the cooling on the one side was accelerated by means of cold water. On the opposite side, cooling was hindered by the use of flannel. The distinct displacement of the pipe in the direction of the flannel may be very distinctly seen in the engraving (Fig. 12). Now let us gather up some of the lessons to be learned from these experiments, in so far as piping is concerned: First, slow teeming reduces the pipe. (See Figs. 1, 2, and 3.) Second, casting with the large end of tapered ingots up tends to shorten the pipe. (See Figs. 4 and 5.) Third, a top kept molten diminishes the pipe. (See Figs. 6 and 9 as contrasted with Figs. 7 and 8, respectively.)

But what of the segregate? In Fig. 1, it lies at *A* near the bottom. The slowness with which Nos. 2 and 3 were cast tended to prevent the concentration of the green oleate into a single segregate. There were a number of local concentrations along the axis of No. 2. In No. 3, which was cast with still more deliberation, the absence of segregation is stated to be very marked. In ingot No. 4, the segregate lies above the center, while in No. 5 it is near the bottom.

The segregate seems to display a tendency to lie in the part which freezes last. By referring to Fig. 12, where the cooling was retarded on the left but hastened on the right, the bridges *E*, *F*, and *G* because of the strong green coloration seem to Profs. Howe and Stoughton to mark the position of the segregate. If this be the case, though they are not unreserved in their statement, then the deflection of the segregate to the warmer side would seem pretty clear. As further evidence of segregation in the last cooling part, the cases of the ingots shown in Figs. 11 and 13 are particularly cited.

GLASS INDUSTRY OF THE UNITED STATES.

If we consider the minor factors of civilization, glass should certainly be accorded a very high place, as it enters into many of the daily affairs of life. It is one of the oldest industries in the world. Pliny states that certain Phœnician merchants were preparing a meal on the seashore, and set their cooking vessel on a mass of the sand and alkali, which, when subjected to the fire, resulted in vitrification. In all the ages glass manufacture was considered of prime importance, and was often regulated by government edicts.

Glass is a hard, transparent substance, formed by fusing together mixtures of the silicates of potash, soda, lime, magnesia, alumina, and lead in various proportions, according to the kind or quality of glass required. Silica in the form of sand is the only constituent of glass that is absolutely essential, and enters into the composition of all varieties of glass as its true foundation. Silica as sand occurs very abundantly in the United States. The proportion of silica used varies according to the character of glass desired. An increase in the percentage of silica in any glass increases the resistance to melting and fusing. The various grades of sand contain more or less impurities, which are removed or neutralized by washing or chemicals. Iron when present imparts to glass a greenish tint, which can be corrected by the use of manganese. The bases used include sodium carbonate, sodium sulphate, sodium nitrate, calcium carbonate, litharge, and potash. Other auxiliary chemicals used in glass making are arsenic, carbon, and manganese. Glass makers call arsenic the "great decarbonizer," while manganese dioxide is known as the "great decolorizer." Carbon is employed in glass making to lower the fusing point when salt cake is used as a base, and to impart color when a glass from a straw yellow to a dark amber is desired.

The question of fuel is undoubtedly the one most important to the glass maker. With the aid of a good fuel a glass maker can produce a comparatively good glass from impure materials, but he cannot make a good glass with a poor fuel, no matter how pure the materials may be. Manufacturers have naturally located where coal was cheap, or where natural gas was available. Natural gas is the ideal fuel for glass making, and as the supplies get exhausted, producer-gas is being substituted. Oil is used to some extent, but is expensive. The following figures showing the quantity and cost of materials used are from the bulletin relating to glass making issued by the Bureau of the Census for the year 1905, the latest available figures:

Materials used, total cost	$26,145,522
Glass sand:	
Tons	769,792
Cost	$1,547,147
Soda ash (carbonate of soda):	
Tons	215,462
Cost	$4,068,804
Salt cake (sulphate of soda):	
Tons	53,905
Cost	$802,611
Nitrate of soda:	
Tons	11,915
Cost	$511,854
Limestone:	
Tons	115,655
Cost	$274,209
Lime:	
Hundredweight	933,074
Cost	$241,755
Arsenic:	
Pounds	2,676,650
Cost	$92,574
Carbon:	
Tons	3,750
Cost	$22,333
Manganese:	
Pounds	3,096,939
Cost	$101,279
Litharge (red lead	
Pounds	9,613,649
Cost	$555,130
Potash or pearlash:	
Pounds	5,446,338
Cost	$228,508
Grinding sand:	
Tons	410,856
Cost	$332,013
Rouge:	
Pounds	1,098,566
Cost	$29,869
Plaster of Paris:	
Tons	33,939
Cost	$169,988
Fire clay or pot clay	
Pounds	42,910,286
Cost	$290,444
Pots, not including those made at works:	
Number	9,343
Cost	$432,591
Flattening stones:	
Number	410
Cost	$22,266
Fuel:	
Total cost	$6,243,006
Natural gas, cost	$2,777,157
Oil—	
Gallons	18,346,660
Cost	$526,868
Coal—	
Tons	1,488,476
Cost	$2,748,766
All other fuel	$190,215
Rent of power and heat	$42,164
Lumber, casks, barrels, boxes, etc	$4,750,213
Caps, metal trimmings, and rubber supplies	$1,696,145
Supplies used in repairs on tanks and furnaces	$741,953
Mill supplies	$265,444
All other materials	$2,192,528
Freight	$490,594

