of the Cooper Creek canal, in the unlikely event that the canal could not be bought. There is no question that the establishment of the new route will make the Albemarle and Chesapeake canal a useless property, if its owners insist on retaining it, consequently it is considered a foregone conclusion that they will sell rather than suffer a loss. The price dictated by the engineers was simply the one which would be economical for the government to make the purchase with—and is in no way a "force-out price." It is, moreover, a large and therefore more than fair price for the length of cut it is designed to purchase.

The mechanical and engineering difficulties are few and small in number. The earth is soft clay and sand mixed, easy to remove with steam shovels and dredges. The climate is somewhat malarious, but the opening of almost all new waterways is that. Insect pests will probably prove a minor vexation. It is not known, and cannot be known, whether all the dredging excavations in the various sounds will result in permanent channels, particularly in the narrow Croatan Sound, where a stronger current and higher waves are met with than in any other place on the route. But the engineers recommended a maintenance plant, and a certain amount to be appropriated yearly for keeping the waterway open, rather than submitting this part of the work to contract; and such a recommendation will undoubtedly be adopted. If Croatan or Currituck Sound fills up the dredged channels, therefore, the maintenance plant will simply be kept busy upon them when necessary, dredging out what the waves and wind fill in, very much as dredges are almost continually at work on the large and important channels in the great harbors of the world.

The photographs show the character of the work to be done, and there is one class of structure which need not be repeated, namely, wooden revetment for the banks; this is admitted by the present Albemarle and Chesapeake canal management to have been an unnecessary investment and practically a waste of money.

Work will probably be started as soon as the season opens, and continued right along, further appropriations being called for as the work progresses. The entire waterway will be built, of course, by United States army engineers.

The British Naval Programme for 1907.

Pursuing the policy adopted for 1906, the British naval programme for the ensuing year shows a still further reduction, the estimates for 1907 being $7,135,000 below those of the preceding year. The total sum required for the naval defenses for the current year is $152,212,045, of which total the expenditure upon new construction will absorb $40,500,000, a reduction of $5,675,000 as compared with the appropriation to this end for 1906. According to the Parliamentary papers devoted to the question, many important innovations are to be made during the coming year, the most important feature of which is to be the creation of a new striking force to be known as the Home Fleet.

The constructional programme is of great importance, emphasizing as it does the complete success that has attended the evolution of the "Dreadnought" class of battleships. At least two similar vessels are to be laid down, the number to be increased to three should the coming discussion among the powers at The Hague Conference regarding the limitation of armaments prove abortive. These vessels will be of somewhat larger dimensions and displacement than the "Dreadnought," and the experience that has been gained with the latter vessel in regard to armament, details of construction, and motive power will be advantageously incorporated in the proposed warclads. Furthermore, an improved design of heavy gun, trials with which have proved eminently successful, is to be adopted for the arming of these vessels, but particulars concerning their caliber and so forth are withheld. In addition, 1 fast armored cruiser, 5 destroyers, 12 torpedo boats, and 12 submarines are to be commenced. With the exception of 1906, when no cruisers were laid down, the present is the smallest British cruiser programme on record. It is generally realized, however, that the coming of the "Dreadnought" class of battleship, which has not yet been fully proved, places the cruiser in a somewhat transient stage, and the present decision to limit strictly the number of cruisers is influenced by these conditions.

