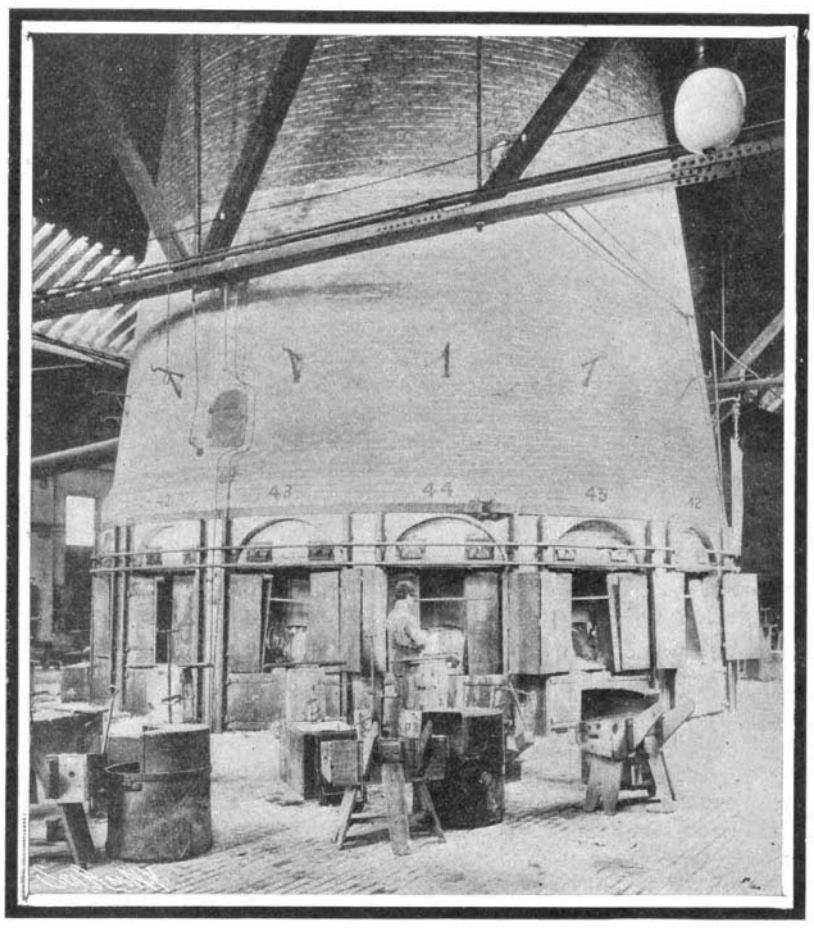
THE MANUFACTURE OF INCISED, OR CUT GLASS.

