12 and thence back through a resistance coil 13 to the contact piece 11. Magnet 12 is thus normally energized and its armature 14 attracted against the action of a spring. The current follows this course at all times except when a contact rail 7 is encountered. At such times the lever 8 is raised, rocking the finger 10 out of contact with the terminal 11. The armature of magnet 12 acts as a switch in a separate circuit comprising the battery 15 and electro-magnet 16, and when released from the attraction of this magnet serves to energize the electro-magnet 16, the armature, 21, of which, operates the air brake valve lever.

Whenever a new block section is about to be entered the contact at terminals 10 and 11 is broken as stated above, and if the track is clear, the current flows from the battery through lever 8, contact rail 7, rails 5, resistance 17, at the end of the section and back through rails 6, trucks 18 of the locomotive, and magnet 12 to the battery. In case of an open drawbridge, or broken rail, or where wreckers attempt to wreck the train by tearing up the rails, as shown in section 3 of the diagram, this flow would be interrupted, and the magnet 12 being de-energized would release its armature, thereby closing the circuit of the battery 15 through electro-magnet 16. The electro-magnet being energized, attracts its armature 21 which operates, through lever and link connections, to shut off the steam, and apply the air brakes, thus automatically bringing the train to a safe and gradual stop before it can enter the dangerous section of track ahead.

In case of a train in the block section ahead, the circuit through the electro-magnet is closed through a different medium. Connected in parallel with the magnet 12, is a magnet 19 which is provided with an armature 20. This armature also serves as a switch for the circuit of battery 15, but differs from armature 14 in that it is normally held back against the attraction of its magnet by the tension of a strong spring. Normally the attraction of the magnet 19 is unable to overcome this spring tension; but when the resistance in the track is short circuited by the trucks of a train, it develops sufficient energy to attract its armature and close the circuit of battery 15. We have already stated that resistance 13 is cut out of the circuit whenever the lever 8 rides over contact rail 7; but at the same time the resistance 17 of the section is looped in, and is such as to produce practically no change in the flow of current. However, if the current were short circuited by the trucks of a car, or a locomotive, in the block, as shown at 21 in section 4, a materially increased flow of electricity through magnet 19 would result, and the armature 20 would be attracted, closing the circuit through electro-magnet 16 which would stop the train as described above. Provision is made against any breaks in the roadbed as well as against danger of collision, and since the parts are self-restoring, they resume their original position when the cause of the danger is removed, thereby indicating to the engineer that the section ahead is clear.



APPARATUS FOR AUTOMATICALLY CONTROLLING TRAINS.

Accidents are sometimes caused by cars on a siding which have not been drawn clear of the main track, but project over the same. In order to prevent such accidents, a section of the siding immediately adjacent to the switch is connected by shunt wires to the main track circuit, so that in case a car is standing in dangerous proximity to the main track, the current will be short circuited through the car tracks and the train approaching that section would be stopped. The apparatus is perfectly reliable, and no fears may be entertained of its failure to act in an emergency; for it will be observed that the parts are so arranged that, unless everything is in perfect order, one or the other of armatures 14 and 20 will be operated to complete the circuit through electro-magnet 16, thus bringing the train to a stop. In order to make the system doubly safe, the electro-magnet circuit may be arranged according to the small diagram at the right. This arrangement provides an unbroken circuit when the conditions are normal. In case of danger, however, the current is interrupted by one or the other of armatures 14 and 20, and the electro magnet 16 is de-energized, releasing the lever 21, which, thereupon, springs back and operates the throttle and air brakes. Should either of the batteries employed become weakened or should any of the parts be broken or disconnected, the engineer would be immediately apprised of the fact by the automatic action of the mechanism. The Automatic Train Controller Company has just closed contracts to equip one of the Eastern railroads with its machines.

