eye from sunlight. One result of Dr. Johnson's researches, according to Prof. Ray Lankester, the celebrated zoologist, will necessitate a reclassification in one section of zoology.

A GRAVITY CABLE RAILROAD IN THE SWISS ALPS.

One of the most remarkable railroads, that constitute such a feature of railroad communication and construction in the Swiss Alps, is that connecting Lauterbrunnen with Mürren. The former township, which is in the valley, is the terminus of the Bernese Oberland railroad, connecting Lauterbrunnen with Interlaken, and forming part of the Bern-Mürren trunk line. Mürren, however, is a small Swiss village situated in the Bernese Oberland, 5,385 feet above sea level, on the opposite side of the valley which is crowned by the Jungfrau. The mountain side is particularly steep, and the railroad stretches from Lauterbrunnen to the Grütsch Alp, 4,890 feet above sea level. Its terminus constitutes one of the most remarkable engineering feats in Swiss railroad engineering.

The track has a striking resemblance to a ladder, so sharp is the angle of the gradient. The mountain face is very rugged, abounding with small, sharp ravines, through which the mountain torrents rush toward the lower-lying country and river, which extends through the valley. The consequence is that in order to negotiate these undulations in the ground, it was necessary to erect viaducts, so as to insure a uniform gradient. These viaducts, of which there are several, are constructed of rough masonry on the small-arch principle with thick, stout piers carried to a substantial depth, to obtain sufficient rigidity to withstand the pressure of the torrent waters in the rainy season.

At other places the track extends through cuttings, and the ballast removed from these sections was employed for strengthening the embankment at points not too well served in this respect. Upon the inclined plane thus constructed the railroad is laid. The rails are carried upon transversely-laid sleepers. There is only one track; but as the railroad is operated upon the simple though highly efficacious principle of raising a pendant weight by the connection of a heavier one upon the other end of the attachment, there is a half-way station, where the ascending and descending cars pass, and at this point the track resolves itself into two loops.

The total length of the railroad from Lauterbrunnen to the Grütsch Alp is 4,530 feet, and the average gradient is 55 in 100, with a maximum of 60 in 100. Down the center of the track is laid a rack rail, in which runs a cog wheel carried underneath the car, which not only greatly assists the car in climbing, but in the descent acts as a highly efficient restraint over the force of gravity.

The railroad is operated by cable, the ascending car being connected by a wire rope, which passes over a drum in the power house at the summit, and thence to the descending car. The cables furthermore are water-balanced. Large pulleys are placed at frequent intervals to carry the cable.

The cars are self-contained, and start from the opposite ends of the road simultaneously, telegraphic communication being maintained between the two termini for purposes of signaling. Each car carries a water-ballast tank, but only the descending tank car carries the water-ballast charge, in order to impart the necessary momentum to overcome the inertia of the car stationary at the lower station. As the car descends, water is gradually emptied from the tank. The displacement of the water coincides with the weight of the cable, which lengthens as the ascending car approaches the top. The skillful manipulation of this water ballast constitutes one of the most important factors in the safe operation of the railroad. Each car must travel at the same speed, and progress must be steadily maintained, so as to obviate any sudden jerks, which would throw severe strains upon the cable. Upon each car is attached a time indicator, and the rate of progress is regulated by the authorities. In order to guard against any inadvertent acceleration in the velocity, a powerful automatic brake is supplied to each car. Should the speed exceed that which is prescribed, the brakes come into operation, and thus check the engineer's progress. As a further precaution against careless or reckless driving, the engineer is subjected to a scale of fines, which are rigorously enforced by the authorities, information concerning this point being supplied by the time indicator.

To guard against any disaster resulting in the remote possibility of the cable rupturing, and to prevent the car running away and getting beyond control, each vehicle is equipped with two powerful brakes in addition to the automatic brake, and these, in conjunction with the cog wheel placed beneath the car, are sufficient to hold it stationary upon any part of the gradient. Accident is thereby adequately provided against, and it is this careful braking system which is responsible for that element of safety so characteristic of these mountain railroads in Switzerland. The cars pass each other at the half-way point by means of a turn-out provided for the purpose; and at this point a momentary stop is made.