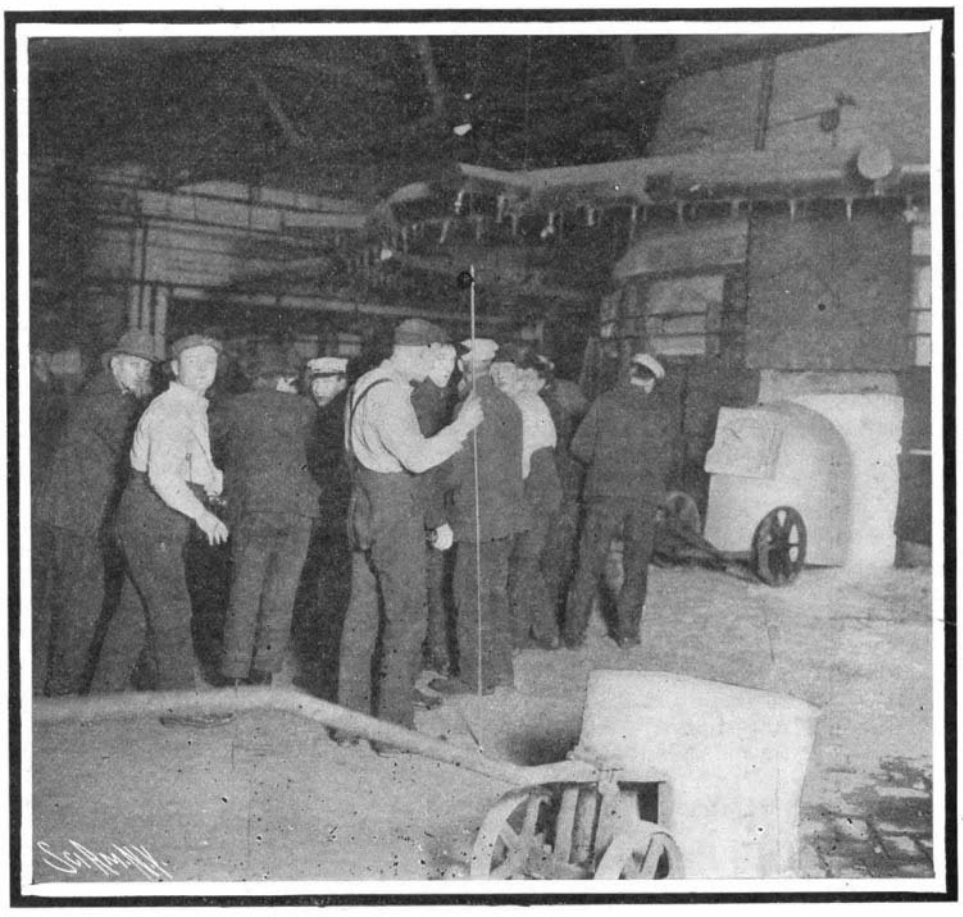
GLASS is a singularly versatile material, at once refractory and yielding, yet lending itself to use in thousands of ways. It is as a means of artistic expression that it is chiefly interesting, for its utility is beyond all question. The iridescent chatoyant colors of antique glass—Nature's destructive action—do not distract us from the charm of perfect form. Venetian glass, the beautiful product of the lagoon-island of Murano, is so very impracticably fragile, that even its possession is a care. Probably glass would have remained in a rather humble position, if it had not been that a Bohemian glass-worker more than two hundred years ago conceived the idea of a new invention, which was destined to change the glass product of the world. He thought of making the heavy "flint" or "lead" glass larger as regards the dimensions of the walls of the article, in order that he might have more stock to work on, so that he could deeply incise, or cut the glass to form patterns, the sides of the rough cut being in turn polished to give the effect of a many-faceted jewel. The success of the new *objet d'art* was not immediate, and it was only when the crude designs and imperfect workmanship of the earlier cutters gave way to the labors of highly-skilled artisans directed by talented designers that cut glass, or "art glass," as we might term it, took the place to which its great beauty entitles it. It is to America that we must look for the perfection, and the superiority of design and skillful workmanship of this branch of the industry. There is no such thing as absolute interchangeability in the glass-cutting establishment, and the artistic bent of the various cutters is encouraged. For purposes of illustration of this interesting industry, we have selected the plant of the Libbey Glass Company, of Toledo, Ohio, as being the best exponent of this really American industry.

Glass is a peculiar product, having as a base silica, which is fused with alkalies and metallic oxides to form a hard transparent substance which we all know as "glass." It can be wrought in various ways, and is susceptible of a high, and, when properly cut, a lasting finish. There are a number of varieties of glass, composed of varying ingredients, but we need only concern ourselves with lead glass, used for decoration by incision, or the cutting away of portions of the reinforced wall so as to form an ornate pattern. The raw materials consist of a sand, so called, of exceptional quality as regards sharpness and color. It is not a sand in the ordinary sense of the word, but is a quarried rock which has been crushed. This accounts for the uniformity of its color, which is so necessary in producing a steely-blue white glass, which is to be used for giving the prismatic colors caused by the cutting process. The red lead, saltpeter, and sodium carbonate are accurately mixed with the sand, and a small percentage of white arsenic or manganese is added to bleach or clarify it. The proportion is varied ac-

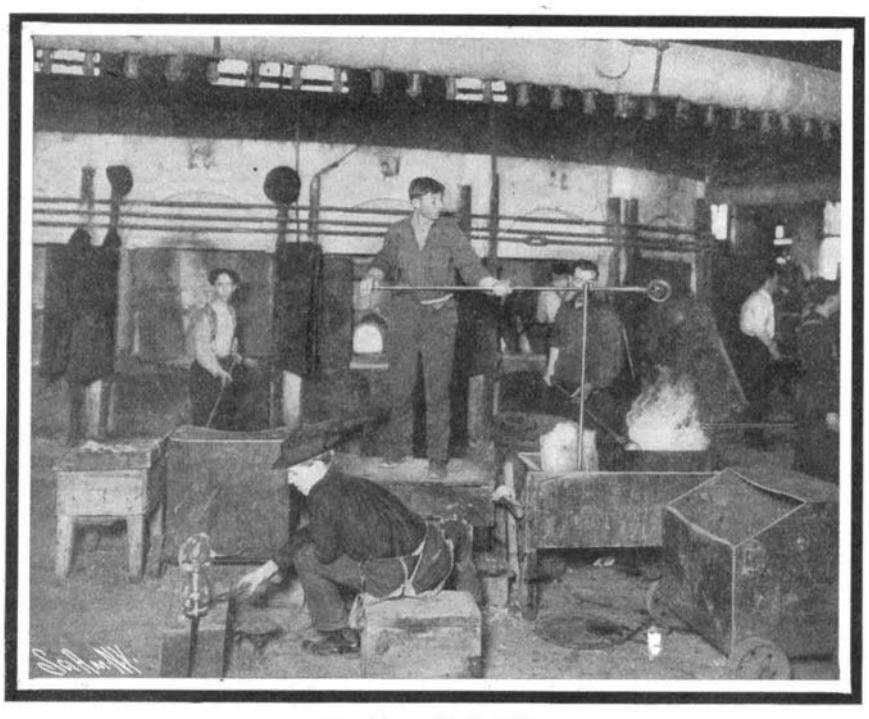
Blowing a Glass Blank



A Glass Furnace.