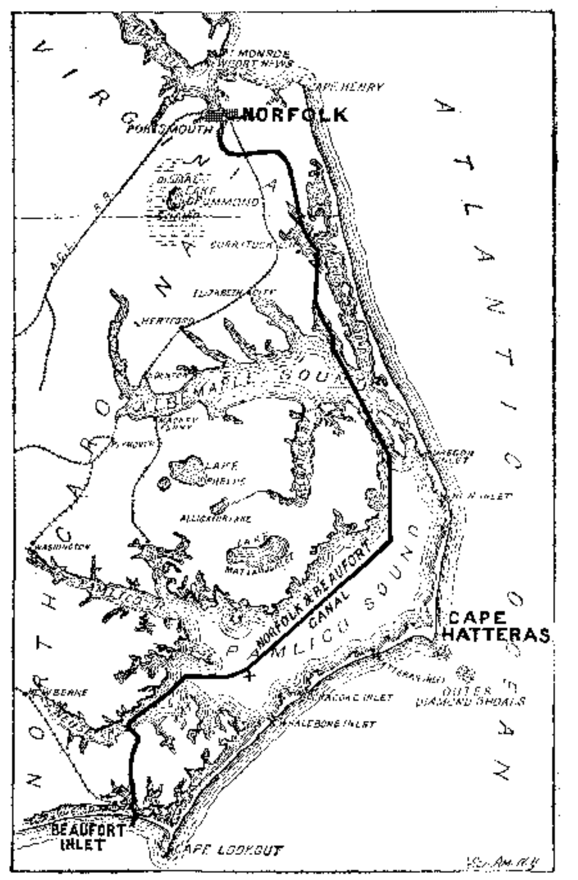
…ring the past year 4 first-class battleships, 3 …d cruisers, 11 submarines, and 7 first-class …boats have been completed and passed into … while there are at present under construc… …leships, 7 armored cruisers, 17 first-class …rpedo boats, 8 ocean-going destroyers, and 12 sub…arines.

During the trials of the "Dreadnought" great secrecy was maintained concerning the behavior of the tur…nes with which it is equipped; but that this propelling machinery is eminently adapted to naval requirements under all and varying conditions is substantiated by the statement that "the results obtained in the 'Dreadnought' and in the other turbine-propelled vessels which have been completed this year justify the adoption of this type of propelling machinery for his Majesty's ships, and this policy is being continued in all war vessels of this year's programme." It will thus be seen that the year 1906 marks an important era in naval engineering by the virtual passing of the reciprocating engine by the rotary motive power, so far as Great Britain is concerned.

The decision to constitute a new striking force by the creation of a Home Fleet, due to the readjustment of the balance of power in consequence of the Russo-Japanese war, is of far-reaching importance. By the distribution of the naval strength the present nucleus crews of ships in the first fighting line will be considerably augmented, while there will be complete manning of squadrons of six battleships and six armored cruisers which will not leave home waters. In addition to these 12 first-class ships, there will be 48 destroyers with full crews, some small cruisers, and the requisite auxiliaries concentrated at the Nore, and these will be maintained on a footing ready for any emergency. The term "in reserve" will no longer be applicable, since all sea-going ships in home ports not belonging to fleets or squadrons will become apportioned to the Home Fleet, and will be so maintained as to be able to proceed to sea with full crews at a few hours' notice.

During the past year a considerable improvement has been effected in regard to the gunnery. In battle practice, by which the gunnery organization of the ship as a whole is tested, and which is therefore the best criterion of efficiency, the average number of hits per ship was practically double that of the previous year, notwithstanding the fact that the 1906 tests were of a more severe nature, the mean range having been increased to 1,000 yards, and the time available for firing restricted to one minute or less.

In the gunlayers' test with heavy guns, the average number of points obtained per man was 80.065, representing an increase of 11.805 per man upon the previous year; or comparing the percentage of hits to rounds fired, it was 71.12 as compared with 56.58. With regard to the quick-firing guns, the percentage of hits to rounds fired rose from 21.63 in 1905 to 34.53 in 1906. In the battle practice of the torpedo-boat destroyers the increase was equally well maintained, the percentage of hits to rounds fired being 20.05 in 1905 to 34.6 in 1906. This improvement is general throughout the whole fleet, and is not confined to a picked selection of crack ships. As a result, the British fleet as a whole, both as regards vessels and personnel, is in a greater state of efficiency than it has been before for a number of years, and this improvement gives every prospect of being well maintained.



Map Showing the Route of the Norfolk and Beaufort Canal for Which Congress Has Recently Appropriated $550,000.

The United States Drainage Commission tests have shown that the best circumferential velocity for the impellers of centrifugal pumps is approximately 50 feet per second. This would represent, for example, a whirl velocity through the discharge of the impellers of, say, from 30 feet to 40 feet a second, which velocity must be slowed down to 12 feet per second or less in the discharge piping connected with the pump.