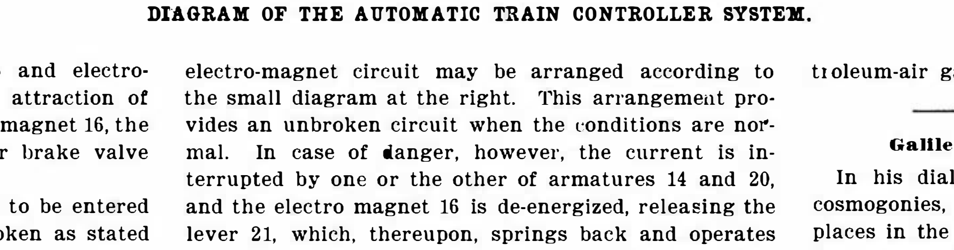


DIAGRAM OF THE AUTOMATIC TRAIN CONTROLLER SYSTEM.

Acetylene has been experimented with for signaling in the Germany army, with great success. Mixed with a certain percentage of oxygen it is said to give three times the light of the oxy-hydrogen lamp and can be plainly observed in daylight at a distance of five miles. This distance is trebled at night.

The Decay of Beachy Head.

The seven white miles of Beachy Head are fast crumbling away. The great chalk cliff in front of the lighthouse of late years has shown signs of insecurity, which in 1893 culminated in a very heavy fall, amounting, it is estimated, to no less than 85,000 tons of chalk. Again in 1896 another dislodgment occurred of an estimated quantity of 89,000 tons. By these serious downfalls the distance between the lighthouse tower and the cliff edge was reduced from 100 to 70 feet, and there are not wanting signs that further disintegration of the cliff may sooner or later take place. Thus has arisen the necessity for a new lighthouse, on a more stable and enduring site. The new lighthouse was fully described and illustrated in the Scientific American.

New York as a Foreign City.

In the city of New York there are only 737,477 white persons born of native parents, or but 21.4 per cent of the population of the city. This statement means that out of every one hundred persons living within the municipal boundaries of New York seventy-eight are either foreigners, or the children of foreign-born parents, or colored people. New York, however, is not the first, but the second city of the country having the largest foreign-born population. Fall River, Mass., is first in that respect. Official figures show that there are in New York city more males under twenty-one years of Slavonic parentage than of any other people, and the number of Slavonic men more than twenty-one years of age exceeds that of any other nationality except Germans and Irish. In the Fourteenth Assembly District of New York County the percentage of Hebrew families with nine children each is six times as great as the Protestant percentage, while the number of Hebrew families with no children is about one-half the Protestant percentage.—H. McMillen, Leslie's Weekly.

Ether-Air Gas.

Descriptions have been published recently of a new form of artificial illuminant made by saturating air with the vapor of ether, and then carbureting the whole with benzol. Ether-air gas itself has found occasional use for years under the name of eth-oxygen gas, being employed for optical lantern work in places where the oil light was too weak, and coal gas not laid on. A new carbureter has been invented in France which is claimed to be specially suitable for ether. The absorbent material is the fiber of a palm-like tree, which has an apparent specific gravity of from 0.114 to 0.122, and is so extremely porous that it will take up nine times its weight of ether, all of which is subsequently evaporated into the gas. Ether itself burns with a luminous, or even smoky flame, but when it is diluted with air, its vapor, as in ether-air gas, gives a blue flame, and, for purposes of illumination, requires either a mantle or the addition of benzol vapor. According to Langlois, incandescent ether-air gas gives a light of 1 Carcel-hour—about 9.5 candles—for every 6.7 grammes of ether burnt; while the material will bear cooling to 21 deg. Fah. without any of the ether condensing out, and without suffering any diminution in illuminating power. By carbureting ether-air gas with 40 or 50 grammes of benzol per cubic meter, a product resembling oil gas in stability can be prepared. It is stated that carbureted ether-air gas is almost twice as expensive as oil gas; but it has an advantage over the latter in the simplicity of the plant required, and in the rapidity with which a small installation can be erected. It may be noted that the introduction of this ether-air gas renders the term "air-gas" as applied to air carbureted with petroleum spirit ambiguous; and the latter product must now be called "petroleum-air gas," or something of the kind.—Engineer.

Galileo and the Magnetic Telegraph.

In his dialogues on the Ptolemaic and Copernican cosmogonies, which first appeared in 1627, Galileo places in the mouth of one of his interlocutors, Sagrado, the words: "You remind me of a man who wanted to sell to me the secret of communicating with a person two or three miles distant, by means of the sympathy of two magnetized bars. When I told him that I would gladly buy his secret, but that I first wanted to see the thing proved, and that it would be sufficient for my purposes to communicate with him in his room while I was stationed in my own room, he answered that the operation could hardly be observed at so small a distance. Thereupon I dismissed him, saying that I had neither the desire nor the time to travel to Cairo or Moscow, but that if he would journey to either of these two places, I would gladly act as his correspondent in Venice."

