mounted in the tubular base. At the outer end of the base are two cylindrical shutters, which may be rotated to expose the glass faces of the two outer prisms mounted in the tubular base. The outer prisms face the target, and the middle prisms face the range-taker. The binocular consists of two telescopes which are connected by a hinge, so that they may be adjusted to varying angles with each other. Between the eye caps is a horizontal rod on which is a graduated scale called the "distance-of-eyes scale." On looking through either telescope at the sky, a balloon is seen with the tail-rope hanging down. The bottom of the tail-rope is at the middle of the field of view. There are really two balloons seen as one by the two eyes. Each eye cap can be revolved to focus the telescope to suit the eye, and this adjustment may be read on focal scales on each eye cap from +10 to —10 divisions. Adjustment of the left eye cap provides for raising or lowering one balloon relatively to the other. On the right side of the binocular there is a drum head carrying a dial with a flat, spiral distance-scale, registering the number of hundred yards from 500 yards upward. This scale is read by a pointer which moves along the spiral radially, to read successive revolutions. On the left side of the dial is a graduated circle, divided into a hundred parts with a fixed pointer.

Fig. 1 shows the shape of the prisms and the path of the two beams of light from the target entering the two outer prisms, suffering a double reflection at each prism, passing along the tubular base, thence through the middle prisms and entering the binocular parallel to their original direction. The two beams of light pass through the object glasses *GG'* of the binocular, and form two images of the target at *I* and *I'* on the line of the beam of light passing through the center of the object glass. In Fig. 2, if *T* be the target, *AA'* the base, then *II'* are the images of the target. By swinging the telescope at the right so that the light travels along *G i*, which is parallel to *G' I'* then the two

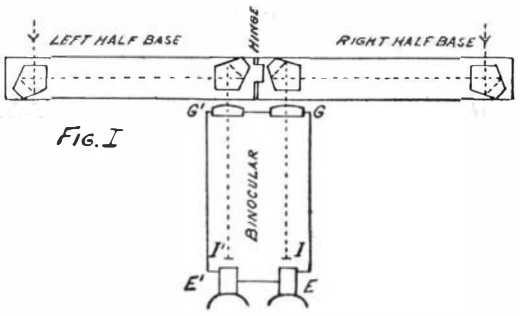

FIG. I

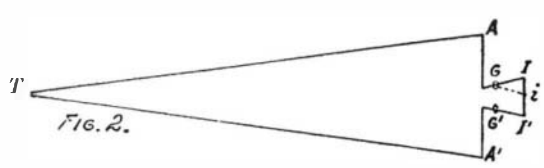

FIG. 2.

images at *I'* and *i* would be seen as one. We measure the distance *I i*, by the drum-head which works a micrometer screw.

$$\text{Now } AT = \frac{GI}{Ii} \times AA'$$

$$\text{or distance of target} = \frac{GI}{Ii} \times \text{length of base} = \frac{GI}{Ii} \times 2 \text{ yards.}$$

$$\text{In the binocular used } \frac{GI}{Ii} = \frac{810}{\text{number of revolutions of drumhead}}$$

So for any distance of target *D* we have to mark that distance on the spiral scale when it and the micrometer screw have turned through a

$$\text{number of revolutions} = \frac{810}{D} \times 2 \text{ yards} = \frac{1{,}620}{D} \text{ yards.}$$

For 1,000 yards it is 1.620 revolutions; for 2,000 yards it is 0.810 revolution, and so on. In this way the graduations for different distances have been calculated.