Correspondence.

The Moth and the Flame.

To the Editor of the Scientific American:

An interesting article, "The Moth and the Flame," which appeared in the Scientific American some time ago, is undoubtedly correct.

One night as I came upstairs to my room I heard the buzzing noise of a large number of moths beating against the window in trying to get through. It was very dark in the room, but the window was somewhat illumined by moonlight, and for that reason the moths were trying to get out by way of the window. I am satisfied that for them lightward means outward, while darkward means inward.

As soon as I struck a match, for the purpose of lighting the lamp, they all rushed toward it, apparently assuming that there was an opening.

After the match was out they flew around a little, and then returned to the window. As soon as I noticed this, I remembered what I had read, and tried the experiment again, with the same results.

When the second match was out, I lighted my lamp with a third one. After the lamp had been burning a few seconds, they left the window and rushed against the chimney again and again. This, according to my opinion, is pretty good proof of what the writer of the article mentioned above told the readers of the Scientific American some time ago.

New Braunfels, Texas. W. Mittendorf.

The New Army 14-Inch Gun.

To the Editor of the Scientific American:

According to the Army and Navy Journal, it is the intention of the Ordnance Department to build three 14-inch guns at once. This would indicate that the department intends to build these guns and mount them for service without subjecting one to an endurance test. If such is the intention, it seems to be a very unwise and dangerous plan, for an emergency might arise and these guns be found to be unfit for service after a very short action.

I am sure it is unwise to build the proposed 14-inch guns for many reasons to which you have called attention in your valuable paper, such as higher angle of elevation, shorter danger space and danger zone, heavier ammunition, longer time of flight, fewer shots in a given interval of time; to say nothing of the expense involved in building them. There is another and far weightier reason for not building them:—the object desired—a longer-lived gun—will not be obtained. Especially is this true if the department builds, as the chief of ordnance has reported it will, a 14-inch gun as light or lighter than the present 12-inch gun which it is to replace. I am sure it will be no longer-lived; in fact, I should not be surprised if it proved to be even shorter-lived.

The short life of a gun is due to scoring or erosion. This scoring results from two causes. The first you have several times pointed out, i. e., faulty obturation before and at the time the rotating band takes the rifling. The second cause, which increases the effect of the first cause and carries the effect farther down the bore, has been apparently overlooked by investigators of this question.

In building guns the bore is placed under a condition of initial compression either by shrinkage or by winding wire under a tension. In either way the effect is the same: the bore of the gun is made smaller by this compression. Now in action, the pressure of the powder gases tends to overcome this initial compression and so must enlarge the bore of the gun while it is at the same time compressing the heel of the shot. This leaves a space through which the gases rush past the rotating band and score the walls of the gun.

The first of these two causes has been recognized by Major Peirce, of the Ordnance Department, in his investigation of the scoring in shoulder arms. The effect of the second cause is not so great in the shoulder arms, for the reason that the scoring effect is overcome once the bullet is well seated in the bore, by the upsetting of the bullet by the pressure of the powder gases against its base, and the further facts that the bullet has a long bearing surface and a diameter of 0.308, while the diameter of the bore at the bottom of the grooves is but 0.306 and the shoulder arm is rifled with a uniform twist.

This expansion of the gun under pressure accounts for the fact that the scoring is greater on the lands than in the bottom of the grooves, for when the bore is expanded away from the shell by the powder pressure, the tendency of the gases to move in a straight line carries them across the lands which, offering the more vulnerable surface, are the more scored. It also accounts for the fact that with the same pressures and velocities the greater the bore the shorter the life of the gun, for under the same pressure a 12-inch gun would expand twice as much as a 6-inch gun and cause the gun to score at least twice as fast. This is true with the thickness of the walls of the gun in proportion to the caliber of the gun. It is the intention of the department not only not to have the thickness of the walls of the gun proportionate to the caliber, but to have them actually thinner than the walls of the present 12-inch gun. Under such conditions I am sure the proposed 14-inch gun will expand as much under the pressure necessary to give 2,000 f. s. as does the bore of the present 12-inch gun under the pressure necessary to give 2,500 f. s., and therefore score as much or more and be even shorter-lived.