The cable has a breaking strength of 62 tons, and it is a splendid testimony to the care used in making it, that the same rope is in use to-day as when the railroad was first opened. The cable is thoroughly inspected at frequent intervals, and not even the weakening of a single strand has been discovered. The cars travel at the rate of 226.35 feet per minute, the whole journey occupying 20 minutes. This rate of progress is much greater than that attained by the locomotive-operated mountain railroads, such as the Rigi, where the speed is only 186.35 feet per minute, and the maximum gradient in three miles is 48 in 100. There is one other important cable-operated railroad in the Swiss Alps, that at St. Beatenberg. This railroad, which also has a maximum gradient of 60 in 100, is 12,795 feet in length and occupies 50 minutes to negotiate. Though the Mürren railroad is of practically the same gradient throughout, the St. Beatenberg track at one section has a rise of only 34 feet in 100, to cover which occupies 15 minutes.

From the Grütsch Alp station extends an electric railroad of the conventional overhead trolley type to Mürren. During the whole of the journey to the latter terminus, a distance of 3¼ miles, the railroad has only to climb 495 feet, the gradient thus being a comparatively easy one. The train is hauled by an electric locomotive. The whole journey from Mürren to Lauterbrunnen, including the negotiation of the cable section, occupies 55 minutes, and the fare charged is 75 cents.

CAR CROSSING A STEEP VIADUCT ON THE LAUTERBRUNNEN-GRÜTSCH ALP GRAVITY CABLE RAILWAY.

A water ballast tank below the car is filled when the car reaches the top, thus causing it to descend and raise the other car owing to the difference in weight.

One of the oddities of our nomenclature is that the combination of metals known as German silver contains no silver in its composition, and is of Chinese and not of German origin, says the American Machinist. It was first introduced into Europe by the Germans, and for some time it was not generally known that they had simply borrowed it from the Chinese.

Automobile Notes.

In place of the Bennett Cup race the new Grand Prix race will be held this year for the first time in France over the Sarthe circuit. This circuit is located some three hours ride by rail from Paris. It is practically an equilateral triangle, about 100 kilometers (62 miles) in length. The lengths of the three sides are: La Fourche-St. Calais, 34 kilometers; St. Calais-Ferté Bernard, 31½ kilometers; and Ferté Bernard-La Fourche, 34½ kilometers. An innovation is that the race will probably be run on two successive days—360 miles a day—and that a different driver may run the car each day. A new rule is that only the driver and mechanic of a machine may change the tires.

The automobilist who has never seen a racer in action on the road can form a very good idea of how one of the huge machines appears by paying a visit to the "Vanderbilt Cup," a new play which has been running for the past several weeks at the Broadway Theater. In this drama a race between two high-powered monsters takes place in full view of the audience, the Gatling-gun effect of a racer being very realistically portrayed by means of an actual four-cylinder motor using alcohol as fuel and belching out blue flames at the audience. The wheels of the machines revolve rapidly, the background flashes past, and, at the critical moment the right machine pulls ahead and wins. Another particularly good effect is the representation, by means of cinematographic views taken from the rear of a moving machine, of the trip of two automobiles (one in tow of the other) from a country town to New York. A galloping horse photographed in the same way furnishes a very striking illusion.

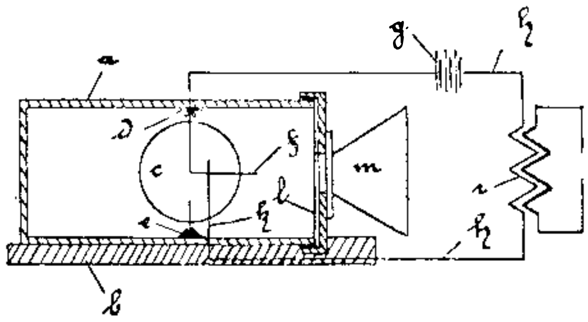
The second annual Cuban road race for the Havana Cup was run on the 12th instant over a distance of 218 miles, and was won by Demogeot on the 80-horse-power Darracq racer, which carried off the Vanderbilt Cup last October. Four runs over the 54½ mile course were made by the winner in 54:26, 51:06 1-5, 58:09, and 54:37 3-5 respectively. The total time was therefore 3 hours, 38 minutes, 18 4-5 seconds, which corresponds to an average speed of about 60 miles an hour. Bernin, on a 90-horse-power Renault, made the fastest time on his first trip out to San Cristobal, which was made in 51:04; but on the return trip he consumed more than the 90 minutes allowed, and was declared out of the race. Lancia and Cedrino on 110-horse-power Fiats both came to grief at a sharp curve near Candelaria. Lancia stopped to look after his mechanic, who was thrown out of the car; while Cedrino's car capsized, and he and his mechanic were both injured. The course was oiled with a mixture of crude oil, water, and asphalt. It was in good condition, and there was no dust.