In order that the range finder may be properly used, it is necessary that every man in the army should have his optical constants determined once a year and given to him on a card for reference. These may read as follows: *L* —1
R 0 This means that left focal scale should
D 66
in this man's case be at —1, the right focal scale at 0, and the distance-of-eye scale at 66 divisions. To take a range the binocular is directed toward the target, and the man is virtually seeing the target by means of eyes placed at the two ends of the base six feet apart. He can then judge relative distances of objects. In looking at the balloon he lays the tail rope of the balloon just above the target and not on any account on it. He notes that he sees both *R* and *L* on the balloon, else he is using only one eye and cannot work. Then by twisting the milled head one way or the other, he brings the balloon near to him or moves it away from him. He should begin with the balloon nearer than the target (by setting the distance scale to 500 yards) and watch the balloon going away as he turns the milled head, always keeping the tail rope above, and never on, the target. He stops turning when the balloon is over the target, and then he reads the difference on the scale in hundreds of yards.

New Chemical Compound.

The aluminate of magnesium is a new product which M. Emile Dufour has succeeded in obtaining. An account of the method used has been presented to the Académie des Sciences. In an electric furnace, using a powerful arc of 1,000 amperes and 60 volts, is heated a mixture of 100 parts of alumina and 230 of oxide of manganese, the heat lasting for 3 minutes. In this way is obtained a porous mass of a brownish-black color, with a metallic reflection. When broken it presents an irregular surface which is of a fine light green color and shows a number of geodes of a brown color lined with brilliant crystals of the octahedral system. To separate the compound the material is broken and treated with hydrochloric acid; gases are given off and the liquid takes a brown tint, which changes gradually to a light yellow. A crystalline deposit is thus obtained which is still further purified and analyzed; its composition corresponds to the formula Al_2O_4Mn. The aluminate of magnesium has the form of small transparent crystals of a light yellow color, having the appearance of octahedra, but somewhat modified on the angles. Their density at 20 deg. C. is 4.12. This body is harder than quartz, and its powder is of a light yellow color. It is quite stable under ordinary conditions, but oxidizes easily when heated in air. At a red heat it gradually changes color to a dark brown, becoming somewhat lighter upon cooling. In oxygen this oxidation, which was before only superficial, is more rapid and takes place below a red heat. Fluorine attacks it with incandescence at a red heat, but it is not acted upon by bromine, iodine or sulphur. It is insoluble in hydrochloric acid, but is easily attacked by nitric and hydrofluoric acids, and especially by sulphuric acid. Oxidizing agents, such as chlorate and nitrate of potash in fusion, and also the alkaline oxides or carbonates, decompose it easily.

Test of a Steel Road.

The new steel trackway on Murray Street, between Broadway and Church Streets, New York city, was recently tested with a two-horse ashcart with a hopper body of sheet iron, the whole weighing 3,700 pounds. Instead of a dynamometer a short ice balance was used. It was found that the cart was started on the steel by a pull of 320 pounds. The wheels were somewhat too wide for the track, so that it was difficult to keep them from binding on one side or the other against the flanges of the steel plates. It was while they were thus bound that a pull of 320 pounds was required to start the cart. Later it was found that only 200 pounds was required. After it had gathered way, the cart was kept moving by an average pull of 100 pounds.

The Current Supplement.

The current SUPPLEMENT, No. 1410, is distinguished by the usual variety of articles on engineering, electrical and mechanical subjects. The opening of the Assouan Dam is commemorated fittingly by a discussion of its engineering features and by illustrations of its more prominent portions. The English correspondent of the SCIENTIFIC AMERICAN continues his discussion of water-tube boilers. The present installment deals with the British Stirling boiler. Sir W. H. Bailey discourses in a scholarly way on the mechanical inventors of Lancashire, England. "Irrigation" is the title of a copiously illustrated article on a matter which, to the western portion of the United States in particular, has been of immeasurable importance. The article describes painstakingly the best methods of irrigation which have been followed in this country. Mr. F. T. Jane continues his interesting fictitious naval battles.