Disregarding the processes of manufacture, which have been repeatedly dwelt upon in these columns, let us consider the finished product. The following figures are for the same period and represent a year's product:

Products, aggregate value	$79,607,998
Building glass:	
Total value	$21,697,861
Window glass—	
50-foot boxes	4,852,315
Value	$11,610,851
Obscured glass—	
100-foot boxes	70,774
Value	$376,030
Plate glass—	
Total cast, square feet	34,804,986
Rough made for sale—	
Square feet	17,784
Value	$3,529
Polished—	
Square feet	27,293,138
Value	$7,978,253
Cathedral—	
Square feet	6,615,093
Value	$293,623
Skylight—	
Square feet	15,255,541
Value	$678,391
All other building glass, value	$757,184
Pressed and blown glass:	
Total value	$21,956,158
Tableware—	
100 pieces	1,283,974
Value	$4,897,537
Jellies, tumblers, and goblets—	
Dozens	7,346,214
Value	$1,639,167
Lamps—	
Dozens	487,017
Value	$1,247,628
Chimneys—	
Dozens	7,039,756
Value	$3,061,334
Lantern globes—	
Dozens	1,765,247
Value	$852,823
Globes and other electrical goods—	
Dozens	1,901,415
Value	$1,106,317
Shades, globes, and other gas goods—	
Dozens	878,244
Value	$1,949,069
Blown tumblers, stemware, and bar goods—	
Dozens	6,282,606
Value	$2,928,198
Opal ware—	
Dozens	1,091,208
Value	$870,221
Cut glass—	
Dozens	83,736
Value	$987,556
All other pressed and blown glass, value	$2,416,308
Bottles and jars:	
Total value	$33,631,063
Prescription vials and druggists' wares—	
Gross	3,202,586
Value	$6,638,508
Beers, sodas, and minerals—	
Gross	2,351,852
Value	$7,927,287
Liquors and flasks—	
Gross	2,157,80[illegible]
Value	$5,555,815
Milk jars—	
Gross	253,651
Value	$1,160,743
Fruit jars—	
Gross	1,061,829
Value	$3,436,047
Battery jars and other electrical goods—	
Gross	19,974
Value	$105,632
Patent and proprietary—	
Gross	1,657,372
Value	$3,709,510
Packers and preservers—	
Gross	1,237,065
Value	$2,989,557
Demijohns and carboys—	
Dozens	64,450
Value	$247,856
All other bottles and jars, value	$1,860,108
All other products, value	$2,322,916

We have chosen the graphical method of presentation, and have translated the quantities into mammoth jars, boxes, bottles, lamps, and chimneys. The Singer Building looks well protected from the elements in the immense bottle. The Statue of Liberty holds her torch aloft in the goblet, which symbolizes the tableware, tumblers, etc., without touching the brim. The use of oil lamps in the United States is decreasing, due to the wider use of gas and electricity, still the lamp shown represents more than a million dollars' worth. In our comparison building-glass looms up very large, the magnitude of the industry being shown by the figures. Many of the most important inventions connected with glass are due to Americans, and the industry is a typical American one.

The Current Supplement.

The great wall of China, which even to this day represents the original idea of Chin, the first emperor, is described and illustrated in the opening article of the current SUPPLEMENT, No. 1738. A. W. Gibbs writes on the smoke nuisance and the railroad. He takes up the subject in a new way and shows that the railroads must produce power with the fuel of the country through which they run, and that bituminous coal is the fuel with which the whole question must be settled. Somewhat of a novelty is the incandescent lamp device which is mounted upon the Eiffel Tower at Paris, so as to show the hour and minute. Our Paris correspondent writes on the subject. Water and salt solutions as dust preventives are discussed by Prevost Hubbard. Robert Grimshaw writes on iron-bronze alloys. Our interest in the effects of radium rays on living organisms is enhanced by the discovery that radio-activity is widely distributed in nature and that all plants and animals are influenced by radio-activity. Prof. C. Stuart Gager, of the University of Missouri, contributes an excellent article to the literature of the subject, in which article he shows the influence of radium rays on a few life processes of plants. Emil Freund tells how artificial gems have been made in the past and how they are made now. Prof. Jacob Reighard's monograph on subaqueous photography is continued. Animal fats and oils is the subject of another technological article of interest.