Setting a White-Hot Melting Pot.



Blowing Glass Articles.

Forming a Glass Article.

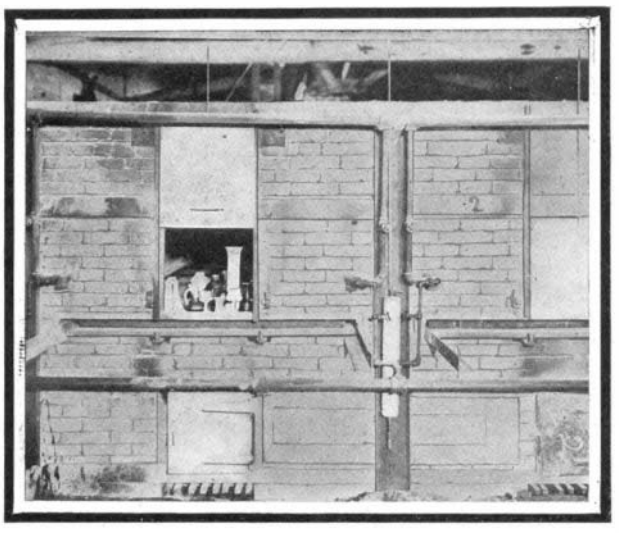
THE MANUFACTURE OF INCISED, OR CUT GLASS.

cording to the nature of the finished product. A glass furnace is a large round or oval fire-brick oven, capable of holding an aggregation of melting pots, which rest on a floor in common under a dome called a crown. These pots are made of unbaked fire-clay. A mouth gives entrance for the raw material and the workmen's blowpipes, to which the molten glass adheres. A furnace may contain as many as sixteen pots arranged radially on the floor of the furnace. They are heated before setting, and are subsequently filled with about 1,600 pounds of raw material, which soon melts at a temperature of 2,500 deg. F., caused by the intense flame of gas and air, which is deflected from the dome downward, the products of combustion passing out through a stack.

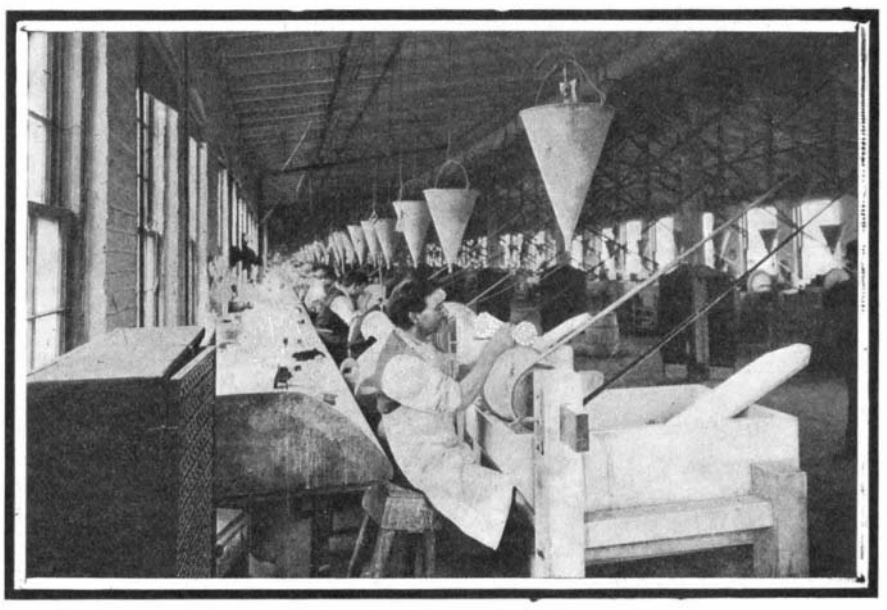
The glass gatherer receives his order for a specified size and shape for his article; and after obtaining a sample to guide his memory, takes his iron blowing-tube, and collecting sufficient of the molten glass from the pot in the furnace, rolls it to and fro on a metal plate to produce a uniformity of distribution of the mass, which is then reheated in a furnace called a "glory-hole." He then turns it over to a glass blower, who takes the pipe and blows the article to approximately its final shape. It is then reheated and given definite form and finish by the most expert workman of all three. The tender glass must now be annealed or tempered to equalize the strains, otherwise the piece would break. It is then placed in kilns or tempering ovens, where it is first reheated and then gradually cooled.