One of the latest long-distance and high-speed electric railways is that from Seattle to Tacoma, which has recently been completed and put into operation. The power is furnished from the Snoqualmie Falls plant, which is thirty-one miles from Seattle. The line is about thirty-four miles long, and the current is transmitted outside of the cities at 27,500 volts; and at substations distributed along the line, this alternating current drives motors direct-connected to direct-current generators, which will supply the third rail with current at 600 volts. The third rail weighs about one hundred pounds to the yard. It is expected to maintain an hourly service between the two cities. The trains will consist of two cars, as a rule. The motor consists of a combination baggage and passenger car about 42 feet long equipped with motors with an aggregated capacity of 500 horse power, and it is expected to make a speed of a mile a minute.

Correspondence.

The Aerodrome.

To the Editor of the SCIENTIFIC AMERICAN:

The article on aerodromes by S. D. Mott, in the SCIENTIFIC AMERICAN SUPPLEMENT, No. 1399, while containing some very ingenious ideas incorporated in the machine therein described, makes the following statements, which I believe are ill-founded, viz.: "In conclusion, it must be acknowledged that this conception eliminates from the problem of manflight the confusing devices usually considered indispensable for maneuvering a so-called airship; . . . or, as it has been more scientifically stated by a practical, conservative engineer, one of the faculty of Columbia University, 'The plan of controlling the direction of the lifting components of your machine by shifting the center of gravity is sound.' "

An examination of the drawings leads me to believe that although if the aeroplanes were rigidly fixed to the body of the machine, including the circular ways of the operator's seat, the center of gravity of the machine *might* be shifted, still, according to the construction of this machine, this is not the case. It seems to me that the only effect of moving around on the circular ways would be to turn the whole body of the machine around the axis of the areoplanes, and that the operator would remain at the vertically lowest position, on the principle of a mouse in a wheel; or to give a comparison more nearly representing the conditions, it would be like a swimmer trying to climb up the side of an empty barrel in the water; the barrel would turn, and the swimmer sink to the lowest position and remain there.

Now, as the aeroplanes in this machine must necessarily have almost frictionless bearings, it seems to me that although you may pull the circular ways around, you cannot alter your relative position toward the line of flight, or raise it above the lowest vertical position.

Furthermore, I believe that unless a rudder of some kind is fixed to the machine, the machine would be absolutely unmanageable, being turned in every direction by the wind, like a windmill or weathervane.

I would suggest to Mr. Mott that he might construct a much simpler machine on the same lines by the use of the marine turbine of Col. J. J. Astor, described in the SCIENTIFIC AMERICAN of November 8, 1902, instead of the motive power he describes.

F. McC., Mining Engineer.

Mexico, December 10, 1902.

Effect of Electricity on Plant Life.

To the Editor of the SCIENTIFIC AMERICAN:

It has long been a matter of speculation with me just why a rain will help plants so much more than any form of artificial watering. The popular theory is that when water is applied to vegetation by the latter method, the heat of the sun causes a kind of steam to form, which scorches it. This is obviously incorrect. My own conclusion, which I reached some time ago, and which may, for all I know, be the accepted scientific explanation, is that rain stimulates the plants on which it falls because it is charged with electricity, and that the mere wetting of a plant has little effect on it.

A few weeks ago I was reading, in your journal, I believe, of an experiment that confirms my view, and incidentally suggests an idea, which, if carried into execution, might prove of immense value. It appears that some experimenter passed a current through some pots in which plants were growing, with the effect that they showed a decided gain in size and fertility over those similarly situated, but not so treated. The difference, if I remember aright, was forty per cent.

Now, why would it not do to apply water electrically charged to the vegetation, and thus simulate, as nearly as could be, nature's method? The water could be placed in a vessel from which the electricity could not escape, an insulated barrel, for instance, or a pail bottomed with rubber or glass. After the water was charged, it could be applied with the aid of an ordinary rubber hose, with a non-conducting nozzle; and that would be all that was necessary.

Now, I am not an electrician, and have not the means of trying this experiment myself, but if some experimenter would follow my suggestion, I believe discoveries of great practical value might be made.

SYDNEY C. HALEY.

Eustis, Fla., December 18, 1902.