Electrical Notes.

The city of San José, California, recently inaugurated its system of electrical lighting. The current is carried for a distance of 173 miles from a plant situated in the very heart of the Sierra Nevada Mountains. The current is used not only for the purpose of illumination, but also for driving the street cars and machinery of the various manufactories.

According to the London Electrical Engineer, successful results are said to have been obtained by a Mr. Storey, of Lancaster, on Lake Windermere with a boat steered from the shore by an adaptation of wireless telegraphy. The experiments were conducted in private, and no particulars are to hand as to how Mr. Storey accomplished his reported achievement. It is stated, however, that he was able to steer the boat from the shore, directing it in safety in and out of a fleet of sloops and steam launches at their moorings.

On October 13 a special train on the Grand Trunk Railway made a trip that will probably be historical. The train passed through Montreal on October 13 bound for Portland, Me. On board a complete set of wireless telegraphy apparatus had been installed for the purpose of experiment. Moving at a speed of sixty miles an hour it was possible to receive messages clearly on the train. Communication was first established eight miles from St. Dominique and continued uninterruptedly until the station had been left eight miles behind.

A paper was read before the British Association at Belfast on the electrical conductivity of certain aluminium alloys as affected by exposure to the London atmosphere. The specimens exhibited were in the form of wire, 0.126-inch (3.2 mm.) diameter, supported on a wooden frame; they were exposed on the roof of a building for thirteen months. It is assumed that the observed effects are principally due to pitting at the surface, but exposure might also affect the structure. The position of aluminium in the electrochemical series with respect to the other substances used is as follows: *Al, Mn, Zn, Fe, Ni, Cu, Si*. It should be expected that copper, widely separated as it is, would be effective in the production of corrosion. This is found to be the case, the effect increasing with the percentage of copper. Nickel is well separated from aluminium in the series, and alone has considerable effect, but if alloyed with copper the conductivity increases slightly during exposures. This specimen is specially promising, as it has a breaking load of 45,900 pounds, and limit of elasticity 36,600 pounds per square inch. It has a comparatively low percentage extension, a high coefficient of expansion, and a low temperature coefficient for electric resistance. Again, iron in the presence of nickel has a slightly increased conductivity. The results of the analysis of the different experiments before and after exposure are given in a table. For exposed aluminium alloys it appears that copper alone should not be used in the alloy; the presence of equal amounts (about one per cent) of nickel and copper certainly reduces conductivity by a small extent, but the increase in mechanical and the decrease in corrosive properties is great.

Haber and Geipert have been investigating the conditions under which aluminium is obtained by the electrolytic method, and have published their results in the Zeitschrift f. Elektrochemie. They point out that no trustworthy details of the method employed in the various works where the metal is now produced have hitherto been made public. Using a small experimental fusion cell, and the ordinary lighting supply current of the Karlsruhe Technical Institute, they were able to reduce alumina without difficulty and to obtain as much as 230 grammes of the metal in one operation. The metal obtained was remarkably pure, one sample tested containing only 0.05 per cent C and 0.34 per cent Si. The mechanical tests made with six samples of the aluminium gave an average tensile strength of 21,425 pounds per square inch. The fused mixture used in the carbon cell contained 33 per cent AlF_3, 33 per cent NaF and 33 per cent Al_2O_3, the high percentage of aluminium fluoride being conducive to fluidity. The current density employed was about 2,800 amperes per square foot, and the E. M. F. varied between 7 and 10 volts. The authors, as the result of their experiments, have come to the conclusion that the steady improvement in the efficiency of the process as carried out in the aluminium works is due, not to secret modifications in the process, but to the more careful attention now given to the purity of the raw materials employed. They also point out that the carbon contained in the aluminium obtained in their experiments was not present in the combined form, and as it was graphitic in character they assume that it represented mechanically inclosed particles, due to the disintegration of the anode and cathode carbon. By remelting the aluminium it was possible to remove a portion of this impurity from the metal. The necessity of employing carbons comparatively free from ash is insisted on, since any impurities of the carbon used will be found in the final product.