The heavy uncut articles are then ready for the cutting operation, by which they lose considerable weight. In some cases the loss is one-third. The cutting operation really consists of three stages. The article is first roughed with sand and a steel grinding wheel. It is then smoothed by a stone cutting wheel, and is lastly finished by a wooden polishing wheel. A workman holds the article against the conical edge of a steel wheel secured to a shaft driven by belts and pulleys. Fine sharp clean sand and water are allowed to drip on the wheel from a cone-shaped bucket. The article is pressed against the rapidly-rotating wheel, and is deeply scored or cut. The heaviest and principal lines in the pattern are roughed-in by these steel wheels and the sand. In order that all articles may stand level, the bottoms are ground on a horizontal grinding wheel, sand and water still being used. The roughed article is now ready for the wet smoothing stones, which resemble steel wheels both as to size and edge, but no sand is used; these wheels follow the cuts that the steel wheels have made, and also cut in the finer lines of the pattern. The practically finished piece is now ready for the polisher, whose rouge-charged wheels are of wood, their size and edge being the same as those of the steel and stone wheels, and therefore adapted to follow every line with almost mathematical accuracy. We have now the finished piece, which may grace a table or which may adorn the buffet of the White House. While cut glass is made abroad, the examples lack shape and depth and uniformity of cut. For this reason American cut glass forms an object of export, and the examples of art in this glass which will be exhibited at the St. Louis Exposition will be a revelation to most visitors.

The Romans and the Orientals were fond of both the cameo and the intaglio processes of engraving, and they had a peculiar combination of both which we now designate as "rock-crystal engraving." This is a long and expensive process, but the superb and highly artistic results fully warrant the expenditure of labor. The somewhat formal and mathematical lines give way to floriated designs, or free rein is given to the plastic fancy by the possibility if not the ease of modeling. The sculptor in his studio adds clay while he is working at his bust or group, while his marble-worker cuts off the marble to attain the same effect, in one case addition and in the other subtraction—the glass engraver does both. This

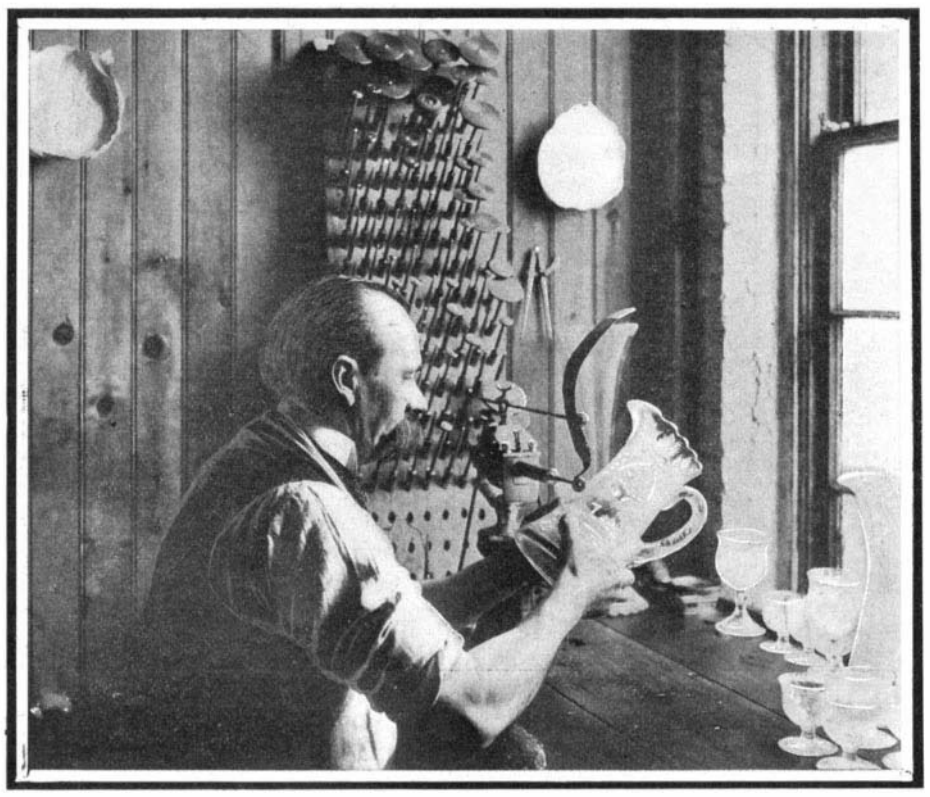


The Tempering Furnace.



