Correspondence.

Jet Propulsion.

To the Editor of the Scientific American:

I have noticed with deep interest the discussion of hydraulic propulsion in the SCIENTIFIC AMERICAN, and I hope it will be continued until marine engineers grasp the importance of the jet propeller as a factor in the near future of marine engineering. I should like to have Mr. James S. Parmenter give further details which he has worked out, as I believe it would prove of value.

It seems to me, at the present stage of this subject, enough has been learned to determine to what the failure of jet propulsion has in the past been due. It is recognized that the principle is superior to that of the screw propeller, but the pumps employed did not produce a jet of water of sufficient power and size to make it practical for propelling steamships. The proper pump is really the vital question.

This settled, the way the jet shall impinge the water will settle itself, which I think was partly demonstrated by Mr. George G. Caldwell, in 1877. He placed a seven-eighths inch jet on each side of the rudder in a tug boat, 43 feet in length, and made 10 knots an hour with 60 pounds of steam and a No. 7 Knowles pump making 180 strokes a minute. He proved conclusively that a common nozzle attached to a larger diameter of pipe was the best way to eject the jet, and he also proved that the pumping power was the cause of failure.

It is true, as Mr. J. B. Brolaski suggests, that, by offering volume of resistance to volume of power, the best results are obtained.

This is the whole matter in a nutshell. A pump that will provide a practical relation of one to the other is the pump that will insure success to hydraulic propulsion. It involves a pump that has power to give great pressure and, at the same time, a capacity to keep up that pressure. JOHN W. HAHN.

Newton, Mass., May 30, 1891.

Pittsburg and Other Great Cities.

To the Editor of the Scientific American:

About two months before the taking of the last census, I wrote you a short article, claiming that the forthcoming census would show a population in Pittsburg of about 450,000. I was taken to task by Mr. "Conservative," who placed his estimate much below mine. The census showed that his figures were as much too low as mine were too high. Yet if Pittsburg figures took in the whole country, as New York, Philadelphia, and Chicago do, to raise their figures, my estimate would have been 100,000 under the census figures. The following extract from one of the daily papers gives a reasonable basis for figures and practically confirms my estimate:

"The Louisville *Courier-Journal* turns aside from the consideration of tariff reform and silver coinage long enough to bring its sagacity to bear upon this curious fact, and lays it down as the correct principle that the size of a city should be estimated by the area of population of which it is the core. Chicago has fattened her census exhibit by taking within the city limits a large slice of the agricultural region of Illinois, while the corporation bounds of New York are much within the real extent of the city as a center of population.

"Taking a section of country about fifty miles square about each city, their population ranks as follows:

	Population.		Population.
New York	3,621,000	Buffalo	385,000
Philadelphia	1.422,000	Minneapolis	381,000
Boston	1,334,000	San Francisco	335,000
Chicago	1,324,000	Detroit	330,000
Pittsburg	677.000	Milwaukee	320.000
St. Louis	629.000	Kansas City	306.000
Cincinnati	590.000	Albany	289.000
Baltimore	586,000	New Orleans	280,000
Providence	532.000	Lonisville	277,000
Cleveland	426,000		

"See what a bound toward head Pittsburg makes on this basis of computation, sizing up alongside of Chicago and ahead of St. Louis, Cincinnati, Baltimore and other places which consider themselves rather large towns. The justice of this way of putting the case is further confirmed by the fact that it tallies pretty well with the showing made by the clearing house returns."

JOHN T. FINDLEY.

Pittsburg, May 27, 1891.