Within the past few months, the Rogers Locomotive Works at Paterson, N. J., have been enlarged by the addition of two large tracts of land. On one of these a new erecting shop is being built, and the other piece will be used for yard purposes principally, although some new buildings will be erected thereon. An imposing building for the construction of tenders will soon be under way, and extensions are being made to the boiler and hammer shops.

Our Foreign Commerce.

The figures of the foreign commerce of the United States during the eleven months ending with November, which have just been completed by the Treasury Bureau of Statistics, indicate a phenomenal activity among the manufacturers of the country and exportations quite as large as could be expected in view of the crop shortage of last year. The value of manufacturers' materials imported into the United States during the eleven months ending with November this year is $407,603,599, against $353,417,288 in the corresponding months of last year, and forms 46½ per cent of the total imports, against 44 per cent of the total imports in the corresponding months of last year. Manufactures exported during the eleven months of 1902 amount to $377,635,961, against $362,392,181 in the corresponding months of last year, and form 31.8 per cent of the total, against 27.8 per cent of the total exports in the same months of 1901. The total imports are $75,000,000 in excess of those for the corresponding months of last year, and of this increase of $75,000,000, $54,000,000 was in the class "manufacturers' materials" and the remainder manufactures and luxuries, articles of food and animals showing a reduction of $10,000,000, as compared with the importations during the corresponding months of last year.

Nearly all of the great articles required for use in manufacturing, with the single exception of india rubber, show a marked increase in importations. Importations of raw silk, for example, amount to $40,905,393 in the eleven months of this year, against $35,411,000 in the corresponding period of 1901; hides and skins, $53,022,521, against $50,877,797 in the eleven months of last year; tin for use in manufacturing tin plate, $19,532,807, against $17,415,302 in the corresponding months of last year. India rubber importations show a slight falling off, the total for eleven months being $22,568,786 this year, against $25,929,985 in the same months of last year.

The most striking increase in importations is in manufactures of iron and steel, which amount, for the eleven months, to $36,766,961 in value, against $18,-267,677 in the corresponding months of last year, the value of the importations having thus more than doubled this year as compared with last year. Practically every item in the list of iron and steel manufactures shows a marked increase. The export figures of iron and steel manufactures show a reduction, the total exports for the eleven months being $90,136,024 this year, against $94,091,967 in the same months of last year and $119,604,848 in eleven months of 1900.

The total exportation of the eleven months falls $116,000,000 below that of the corresponding period of 1901. This reduction occurs in agricultural products, of which the exportations during the eleven months of this year fall $130,000,000 below those of last year, indicating that in the other great classes, especially manufactures, there is an increase. This reduction of $130,000,000 in agricultural exports is due in part to the increased home demand, in part to the loss of a part of the corn crop of last year, corn exportations having fallen from $49,501,374 in eleven months of 1901 to $6,745,151 in the corresponding months of this year. There is also a considerable reduction in the value of wheat exported, due to the fact that last year's exportations were exceptionally large.

Governmental Aid in Improving Our Highways.

The system in vogue in some States, of appropriating sums of money for road improvement in towns and villages, provided the taxpayers of these places pay one-half or other proportionate amount of the expense involved, has been found to operate so well that the bill recently introduced in the House of Representatives by Mr. Brownlow, for the purpose of establishing a National Bureau of Road Construction, appears to be the logical outcome of it. This bill provides for a new Bureau of Public Roads in the Department of Agriculture, whose object shall be "to instruct, assist, and co-operate in the building and improvement of the public roads, at the discretion and under the direction of the Director of said Bureau, in such States, counties, parishes, townships, and districts in the United States as shall be determined upon by said Director. The general policy of such Bureau shall be to bring about, so far as may be, a uniform system of taxation for road purposes and a uniform method of road construction, repair, and maintenance throughout the United States, and to co-operate with any State or political subdivision thereof in the actual construction of permanent highways."