There has been much talk of late about using the engine as a brake when descending a hill, and thus saving unnecessary wear on the brakes. All that is necessary is to cut off the ignition current when running on the high speed, for instance, and let the car coast. The foot brake can also be applied gently if needed. If the hill is a steep one, and there is doubt about the brakes holding, the car should be set on the intermediate or low speed before starting to make the descent, as it is practically impossible to shift back if the car gets going rapidly. The action of the pistons in drawing in and compressing the gas forms a powerful brake, especially when the lower gears are engaged. The only disadvantage is that when the ignition current is again switched on, there is apt to be an explosion in the muffler, which may damage the latter. To obviate this disadvantage an air valve of some sort should be fitted between the carbureter and the motor. Then, when the motor is being used as a brake, it can be made to draw in air instead of gas. This will cool the cylinders without consuming fuel, and will effectually do away with muffler explosions. This valve, if arranged so it can be opened gradually, may be used as a throttle by producing dilution of the mixture, which is a much better and more economical way of throttling than that ordinarily employed.

As a result of a prize competition for the best automatic starting device for the motor of a gasoline automobile, several of the leading makes of cars at the Paris Show were fitted with automatic starters. One of the best of these was that shown on the Mors car. This is an automatic starting device, consisting of a hand pump having a piston of 5 or 6 inches diameter for forcing gas into the cylinders. The pump is located behind the speed change levers and beside the driver's seat. On the suction stroke it draws air through a small surface carbureter known as the "dynamogene" and located on the dash. The gas thus formed is forced into the cylinder through a special valve which has been previously opened. This valve is then closed, the spark switched on, and the motor starts. The Renault starter is a more elaborate device, consisting of a compressed air tank resembling a 5 cubic foot gas cylinder attached to the chassis under the driver's seat. This is kept charged by a connection with a non-return valve to the rear cylinder head. On the left of the flywheel, which has a ring of teeth attached to it, is a very small and compact three-cylinder motor. A lever on the dash simultaneously throws a pinion on the shaft of this latter into gear with the flywheel and opens the air valve to the small motor, which starts under the pressure of exhaust gases collected in the gas cylinder. Another starter has a ratchet actuated by depressing the clutch pedal to its full extent, engaging with a ratchet wheel on the engine shaft.

DETONATION OF SUBMARINE MINES BY MEANS OF SOUND WAVES.

A singular phenomenon has been recently observed on tube-shaped resonators in the interior of which thin disks of any rigid material are suspended, so as to be readily susceptible of rotation. In fact, if the characteristic sound of the resonator be given off, the disk was found to rotate until its surface was at right angles to the longitudinal of the resonator, remaining in this position as long as the sound in question was continued, and returning to its initial position as soon as this ceased. Other sounds of any intensity were found to be unable to produce a rotation of the disk. Now this phenomenon, according to a recent issue of the Technische Rundschau, has induced an inventor to construct a device in which an electrical current is switched on or off, reinforced or weakened, by the rotation of the disk, thus disengaging forces of the most varied description. One of the most remarkable uses this apparatus may be applied to is the detonation of mines without conductive connection between the apparatus and the sound generator. In the illustration herewith, *a* is the tubular resonator resting on a foundation *b*, and in the interior of which a thin disk *c* has been arranged in the bearings *d e*, so as to be readily susceptible of rotation. To the disk *c* is fixed a contact-lever *f*, projecting above the latter and connected at the top of the bearing *d* to one of the terminals of a battery *g*. The other terminal of the latter communicates through a conductor *h* with the primary coil *i* of an electrical ignition apparatus, as well as with the contact lever *k*, which is placed in the path of the contact lever *f*. In order to protect the disk and



DETONATION OF SUBMARINE MINES.

contacts against atmospheric influences, the resonator is sealed at its upper end by a membrane *l*, of rubber or the like, a funnel *m* being arranged above this membrane to reinforce the sound effect.

If the apparatus be connected to a mine arranged on shore close to the coast, when a signal is given from a torpedo-boat siren which is tuned to the characteristic sound of the resonator *a*, the disk *c* will be set rotating, and the lever *f* will touch the contact arm *k*, thus closing the circuit of the battery *g*, and producing an igniting spark, which will result in an explosion. The disk *c* before operation is held by a weak spring or the like in a position neither at right angles to the longitudinal axis of the resonator nor susceptible of producing a contact between the levers *f* and *k*.

In order to prevent an involuntary explosion, which might result from a signal given by the siren of some other warship tuned by chance to the same sound, means may be provided to enable the ignition to be produced only after a certain number of signals have been given. This invention seems to be preferable to the ignition by electrical waves which has likewise recently been suggested, as an involuntary ignition is more liable to be produced with the latter, owing to the numerous applications of wireless telegraphy.