From a careful study of the star-gaging reports of the two 6-inch wire guns recently tested at Sandy Hook, I am convinced that with proper banding and uniform twist of rifling the life of the gun can be materially increased without reducing the present service velocities. I am positive it is possible so greatly to reduce the scoring as to render it unnecessary to reduce velocities and to permit even of increasing them.

I regret and deplore the expenditure of so much money to build guns which, once it is proved that scoring can be materially reduced, will be so much scrap steel. Why not build 12-inch guns on the lines of the two 6-inch wire guns recently tested at Sandy Hook? Such guns would give the required 2,500 f. s. with pressures far below 30,000 pounds, and with proper banding and uniform twist of rifling would have a life of fully 300 rounds. They would have the additional advantage, once it is proved that scoring can be materially reduced, of having a service velocity of fully 3,500 f. s. and still have a life of fully 300 rounds. J. H. BROWN.

Gyroscopic Action of Electric Locomotives on Curves.

To the Editor of the SCIENTIFIC AMERICAN:

A note by Mr. C. H. Kennison in the SCIENTIFIC AMERICAN of March 16, 1907, upon the possible importance of the gyroscopic action of electric motors in cars upon curves, gives rise to an interesting line of thought. Practically, it is scarcely probable that the effect would be appreciable, although we must admit the existence of some such action. It may be of interest to look a little more in detail into just what various forces are concerned.

At the outset it is necessary to call attention to one very common misapprehension as regards gyroscopic force. It is commonly said that a wheel rotating in a given plane offers a resistance to any force tending to change the plane of rotation. This statement is not strictly true. If the axis of rotation of a rotating wheel is moved angularly in a given plane, the gyroscopic force thus developed does not directly act to oppose the motion, but acts in a plane at right angles to that in which the axis moves, tending to deviate it one way or the other. This can be plainly seen by holding a rotating gyroscope in the hands, and attempting to move backward or forward one end of the axis, when it will be found that no immediate and direct opposition exists to the motion in the horizontal plane, but only a force tending to raise or lower the end of the axis. The fact that the gyroscopic force always acts at right angles to the plane of change of direction of the axis cannot be too strongly impressed upon the mind. What is commonly spoken of as the resistance of the wheel to a change in its plane of rotation is only a secondary effect of the gyroscopic force, and is very prettily illustrated in the ordinary gyroscope.

In the common form of gyroscope, the axis when first released falls vertically. The gyroscopic force, or couple, as it really is, does not act in any way to oppose this fall, but simply to deviate the direction of motion from the vertical. The axis therefore takes an inclined path. As the path becomes more and more inclined, the gyroscopic force, always at right angles to the plane of motion of the axis, is directed more and more upward, gradually destroying the fall and deviating this motion into the horizontal direction. The gyroscopic force is now directed upward, opposing the attraction of gravitation. The gyroscopic force begins now to deviate the axis upward at the same time, becoming itself more and more directed backward. The path of the axis hence gradually curves upward until finally the axis comes to rest at the same level as before, but pointing in a different direction. Another loop is described in a similar manner, and so on and on a succession of minute arcs. Hence we see, generally speaking, that the gyroscopic force supports the apparatus, not by direct opposition to the falling, but secondarily by its ability to deviate the motion of the end of the axis into the series of little arcs referred to. A special case arises however when, by a rather common combination of circumstances, the axis attains a certain uniform horizontal velocity, which produces a gyroscopic force just sufficient to support the weight of the apparatus. In this case nevertheless the gyroscopic force, directly opposed to the attraction of gravitation, in no wise opposes the motion of the axis in the horizontal plane.

Let us consider now from a purely theoretical standpoint the question raised by the communication above referred to. Assume the armature of the motor to be directly applied to the axle of the wheels. So long as the track remains straight, the plane of rotation remains unchanged, and no gyroscopic effect results. When the car strikes a curve however, the plane of rotation is forced to change one way or the other, the axis of rotation changing direction in a horizontal plane. The result is the production of a force at right angles to this plane, tending to raise one end of the axis and lower the other. An analysis of the relative motions concerned will show that the gyroscopic force acts in such a direction as to raise the end of the axis nearest the center of curvature of the track, that is, that it tends to overturn the car. The result is the same, no matter which way the track curves. This observation can be easily verified by experiment with the gyroscope held in the hands.