THE INFLUENCE OF GRADES.

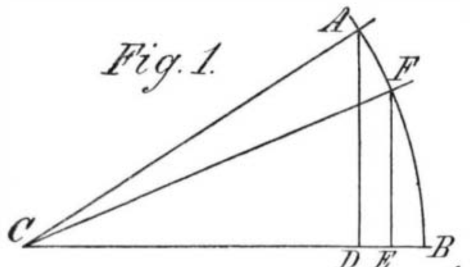
Automobilists and cyclists know, of course, that more force is required to climb a hill than to run on a level. But few know just what the relation is. When they consult a text-book, they generally run into a formula which contains "the sine of alpha;" and that usually finishes their investigations. I purpose to give a rule that is just as good, for all practical purposes, as can be had by using a table of sines, which in any case is not always accessible even if it would be comprehended by the wheelist or automobilist.

When any vehicle runs on a level road, the amount of traction (that is, the amount which would be indicated by pulling through a spring balance placed between the vehicle and the motive power if the latter preceded the vehicle as in horse traction) runs on a good surface from 1-80th to 1-50th of the weight of the vehicle, according to the character of the road surface and that of the bearings, tires, etc. That is, a 25-pound wheel would call for about half a pound of pull, and could be towed by a thread which would hold up a weight of eight ounces; and if the road were good, a 40-pound tricycle could be towed by the same half-pound effort.

On level stone pavements of good class it takes 1-40th to 1-30th of the weight of the ordinary wheeled vehicle to tow it; and on macadam in bad condition 1-20th; that is, a 20-pound racer would here take a pound to tow it empty. We will say for average road surfaces 1-30th the weights; which would give us for a one-ton automobile nearly 75 pounds average.

The books tell us, and with reason, that the extra traction on up grades increases directly as the sine of the angle of the grade; and refer us of course to a "table of logarithmic sines" for long fine work, or a "table of natural sines" where there is not much figuring to do.

That is, if we had a hill, *AC*, with an angle, *ACB*,



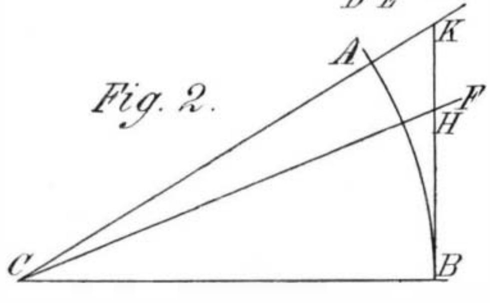


DIAGRAM SHOWING METHOD OF COMPUTING GRADES.

counting from the level, we would have the necessary increased tractive force, compared with that on a hill, *FC*, in the same proportions as the lines, *AD* and *FE*, dropped "plumb" from the ends of the arcs (that is, from the ends of the inclined radii, also) to the horizontal radius. And if we know the angles, *ACB* and *FCB*, we can get these "sines" for a radius, 1, from a table of natural sines and cipher it up that the increased traction is equal to that on a level, multiplied by the natural sine of the angle.

But road grades are not reckoned by angles; they are counted by so much rise per mile or per hundred feet or other convenient standard unit—as for instance "1 in 100," or "10 feet to the mile," or what not. Now this "rise" per hundred feet of horizontal distance corresponds exactly to the tangent of the angle of the grade; and the natural tangent is so near the natural sine that for our purposes, where the angles are small anyhow, we can use it to multiply by.

In the second figure we have the same grades, *AC* and *FC*, the same radii, *AC* and *BC*; but instead of the sines (dropped plumb from the ends of the inclined radii to the horizontal radius) we have the tangents, *BH*, *BK*, raised plumb from the end of the horizontal radius to the inclined radii produced. In both cases the lines, sines and tangents, start from an intersection of one arc with a radius.

Now using the tangent instead of the sine, we find that on any grade the amount required to tow the vehicle is equal to the original weight times the coefficient (this coefficient being 1-20th or 1-30th or 1-40th or what not, according to the grade and the condition of bearings, tires, etc.) plus the extra traction, which latter is the weight times the per cent of grade.