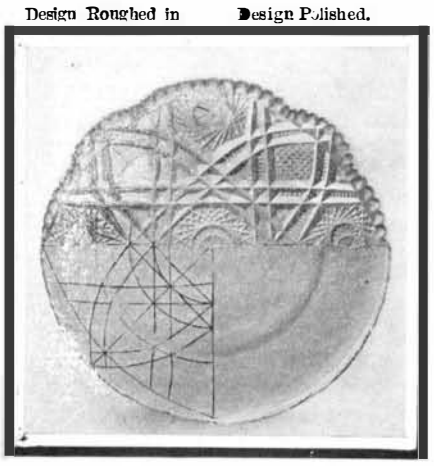
Polishing the Cut Glass.

Grinding the Foot of a Vase.



Engraving Glass.

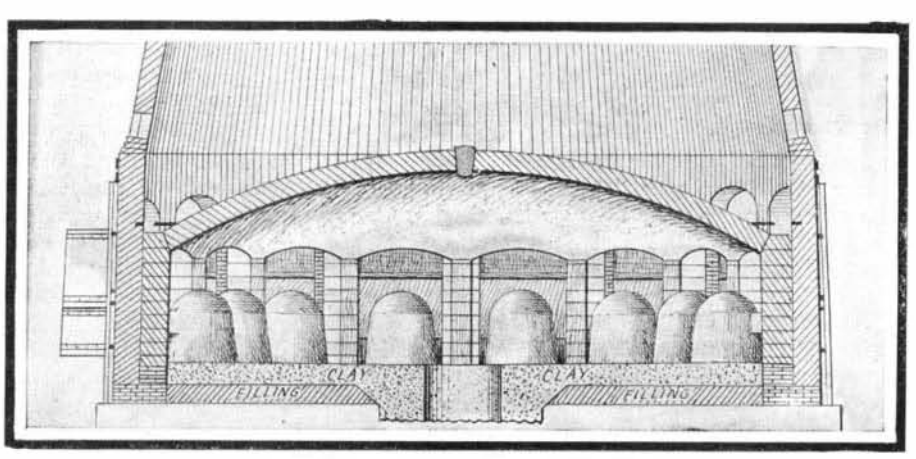
Design Roughed in. Design Polished.



The Pattern. The Blank.

A Cut Glass Plate.

An Engraved Plate.



A Glass Furnace, Showing Melting Pots.

THE MANUFACTURE OF INCISED, OR CUT GLASS.

style of glass art work is also carried on by the Libbey Glass Company. The engravers use copper disks of various diameters and thicknesses. The steel spindles carrying the disks are secured to a rapidly-rotating polishing head, the copper being charged with olive oil and emery powder. The tools are changed as often as necessary to obtain the desired effect. Both smooth and matt surfaces may be produced, or delightful combinations can be made of them. The cut glass industry certainly has a bright future in this country.

THE AUTOMOBILE AND MOTOR-BOAT RACES AT NICE AND MONTE CARLO.

BY THE SCIENTIFIC AMERICAN'S SPECIAL CORRESPONDENT.

Interest in the annual automobile speed trials at Nice was increased this year because of the motor-boat races in the Bay of Monaco, which were run off a few days later in connection with an exhibition of this new type of speedy craft.

The automobile speed trials were held on the first day of April, and were carried out without accident and with a considerable lowering of existing records. These trials took place on an extension of the Promenade des Anglais, and the road, while not so straight or smooth as the cement road of the Promenade, was not bad enough to prevent the breaking of records.

Last year the Serpollet steam racer swept all records away and won for the third time (and thus permanently) the original Rothschild cup for the flying kilometer, in 29.19 seconds. A new cup was immediately donated by Baron de Rothschild, and was won for the first time last year by Hieronymus on a Mercedes car in 31.66 seconds. This, the best time previously of a gasoline racer in the Nice speed trials for the flying kilometer, was cut this year to 23 3-5 seconds by Rigolly on a 100-horse-power (nominal) Gobron-Brillié car. This new time for the kilometer corresponds to a speed of 152.54 kilometers, or 94.70 miles, an hour, which is an increase of 24.37 miles an hour in the rate of speed over that attained last year by Hieronymus on the 60-horse-power Mercedes. When the fact is taken into consideration that this much faster speed was attained on a poorer roadbed than that on which last year's records were made, one can readily see that there has been not only a considerable increase in the power of the machines, but also an increase in skill in guiding them. The sensations of going at a 95-mile-an-hour gait in an open automobile are graphically portrayed by Rigolly in the following words: "I felt I was traveling very fast—faster than at Ostend; but I was quite unable to judge the pace. I saw nothing of the road but a white ribbon which I did my best to follow in the middle. The only real sensation of my speed was the impression that my head was coming off—was being torn backward by a furious wind. I was in great need of a support, such as photographers employ." Asked if he could have maintained such speed for half an hour, he replied that the strain on his eyes and neck was so great that he did not believe anyone could keep up such a pace for 20 kilometers. Despite the fact that the machines, throwing up clouds of dust, all traversed this curving "ribbon" of road, whose surface had numerous small holes and hummocks, and which was lined on both sides with sightseers, not a single accident marred the events of the day.