The new Bureau is to be under the general supervision of the Secretary of Agriculture, and is to have a Director and suitable corps of clerks, civil engineers, field and road experts, a chemist and assistant in charge of the road material laboratory, a petrographer, and such other officers, agents, and servants as may be required for carrying out the provisions of the Act.

The bill provides an appropriation of $75,000 for salaries and general expenses of the Bureau, and for the purpose of enabling the Director "to make inquiries in regard to systems of road building and management throughout the United States; to make investigations and experiments in regard to the best methods of road making and the best kinds of road-making materials; to co-operate in the building of object-lesson roads in the several States; to employ local and special agents, clerks, assistants and other labor required in conducting experiments and collecting, digesting, reporting, and illustrating the results of such experiments; to investigate the chemical and physical character of road materials; to purchase necessary apparatus, materials, supplies, office and laboratory fixtures; to pay freight and express charges and traveling and other necessary expenses; to prepare, publish, and distribute bulletins and reports on the subject of road improvement; to enable him to instruct and assist in the building and improving of the public roads and highways in such States, parishes, counties, townships, and districts in the United States as shall determine to follow the plans and methods directed and determined upon by the Director of said Bureau; and to enable him to assist agricultural colleges and experiment stations in disseminating information on the subject of improved roads.

"Any State or political subdivision thereof, through its proper officers having jurisdiction of the public roads, may apply to the Director of the Bureau for co-operation in the actual construction of a permanent improvement of any public highway within the State, by presenting an application accompanied by a properly certified resolution stating that the public interest demands the improvement of the highway described therein, but such description shall not include any portion of a highway within the boundaries of any city or incorporated village. The Director of said Bureau, upon receipt of any such application, shall investigate and determine whether the highway or section thereof sought to be improved is of sufficient public importance to come within the purposes of this Act, taking into account the use, location, and value of such highway or section thereof for the purposes of common traffic and travel, and for the rural free delivery of mail by the United States Government, and after such investigation shall certify his approval or disapproval of such application. If he shall disapprove such application, he shall certify his reasons therefor to the public officer or officers making the application; but if he shall approve such application, he shall cause the highway or section thereof therein described to be mapped, both in outline and profile. He shall indicate how much of said highway or section thereof may be improved by deviation from the existing lines whenever it shall be deemed of advantage to obtain a shorter or more direct road without lessening its usefulness, or wherever such deviation is of advantage by reason of lessened gradients. He shall also cause plans and specifications of such highway or section thereof to be made for telford, macadam, or gravel roadway, or other suitable construction, taking into consideration climate, soil, and material to be had in the vicinity thereof and the extent and nature of the traffic likely to be upon the highway, specifying in his judgment the kind of road a wise economy demands. The improved or permanent roadway of all highways so improved shall not be less than eight nor more than twenty-four feet in width, unless for special reasons it is required that it shall be of greater width. He shall, if requested by the application, include provisions for steel-plate or other flat-rail construction in double track."

Upon the completion of the maps, plans, and specifications, an estimate is to be made of the cost of construction and submitted to the officials from whom the application for assistance proceeded. These officials must then file a second application, confirming the first, before the Director is authorized to advertise for bids in the vicinity of the work. In case the line of the road is to be changed and a new right of way has to be obtained, the applicants must secure this.

In regard to the expense of the construction, the Federal government bears one-half of this. The other half may be divided between the applicants, the county, and the State, if so desired, or may be borne by either alone. An appropriation of $20,000,000 is asked for to cover the cost of construction, with the provision that no State shall receive a greater proportion of the total amount appropriated than its population bears to the population of the United States.

The results of governmental supervision in road construction will in time be far-reaching and of vast importance. A scientific study of materials and methods of road building, aided by experience which will soon be had as to the most suitable construction for varying conditions of soil and traffic, will enable the government to build roads that will last indefinitely, if properly maintained. The only weak point in the present bill seems to be, that no provision is made for such maintenance and keeping in repair of roads thus constructed. This, however, can be easily added, and doubtless will be before the bill is passed. With its passage, the construction of a splendid transcontinental highway will become a possibility which, let us hope, will be realized in the near future.