If this is the case (i. e., this being the case, which it practically is) we have with a coefficient of 1-30th = 3 1-3 per cent, double the traction as soon as we have a 3 1-3 grade, and triple where we have a 6 2-3 per cent grade; and when we reach an up grade of 10 feet in a hundred, four times the power is needed that would suffice on a level.

For better roads, where our coefficient is 1-40th instead of 1-30th, we have for a ten per cent grade five times the tractive force which is necessary on a level; and where we have the very best roads usually attainable, and run our traction on a level down to 1-60th the weight of the vehicle, then we need, on a 10 per cent up grade, 6 2-3 times as much as on the level. The better the roads, the greater the proportionate bad influence of grades. There are roads in France, and perhaps also in Germany, where the traction coefficient runs down to 1-80th; and here a 10 per cent up-grade calls for nine times as much power as a level!

So, in figuring up the power required to mount a hill, remember that comparatively more "notching up" is required where the roads are good than where they are bad!

Transportation in Madagascar.

With the completion of the road between Mahatsara, on the east coast of Madagascar, and Tananarivo, the capital, it is now possible to transport goods for a distance of 200 miles. To be sure, goods are transported not entirely upon land, but partly over this newly completed road, and largely by waterway formed by a series of lagoons and canals. It is hoped that before many years have passed the roads and canals will give place to a railway which is to lie between Tamatave and Tananarivo.

In order to transport goods to the coast, Hova carriers are employed to carry huge packs through the mountains. With the completion of a new road the Hova porter will be compelled to seek a new field of employment. Between four and five thousand porters usually made the trip through the mountains to the coast. When the new road was finished, carts immediately began to displace the Hovas. Where three wagons were used last January, 372 were used in June.

To be sure, the cartage is still rather primitive; for the vehicles are hauled by men. If human power is used to draw these carts, the question naturally arises, How is it that the Hova carriers are compelled to seek other employment? The reason is to be found in the fact that each cart, having a carrying capacity of 750 pounds, is drawn by three men; whereas the Hova carrier, however strong he may be, can hardly bear more than 100 pounds. When oxen and mules are substituted for men, we may expect a reduction in the price of cartage transportation.

The Current Supplement.

The current SUPPLEMENT, No. 1401, opens with a continuation of Mr. F. C. Perkins' article on "The Berlin Underground and Elevated Railway." The present installment is just as copiously illustrated as was the last. The question of using oil fuel in the United States Navy has been fully discussed in a report prepared by the Bureau of Steam Engineering. The current SUPPLEMENT contains the first installment of that report. M. Berthelet discusses researches on argon and its combinations. "Radio-Activity and the Electron Theory" is the title of an interesting paper. Dr. Lorenz's operation is concisely described. "New Apparatus for Short Distance Stereoscopic Photography" forms the subject of an exhaustive article. The French first-class battleship "Gaulois," which it will be remembered figured prominently during the Rochambeau celebration in this country, is described and illustrated. Mr. Henry Clay Weeks gives some practical suggestions on mosquito extermination in New Jersey. Mr. A. Wehnelt, inventor of the interrupter that bears his name, discourses interestingly on the distribution of current at the surface of cathodes in vacuum tubes. The usual Selected Formulæ, Trade Notes and Recipes and consular information are also published.

$2,197,789,824 of Money in Circulation.

The total stock of money of all kinds in the United States on September 1, as reported by the Treasury Department, was $2,579,306,217, being an increase of $67,446,684 over that on the same date last year. The amount in circulation was $2,197,789,824, which, based on an estimated population of 79,344,000, is a per capita of $28.55. The per capita on September 1, 1901, was $28.18, and on the same date in 1900 was $26.85.

Spencer's Latest Feat.

On the afternoon of October 20, Stanley Spencer, the aeronaut who recently made a successful trip over London, made an ascent at Blackpool, in Lancashire. After traveling about 26 miles, he descended near Preston. There was a good breeze when he ascended. At about a height of 1,000 feet he made several evolutions, and finally sailed off in the direction in which the wind was blowing. Spencer almost collided with an express train in descending, but escaped by ramming a tree. No serious damage was done.