These began with the mile speed trials from a standing start, which were opened at about 2:30 P. M., by a motor bicycle. Tamagni, on an Italian, 5-horse-power, twin-cylinder Marchand machine, won in 1 minute, 7 2-5 seconds, averaging a speed of 53½ miles an hour. A 5-horse-power Griffon machine was second in 1 minute, 9 seconds. The previous world's record for this event was 1 minute, 13 4-5 seconds, held by a Griffon machine.

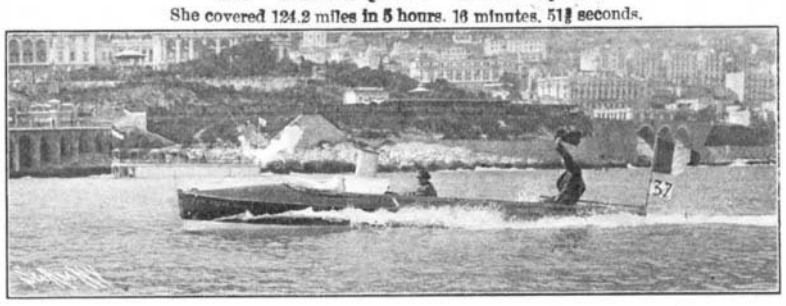
There were eight huge racing cars in the speed trials, two of which were 100-horse-power Gobron-Brillié machines; one, a new 100-horse-power Napier racer; and four, 80-horse-power Mercedes racers. The Gobron-Brillié cars won all the trials, and tied each other in the mile from a standing start, which they covered in 53 3-5 seconds. The older of these two machines, driven by Duray, is fitted with three speeds, while the new car, driven by Rigolly, has four. This gave Duray an advantage when there was but a short distance in which to start, or in starting from a standstill. Four Mercedes machines made the next best times to the Gobron-Brillié's in the mile from a standing start, the first of these, driven by Werner, making it in 57 4-5. Mark Mahew, on his Napier, was seventh in 1 minute, 3 seconds.

The great events of the trials were the flying kilometer tests for the second and third Rothschild cups, which can be competed for by machines with explosive motors only, and by machines of any motive power, respectively. The weight of the machines in both instances must not exceed 1,000 kilogrammes (2,204.6 pounds). A distance of 600 meters (656.4 yards) was allowed in which to get up speed for these flying kilometer trials. The one for the second Rothschild cup was won by Rigolly in 24 seconds, with Duray second in 26 3-5 seconds, and Mark Mahew third in 28 3-5 seconds. Three out of the four 80-horse-power Mercedes cars finished next in 29 2-5 seconds, the fourth covering the 6-10 of a mile in only 2-5 of a second longer time. Although the Mercedes cars were beaten, they nevertheless showed their great uniformity by making such an even performance.

