tion basins will be another building 200 ft. by 30 ft., which will be used for heating purposes to prevent the filters from freezing.

The estimated quantities of this work are as follows:—

35,000 cub. yds. of concrete.
500,000 cub. yds. of excavations.
250,000 cub. yds of fill and embankments.
900,000 lbs. of reinforcement.

The cost of excavations were about 65c. per cub. yd.

Fill and embankments watered and rolled, 85c.

This work is being done by the city of Minneapolis, and carried along at a lower cost than the lowest tender submitted, thus saving the city all there is to be derived from this work, and a right at any time to alter, add, or subtract, without the usual complications that follow.

The constructional part of this work is being supervised by Mr. A. W. Ellson Fawkes, C.E.

The estimated consumption of water for Minneapolis is about 30 million gallons, so in laying down this extensive filtration plant the city is taking care of future possibilities.

The accompanying photos show the work in various stages of construction.

PURIFICATION OF SEA WATER.

While much has been said concerning objections to polluting salt water in bays and channels on account of the danger of contaminating oysters and other bivalves, we do not recall having heard of any instance in which it was seriously contemplated to purify salt water so polluted, until the presentation on Sept. 13th before the New England Water Works Association of a paper by R. Spurr Weston describing plants employed for this purpose in the city of Gloucester, Mass. These were for the purification of water drawn from Gloucester harbor by the packers of cod and other salt-cured fish for washing the fish and making the pickle; investigation having demonstrated that the polluted water of the harbor, when used for this purpose, was responsible for the subsequent decaying of fish cured at this place. While the purification of salt water for this purpose is not a municipal matter, the pollution which rendered this purification necessary was largely caused by municipal sewage, and thus calls attention to an additional reason for preventing the pollution of certain bodies of salt water.

Incidentally it is of interest to those who have to do with the filtration of water to learn that slow sand filters operating at the rate of 4,000,000 to 5,000,000 gallons per acre per day have proved very effective in reducing the bacterial contents of this water, and especially the B. Coli. The filter described by Mr. Weston was put into operation in May of this year, and the results obtained have steadily improved as the filter has aged. Tests for B. Coli were made at intervals of from one to three weeks, and since the second or third week of operation have all been negative, although the tests of unfiltered water have always been positive for B. Coli.

The filter consists of a wooden tank containing 3 feet of sand supported upon a 1-foot graded gravel layer. The capacity of this is 5,000 gallons per hour. Two other filters are under construction, each 21 feet square which, with a clear water basin and a pump house, are constructed of reinforced concrete and covered, the filters and regulating chambers with a wooden house and the clear water basin and the pump house with a concrete slab roof. These filters contain 4 feet of sand supported upon 1 foot of graded gravel, underdrained with split tiles.

PRINCIPLES OF FLIGHT.*

By Algernon E. Berman.

One of the greatest services that can be rendered to the science of aeronautics at the present time is to attract towards it the serious interest of minds that have matured in other departments of the world's work. With this object in view an attempt will be made to give a résumé of the more interesting problems as they are understood by the majority of students, in the hope that those taking part in the discussion may thereby be enabled to direct their remarks along such lines as shall add most to the sum total of our little knowledge in the short space of time available.

The present predominance of the military aspect in the perspective view of the immediate future of aeronautics serves also to draw a dividing line between different forms of aircraft; such as to group all systems essentially possessed of the ability to ascend vertically and hover stationary in the air on one side, and all those that can neither stand still in the air nor get up from anywhere, on the other.

Balloons and Kites.—Thus, the captive balloon and the man-lifting kite both perform useful work, although neither navigates the air at large. The free-moving aeroplane, on the other hand, is frequently criticized because it does not at present possess the potential qualities of the as yet unsuccessful helicopter.

The Helicopter.—It seems necessary to pay some attention to the problem of the helicopter, therefore, in order to see how far an elementary investigation of its principles supports the likelihood of realizing the possibilities frequently assumed in its favor. It has been suggested that some insects fly on the helicopter principle.

It may be demonstrated that the very small helicopter is a remarkably successful toy, although the large helicopter is as yet an unsuccessful machine. A mathematical ratio (see the "two-thirds power law" in summary of formulæ) indicates that the application of increased power to a given screw is an insufficient method of increasing the lift. It is suggested that the ratio of the essential dead-weight to effective lifting area may also increase so disproportionately in large machines as to prevent the practical success of the helicopter class. Inasmuch as the largest screw for a given load is the most efficient, it is argued that the aeroplane is the helicopter of maximum efficiency, inasmuch as it represents a blade element flying on the straight-line periphery of a circle of infinite diameter.

Dirigibles.—Under the assumed division dirigibles and aeroplanes have to be compared as alternative machines for fulfilling the same purpose. Both navigate the air, but the dirigible, in addition, can ascend vertically and hover stationary above any given spot. Windy weather adversely affects both types of machines. In the aeroplane the gust is inimical to stability; in the dirigible a high wind exerts an enormous drifting force. Comparatively large sizes are necessary in dirigibles if they are to have a wide range of action. The more important disadvantages of dirigibles result from the permeability of the fabric to hydrogen, the costliness and inconvenience of using this gas, and the distributing influences of sunshine and shadow on buoyancy.

Aeroplanes.—The aeroplane is the more interesting machine of the two in the eyes of the majority of students, owing to the popularity of flight as sport. A broad treatment of the problems relating to this section divides them under two heads, one dealing with the lift and resistance of the cambered plane, the other dealing with stability, which has

*Paper read at the joint meeting of Sections A and G of the British Association at Portsmouth, September 4.