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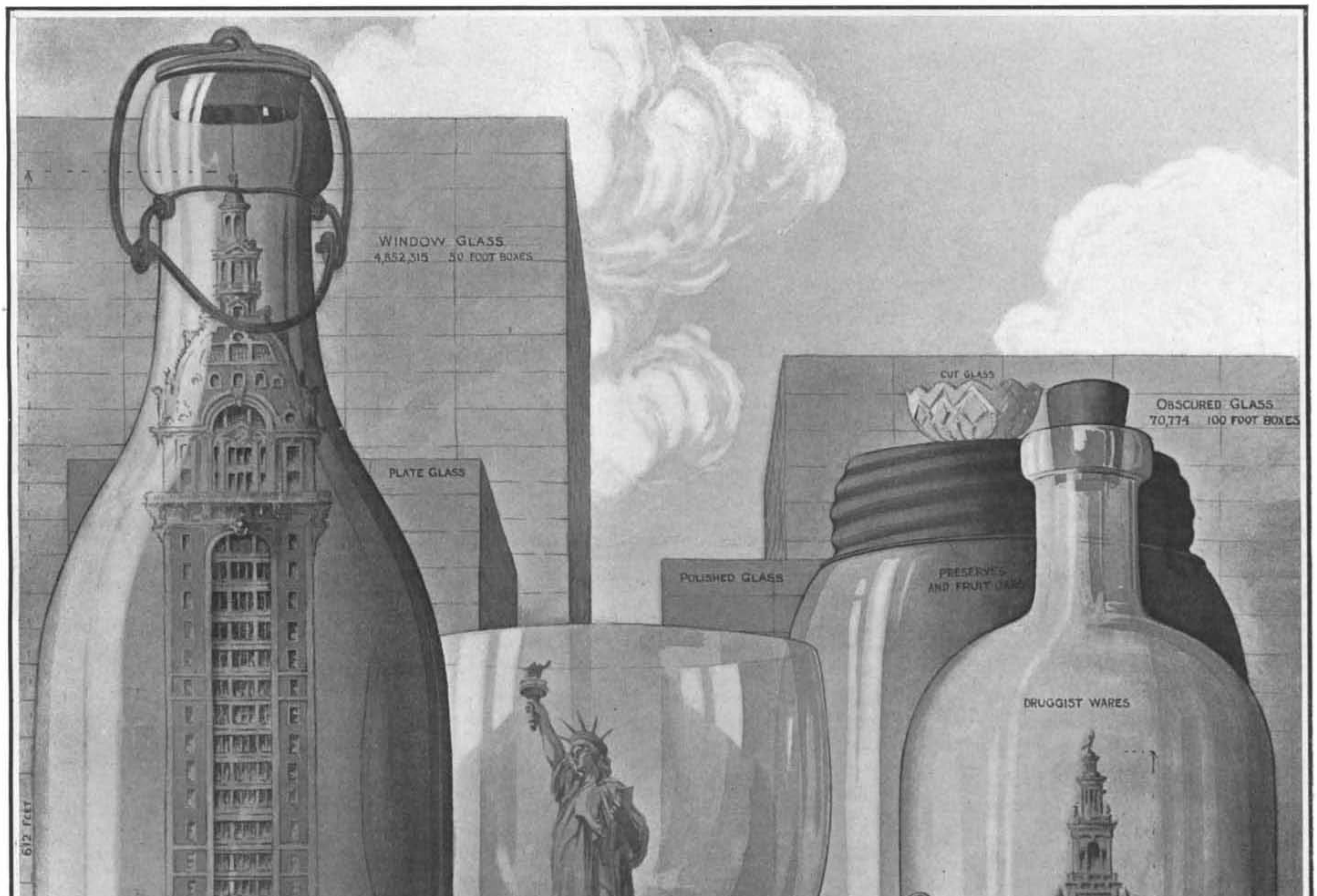

THE GIANT GLASS INDUSTRY. NEARLY $80,000,000 WORTH OF FUSED SILICA MADE ANNUALLY IN THE UNITED STATES.—[See page 314.]