The Current Supplement.

The current SUPPLEMENT, No. 1573, opens with an article on the Interborough Rapid Transit Company's test of Subway engines. The use of alcohol as fuel for internal-combustion motors is discussed. James Swinburne writes on efficiencies with his usual force and clearness. One of the best articles that has ever appeared in the SUPPLEMENT is that by Lionel Calisch on single-phase alternating-current railway work. The physics of ore flotation is discussed by J. Swinburne and G. Rudorf. Prof. Jacques Loeb, whose recent investigations in biology have attracted worldwide attention, writes on the changes in the nerve and muscle which seem to underlie the electrotonic effects of the galvanic current. Louis H. Gibson contributes an article on the principles of success in concrete block manufacture.

The Deutsch-Archdeacon Prize for Flying Machines.

In view of the widespread interest in flying machines of the heavier-than-air type at present, the rules of the Deutsch-Archdeacon $10,000 prize contest for the first machine of this type to make a successful flight in France will be of interest. Additional prizes, which may be competed for by either airships or flying machines, were noted in our issue of February 10.

1. Any type or size of apparatus may compete, provided it does not rely for its suspension on any gas which is lighter than air, nor have any material connection with the ground during its flight.
2. Those desiring to make a trial must notify the Aero Club de France.
3. Each entrant must send a fee of fifty francs before he makes his trial. The entry fee is not returnable; it covers all trials made by the entrant during one day only.
4. Notification of a trial must be made in time for the Aero Club officials to be advised on the previous evening at least. Should the trial ground be far distant from Paris, the notification must be sent in earlier than this.
5. Trials will be only recorded between sunrise and sunset.
6. The committee reserve the right of refusing to officially observe a trial if the *bona fides* submitted to them are not considered to give sufficient evidence of extensive private experiments. On this point their decision is final.
7. Only one entrant may make trials during one day. If there are more entries, the others must compete on successive days, following the first.
8. Entrants must specify the starting and turning points, which must be separated by at least 500 meters.
9. Trials must be held in France, and if conducted outside a radius of 40 kilometers from Paris, the competitor must bear the expenses of the official observers.
10. Trials may only take place in the presence of club officials. The "start" will be considered to occur when the machine ceases to touch the ground. If the experimenter does not wish to alight on returning, he must drop some object on the ground within a radius of 25 meters of his starting point.
11. The club officials may take any steps for the general safety, but are, nevertheless, not responsible for accidents.
12. The prize may be competed for within five years from the 1st of October, 1904.

Quartz Vessels and Apparatus.

In 1899 M. Heraeus succeeded in melting a considerable amount of quartz in the oxy-hydrogen furnace, using iridium crucibles, as this was the only metal which would stand temperatures as high as 1,850 degrees C. without melting or acting on the material under treatment. Later on, in connection with the work of Siebert and Kühn, he attempted to form vessels and apparatus of quartz. The technique of the process gives rise to two main operations. The first is the fusion of the quartz. It is brought to the proper temperature to modify its structure, and this causes a change of the optical properties. Near 570 degrees the large pieces split up into fragments. This had led Shenstone to make certain researches in 1901, but without being able to treat the large pieces by the blowpipe otherwise than by a double operation. Shenstone's method consists in heating the large pieces to 1,000 degrees and quenching them in water, thus procuring a material which had lost all transparence, or nearly so, but which when reduced to fragments could be vitrified by the blowpipe. This process, taken up by Heraeus, only gave a quartz glass which was full of air-bubbles. To remedy this he was obliged to return to the current method which consists in melting the matter in iridium or iridium-ruthenium crucibles placed in a refractory furnace and heated by the oxy-hydrogen blowpipe. The vitreous modification is produced at about 1,700 degrees or 80 degrees above the fusing point of platinum. Such a product has only very large air-bubbles, which are suppressed by keeping the bath fluid. This is easily possible, as iridium tubes are made now which resist 2,000 degrees for a long time. In the second place we have the fabrication of the quartz vessels and other apparatus. Shenstone's first attempts gave only very small ones. Later on, Kühn made vessels up to 50 c. c. and larger by joining together smaller pieces which were obtained by blowing. However the process of making quartz vessels is a delicate one owing to the great heat of the melted matter. New methods would be of especial interest, for the quartz is of great use in industry, as it is not attacked by acids, water, saline solutions, and it can undergo varied oxidiations at high temperatures. Care must be taken in this case that the pieces are quite clean and do not come in contact with the hand or with other objects.