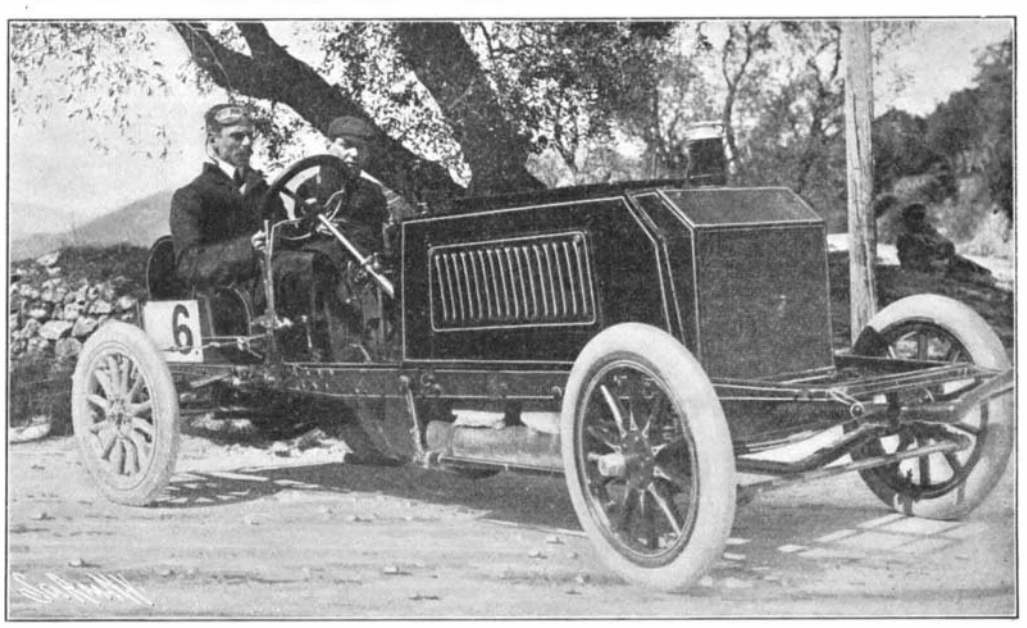
It was in the trials for the third Rothschild cup that Rigolly broke all records. Mark Mahew, on his Napier, flashed by first at 82.24 miles an hour His time for the kilometer was 27 1-5 seconds. Hardly had the roar of his machine died away when sounds like those of a rapid-fire gun of large caliber were heard in the distance. One had barely time to guess what machine it was, when a huge racer with boat-shaped prow flashed by and was hid in a cloud of dust. The car jumped and bounded on the rather rough road in a most startling manner. But it was past before one could realize one's danger should anything go wrong. The spectators expected that a new record had been created, and cheered vociferously. Rigolly's machine covered the kilometer in 23 3-5 seconds, or at a 12½-mile-an-hour faster rate of speed than that attained by the Napier. The other Gobron-Brillié was second in 25 1-5 seconds, and the times of the Mercedes machines were 29, 29 1-5, 29 3-5, 29 4-5, and 30 2-5 seconds respectively. The Mercedes, which we illustrate, driven by Werner, was fifth in 29 1-5 seconds.

The Gobron-Brillié machines have been manufactured in France for a number of years past, and a full description of them will be found in the SCIENTIFIC AMERICAN for December 28, 1901. Their great peculiarity is the employment of a double piston motor in which the explosion occurs between the two pistons, driving them apart. The four-cylinder motor used on the present car has eight pistons. The casings on top of the cylinders cover the piston rods and the connecting rods which extend down to the crank shaft. The positive fuel-feed device which has been used heretofore has, we understand, been now abandoned for an

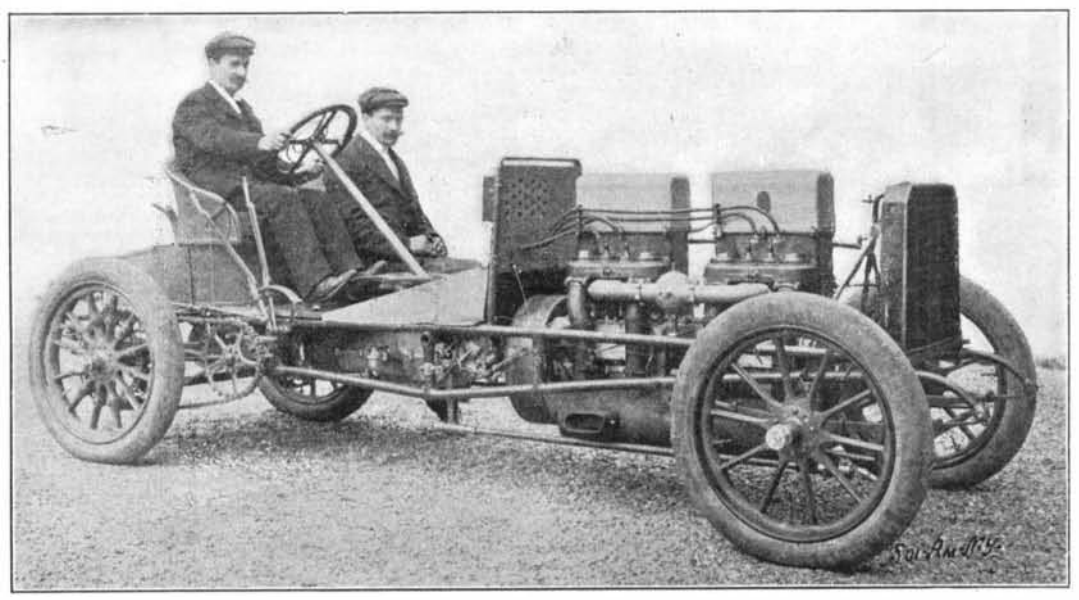
The "Trefle-a-Quatre" at Full Speed.
She covered 124.2 miles in 5 hours, 16 minutes, 51⅘ seconds.



"La Rapee III." Winning the 93.15-Mile Race in 4 Hours, 30 Minutes, 22 1-5 Seconds.



Lieut.-Col. Mark Mahew on His 100-Horse-Power Napier Racer.
Record: One mile from a standing start in 1 minute, 8 seconds. One kilometer with a flying start in 27⅘ seconds. (Third place.)