Sociological Aspect of the Irrigation Problem.

In a paper read before the American Association for the Advancement of Science, Mr. Guy E. Mitchell stated that the reclamation of arid America through government construction of irrigation works will furnish for years to come an effective outlet for the industrious surplus population of our great cities. The irrigation sections of the West present almost ideal rural conditions. The tendency is, where water is used for farming, to subdivide land into small individual holdings, which gives to a community a prosperity and stability not found in larger farming districts, nor in cities. This is not a new idea. But while this is being done, the people of the entire United States will become so educated in irrigation matters and irrigation methods that there will be a gradual spreading eastward of the irrigation idea. This will eventually result in the subdivision of great numbers of large eastern and southern farms and plantations which are now farmed without thought of artificial water supply, into smaller irrigated farms. Never a season goes by, even in the best watered districts of the rain belt, that there is not some period of plant growth where the judicious application of water would very greatly increase the yield, and in some years double and treble it. It takes only a year of excessive drought among eastern farmers to get them talking about irrigation, but little comes of it for the reason that they are entirely unfamiliar with irrigation methods and have no idea how to go about the practice of supplementing the natural water supply. The irrigation, then, of the one hundred million acres of western plains and valleys, while it will create innumerable small rural homes of five, ten, twenty or thirty acres each, will serve further to encourage subdivision of larger areas in the East and South and tend to make the small farm and home a general rule throughout the entire country.

Under wise administration, arid America has a glorious future. With her countless small farms and rural homes, communities where people live in the open air, till the soil with their hands and yet enjoy the privileges and advantages of the city, she will prove the sheet anchor of the republic in any time of national peril; while from her will radiate eastward the same idea of the division of the large into small farms, and the utilization of the stream and the pond in making certain and increasing an oftentimes unreliable crop.

Science Notes.

The contract for replacing the great telescope that was destroyed by fire recently at the Yerkes Observatory at Williams Bay, Wis., will probably be given to Prof. John Brashear. Six months will be required to complete the work.

It is very doubtful whether the splendid work carried on at Ben Nevis will be continued. Want of funds threatened an interruption in the observations some years ago. Then Mr. Mackay Bernard, of Dunsinnan, came to the rescue. Since 1883 the Ben Nevis Observatory and the Low-Level Observatory at Fort William, connected with it, have altogether cost £24,000, some of the observers giving their services for the cause; £17,000 were received by subscription. The Meteorological Council has allowed £100 yearly for the Ben Nevis Observatory, and, since 1890, £250 for the Fort William station. The directors were officially informed this summer that the latter sum would be stopped.

The Department of Vertebrate Paleontology of the American Museum of Natural History has come into possession of three specimens of rare interest. The first is the complete skeleton of a small dinosaur, which has been named "the bird catcher," by reason of its apparent ability to run fast and its long, slender, grasping fore limbs. The second specimen is the great *Portheus molussus*, secured by Charles H. Sternberg in Kansas in 1900. The fish is 16 feet long, and is one of the most striking specimens of a fossil to be found in any of the world's museums. The third exhibit is a superb pair of tusks of the great *Elephas imperator*, found last year in Texas. The tusks are 13½ feet in length and about 2 feet in circumference.

Floyd J. Metzger makes a preliminary announcement on a new method of separating thorium from cerium, lanthanum and didymium. He finds that from a 40 per cent alcoholic solution, thorium is precipitated quantitatively on the addition of fumaric acid, while no change is produced by that reagent in cold solutions of cerium, lanthanum or didymium. When thorium is precipitated in this way in the presence of the above-mentioned elements, traces of these are carried down with the thorium, but may be removed by a single reprecipitation. A number of other weak organic acids are being investigated in the same way, and several of these show interesting results.—Journ. Amer. Chem. Soc.