The Adjustment of Damages Arising from a Diversion of Water.*

There is no one feature more essential to the health, growth, and prosperity of a municipality than an ample supply of pure water. When a city is situated on or within a comparatively short distance of a stream of fresh water from such a source that it flows throughout the entire year through a region in which it is not liable to contamination other than a temporary discoloration by earthy matter washed into it during storms, it is customary to lift such portion of the water as is required from the bed of the stream to a distributing reservoir by means of pumps operated either by water power or steam pumping engines. In some cases a stream is available at a sufficient elevation above the city to enable the water to be conducted by gravity through an aqueduct or pipes to a distributing reservoir at a sufficient elevation above the city to enable the distribution to be effected by gravity over the greater portion thereof, when water for the higher portions is supplied by a subsidiary pumping station which lifts a smaller quantity of water either into a small reservoir at a higher elevation or into a water tower or stand pipe directly supplying water to the higher district. In some cases pumps receiving water directly from the bed of a stream or from a low service reservoir are operated to simply maintain a pressure in the whole or part of the distributing pipes of a city, and the speed of such pumps regulated merely to supply the demand. Frequently the distributing reservoirs are at such a height that the water is delivered to the mains under considerable pressure and can be utilized directly from the hydrants for the extinguishment of fires. In the direct pumping systems referred to, comparatively small pumps are generally kept in motion to supply the regular demand and larger pumps started (when notice is given by an electric or other signal) to deliver into the same mains water at a higher pressure which can be utilized at the hydrants for fire purposes.

In many cases, however, towns, villages, and cities are so situated that no stream is available to supply a sufficient quantity of water at all seasons of the year, in which case it is customary to work back into the hills, preferably at a considerable elevation above the village or city to be supplied, and to erect a dam across the course of the stream in a narrow portion of the valley where the hills rise with sufficient abruptness to form an artificial pond or lake. In such case all vegetable growth should be removed from the soil to the elevation of the proposed water level. The pond will fill up during the heavy rains in the fall and spring, and although the stream supplying the same be a small one, the water stored in the pond will be sufficient to supply deficiencies during the droughts in the summer, when there is little rain, and in the winter when the rainfall is congealed and temporarily remains as snow and ice on the hillsides. These various operations affect in different ways, according to location, the rights of the owners of the soil. If water be abstracted from a stream to supply a village or city, necessarily the amount flowing in the stream, below the dam or other point where the water is taken, is less in quantity than before and the diversion may cause injury to riparian owners by reducing the quantity of water available for water power or other manufacturing purposes, or in extreme cases that required for the proper irrigation or regular watering of the land. In very extreme cases the navigation of rivers or certain reaches in the same may be affected. It is well settled that a riparian owner is entitled to the proper use of the water as it passes his own land, and he may even divert it upon his own property so long as he returns it to the stream upon his own land, and this, evidently, may include the use of water for irrigation where the drainage returns the water to the stream. The rule brought from the Old World and established by the decisions of all countries is: "A watercourse begins *ex jure naturæ*, and having taken a certain course cannot (lawfully) be diverted." While not exactly in the line of the present discussion, it may be added that this principle applies not only when the water is usefully applied, as for water power and irrigation, but also when the water is useless, as in case of drainage. It is an established principle that "no man can divert water upon a neighbor's land," and "no change can be made in respect to surface water to the injury of any other owner." The difference in the two cases will be observed. In the first case the property owner, who wishes to utilize the water, would complain, and in the second case other parties would complain who do not wish to have the surplus water from undesirable swamps and low lands discharged upon their property. It will be seen, however, that if a natural watercourse has ever been established for the drainage of a swamp or low lands the first principle comes into play for the benefit of the owner of such low lands, for the reason that he has a right to discharge the water into the natural stream. There are also legal provisions by which low lands with no natural outlet can be drained across the lands of others in regular channels initiated and maintained under the provisions of law, and here it may be stated again collaterally that the principles of drainage are somewhat modified in large cities, where the health of all is of paramount importance, and in which, therefore, watercourses are frequently closed and the streams diverted and low lands drained under the provisions of law.