If on the other hand we assume the motor to be geared to the axle so that the armature rotates in the opposite direction to the car wheels, then the tendency of the gyroscopic force is to prevent overturning as the car rounds the curve.

In either case, however, if it is granted that the car does not overturn, it is obvious that the gyroscopic force, being always directed in a vertical plane, can offer no opposition whatever to the change of direction of the car. C. M. BROOMALL.

The Delaware County Institute of Science,
Media, Pa., March 18, 1907.

To the Editor of the SCIENTIFIC AMERICAN:

If you will allow me, I will correct the impression of your recent correspondents, who think the gyrostatic effect of the rotors of an electric locomotive resists the angular movement of the locomotive in going round a curve. A rotating body does not resist a change of plane unless it is free to gyrate, or turn on another axis normal to its axis of rotation. For instance, a gyroscope does not resist the effect of gravity unless it is free to turn in a horizontal plane. In the case of the rotors, being held rigidly as they are in their bearings, the effect of gyrostatic action would be to simply lift on one bearing and bear down on the other, depending on the direction of rotation.

Niles, Mich., March 26, 1907. W. G. BLISH.

The Current Supplement.

The current SUPPLEMENT, No. 1632, opens with a most interesting and exhaustive article on liquid crystals and theories of life. In this article Prof. Lehmann's experiments with liquid crystals are instructively reviewed. The article is elaborately illustrated. Mr. Arthur P. Davis's discussion of the inundation of the Salton Sink is concluded. An excellent paper is that by Mr. William North Rice on the permanence of continents. Those of our readers who desire to learn how half-tone engravings for the SCIENTIFIC AMERICAN and other publications are made should read the article in the SUPPLEMENT entitled "The Making of a Half-Tone Engraving." The chemical composition of tool steel and the more important characteristics of high-speed tools are considered by F. W. Taylor. In winding small induction coils, that is, those giving sparks up to and including two inches in length, the secondary may be formed of bare copper wire wound in layers on the primary helix instead of using insulated wire. How thus to construct small induction coils with bare wire is very clearly explained by Mr. A. Frederick Collins. So clear is his text, and so elucidating the illustrations which accompany it, that any one should be able to construct a bare wire coil by the mere reading of the article. Dimensions are given. Mr. W. H. Wakeman writes on pumping devices for open tank service. The shortly expected return of Halley's comet renders particularly timely Mr. F. W. Henkel's article on the subject.

Official Meteorological Summary, New York, N. Y., March, 1907.

Atmospheric pressure: Highest, 30.57; lowest, 29.55; mean, 30.07. Temperature: Highest, 75; date, 23d; lowest, 16; date, 7th; mean of warmest day, 64; date, 29th; coolest day, 24; date, 7th; mean of maximum for the month, 47.9; mean of minimum, 33.6; absolute mean, 40.8; normal, 37.6; excess compared with mean of 37 years, +3.2. Warmest mean temperature of March, 48, in 1903. Coldest mean, 29, in 1872. Absolute maximum and minimum of this month for 37 years, 75 and 3. Average daily deficiency since January 1, —0.2. Precipitation, 3.80; greatest in 24 hours, 1.03; date, 19th; average of this month for 37 years, 4.08. Deficiency, —0.28. Accumulated deficiency since January 1, —2.00. Greatest precipitation, 7.90, in 1876; least, 1.19, in 1885. Snowfall, 13.8. Wind: Prevailing direction, N. W.; total movement, 8,813 miles; average hourly velocity, 11.8; maximum velocity, 58 miles per hour. Weather: Clear days, 10; cloudy, 10; partly cloudy, 11. Fog, 13th, 14th. Sleet, 12th. Thunderstorms, 19th.

BRANCH RAILWAYS BY THE TELPHERAGE SYSTEM.