Rigolly on His 100-Horse-Power Gobron-Brillie Racer.
Record: One mile from a standing start in 53⅘ seconds. One kilometer with a flying start in 23⅘ seconds.

Werner on an 80-Horse-Power Mercedes Racer.
Record: One mile from a standing start in 57⅘ seconds. (Third place.) One kilometer with a flying start in 29⅕ seconds.

THE AUTOMOBILE SPEED TRIALS AND MOTOR-BOAT RACES AT NICE AND MONACO.

SCIENTIFIC AMERICAN

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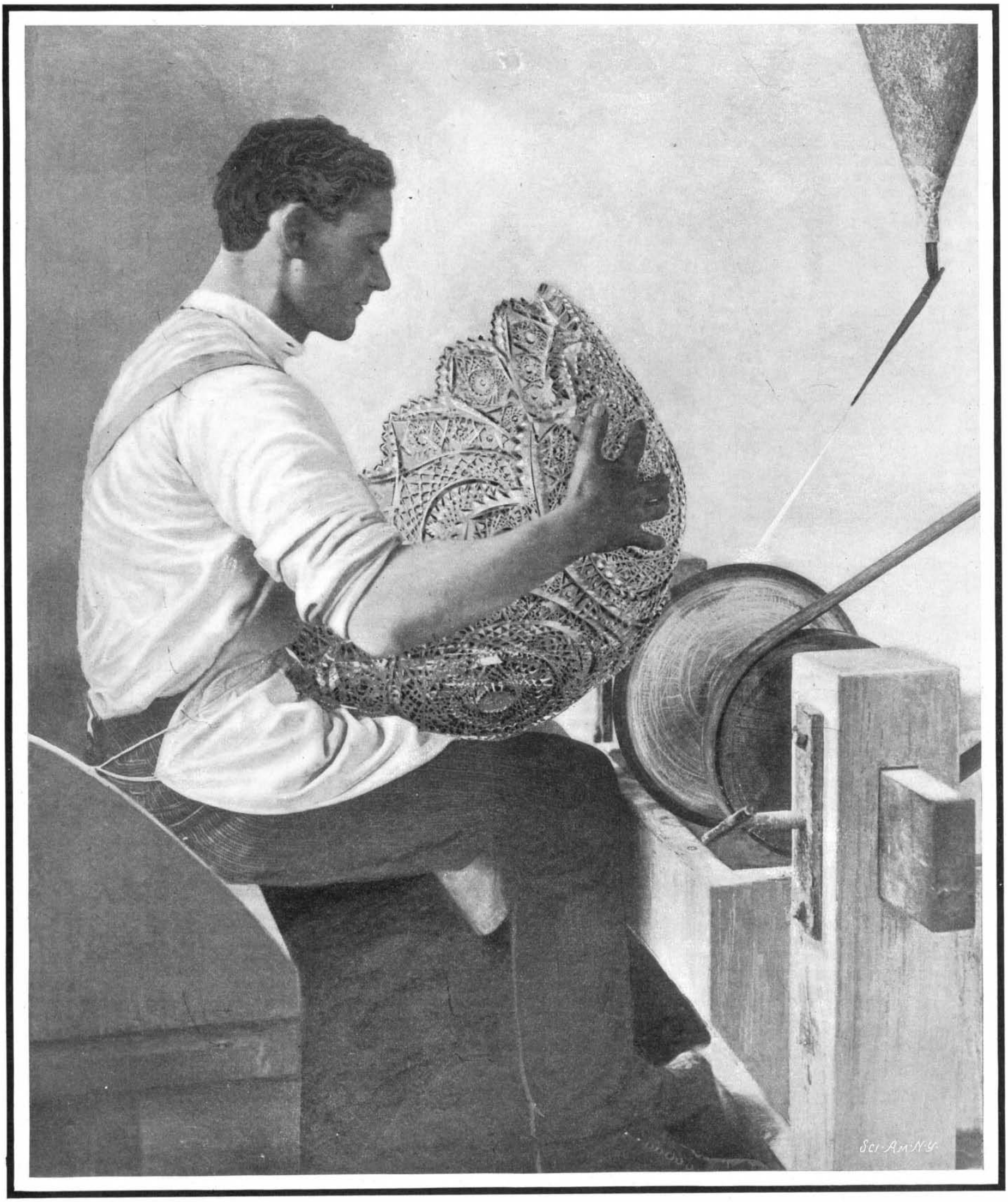

Polishing a 25-Inch Glass Bowl for Exhibition at the St. Louis Exposition. Height with Foot, 24 Inches; Weight of Bowl and Foot Before Cutting, 143 Pounds.

THE LARGEST PIECE OF CUT GLASS IN THE WORLD.—[See page 348.]