At this time we have to deal only with the question of obtaining a pure supply of water for municipal purposes. In designing a system of water supply, the first problem is to find a proper source. Even though pure streams may be near at hand at a low level, it is better first to examine all available sources at such an elevation that the distribution may be made by gravity. Natural lakes or ponds will frequently be available within five to ten miles of the place where the water is to be used, and if not, particularly if the stream is small, an artificial pond, as previously referred to, must be provided. When a desirable site is found, the first question is to ascertain whether sufficient water can be obtained at that point for the purposes required. All the water available is derived primarily from rainfall, which varies in different localities and in different years in this latitude from say 30 to 70 inches per year. An inch of water in this sense means that sufficient rain falls to cover, to a depth of one inch, the horizontal projected surface of the land, that is not the actual surface of the hillsides, but the sum of the horizontal components of all the inclined surfaces, or the area of an imaginary lake with its surface above the tops of the hills. Ordinarily the total quantity of rainfall in a year would cover this projected surface to a depth of 40 to 45 inches in this latitude, but even at the same place the quantity of water would vary greatly in different years, and this possible deficiency must be considered in connection with the size of the pond or reservoir which it is proposed to build. The quantity of rainfall will also vary greatly in different localities comparatively near each other, those on one side of a hill or mountain having more rainfall than those on the other. So it is desirable to base all calculations on records of rainfall taken for a series of years in a particular region.

There must next be determined the proportional quantity of rainfall which reaches the streams. In very sandy soil in an elevated position most of the rainfall would percolate through the soil and feed streams lower down the slope; whereas in clay soil, or basins in which part of the strata were of that nature, a larger portion of the water would reach the elevated streams. The quantity would, however, in either case, be very much dependent upon the kind and quantity of vegetation. A very large quantity of water is evaporated from the foliage of the ferns and luxuriant bushes which grow in swampy land. The evaporation from short growths of grass and weeds is greater than from tall trees. In addition to this there is always a considerable quantity of water evaporated from moist earth and quite a large quantity from all water surfaces exposed to the atmosphere. This is particularly the case where the air is dry, as it is in most inland locations. The quantity of water reaching the streams at a given elevation can only be determined accurately by actually measuring the rainfall and gauging the streams throughout the year for a number of years. This is, however, rarely practicable. It is generally necessary to estimate the flow. Gauging can, however, be made of the summer flow and of the average flow as nearly as can be judged by conference with the residents of the vicinity. It is in general necessary, however, to estimate the flow on a basis of similar conditions, which requires a study of waterworks reports and other information available in similar localities. It can frequently be assumed that 25 per cent of the rainfall reaches the streams during the summer months, from 50 to 60 per cent during a portion of the remaining period, and as high as 80 to 90 per cent when the ground is frozen, so that it will sometimes be safe to assume that one-half the rainfall reaches the streams on the average through the year. It will rarely be proper, however, to assume that so much can be utilized. This depends largely upon the amount of storage available.

One inch of rainfall corresponds to 27,152 gallons per acre, and if the average rainfall be 40 inches, a little less than one-half of this will furnish half a million gallons for each acre included in the watershed, which should in all cases be measured approximately by tracing out the height of land on a county map, or from actual survey, or something of that kind. On this basis one square mile, or 640 acres, would furnish 320,000,000 of gallons per year, or less than one million gallons per day. It may here be stated that under very favorable conditions with large storage reservoirs an average supply of 1,000,000 gallons per day throughout the year has been obtained from one square mile, but this was on a stream used for power purposes and in which the flow was frequently much less than that rate in the summer season. This example shows that such a quantity can rarely be depended upon for municipal purposes, though more than two-thirds of a million can generally be secured where the storage capacity is ample.

In calculating the proper size of storage reservoirs, the relative winter and summer flow must be considered separately, much in the same way as above described, and it must be remembered that there is an evaporation in this latitude of about 25 inches per year from the surfaces of ponds and lakes, which in effect decreases the amount of water actually available from a particular watershed. This evaporation represents an enormous quantity of water, but fortunately the loss applies only to that portion of the watershed represented by the area of the pond or lake and that of the streams entering the same.

* Chas. E. Emery, Ph.D., in the *Crank*, a publication issued the 15th of each month by the students of Sibley College.

THE maximum safe velocity of cast iron fly wheels should not exceed a rim speed of 80 feet per second.