The building up of a vast railroad system like that of the United States is marked by two distinct periods: the first, that in which the main arteries of travel are pushed boldly out over the territory to be covered; and the second, that in which these main lines are made accessible for the outlying regions they traverse, by the construction of branch or feeder lines. The railroad system of this country has passed through the first phase, and it is not likely that many, if any more, great trunk lines will be projected. Also, in the East and Middle West, the main feeders to the trunk line have been so far constructed, that they will serve the needs of the country for many years to come. The 220,000 miles of track in the United States probably represent the sum total of trackage of the standard broad-gage type that would yield a profitable return on the investment, if it were worked with the full complement of rolling stock that it is capable of carrying.

At the present time the railroad situation may be said to be face to face with yet another phase of development, which will consist, not in the construction of heavy, broad-gage track carrying heavy rolling stock of the standard type, but of light railways, either of the narrow-gage surface, or of the light overhead type, cheap to construct, cheap to operate, and having a capacity, at least in the case of overhead lines, far exceeding that of any known system of land transportation. Although the narrow-gage railway has met with considerable favor in some European colonies, it has failed to meet the conditions of traffic in this country, its capacity being too small for heavy traffic, and its cost too great for the needs of those sparsely-settled districts where, for the present at least, freight and passenger movements must necessarily be infrequent and small in quantity. Nevertheless, the demand for some inexpensive and easily-constructed railway system which would bring the vast farming districts of the West and Southwest into direct communication with the railroads is most imperative. Could some system of cheap feeder lines be devised, not only would the value of these farms be increased, but the settlement of the sparsely-settled districts would be greatly stimulated; for such a connection would rob the vast prairie lands of the West of those associations of loneliness and isolation which, doubtless, serve to prevent many would-be settlers from making their homes there.

The leading railroad men of the day have been devoting much attention to the system of telpherage, which forms the subject of the accompanying illustrations, with a view to adapting it to the needs of railway service, and particularly to the demand, as above mentioned, for an inexpensive system of branch railways in sparsely-settled country. It is particularly suited to the conditions; for it is cheap to construct, inexpensive in operation, and possesses a flexibility as to capacity which is unequaled by any other method of transportation. The nature of the construction and the simplicity of operation of the Common Carrier Telpherage System, as it is called, are clearly shown in the accompanying drawing, which was made from a description furnished by Mr. John Brisben Walker, of this city, who is the owner of the common carrier rights for the United States, and all the telpherage rights for Canada. In this view, a typical telpherage line is shown starting from the siding of a broad-gage railway, crossing a river, and running into the country to be served, say for a distance of from 20 to 30 miles. The construction is of the most economical kind. It consists of two lines of 8-inch by 10-inch stringers with 20-pound rail, carried at the outer ends of a series of trestle bents consisting of 8-inch by 8-inch caps, spiked down upon posts, which may be of sawed lumber, or even of suitable lengths of common telegraph posts. The "trains" are made up generally of sets of four light corrugated-iron cars, circular in section, 4½ feet in diameter by 16 feet in length. Each car is supported by two light iron straps to two two-wheeled trucks. The forward truck of the motor car is provided with a motor and a short trolley pole engaging an overhead trolley wire. The crossing of rivers, canyons, or precipitous valleys is accomplished by supporting the cable or traveler wire from a series of suspender cables, passing over the tops of latticed towers, and guyed back to anchorages on either bank; the suspender wires forming a modified catenary, from which the traveler cable is supported at stated intervals, as shown in the engraving. A notable advanta[ge] of the system is that the method of support or sus[pen]sion of the track or cable is capable of wide vari[ation] to suit the topographical difficulties of the cou[ntry to] be traversed. Tunneling is unnecessary, since [illegible] may be so developed as to cross the loftiest mountains, without exceeding the maximum grade of four [per c]ent; or, where rocky bluffs are encountered, it may be supported on iron brackets attached at intervals to the sides of the bluff, as shown in the accompanying engraving.

In no character of country does the telpherage system show to better advantage than for transportation through the mountains. A railro[ad] in the West, which