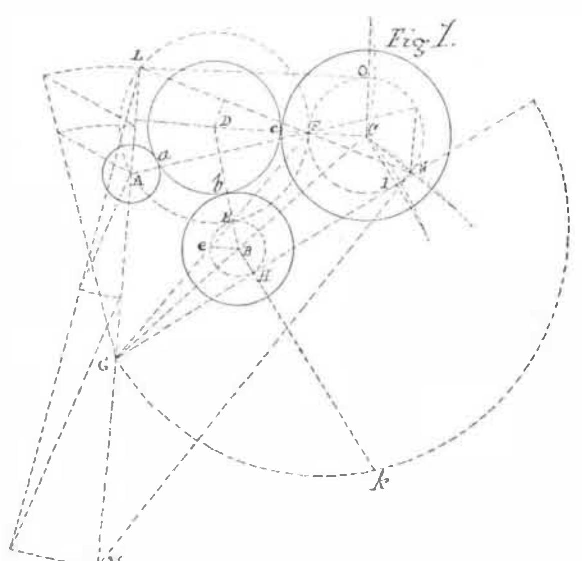
try, of models and of drawings of art more especially relating to industry, and perhaps a retrospective exposition. This principal building, which will occupy the middle part of the Champ de Mars, will be joined to the other buildings of the Exposition, by means of a large covered gallery that will cross the quays and the bridge of Jena at some distance above the ground, so as to allow free circulation to foot passengers and carriages to pass under it. This gallery will be bordered by spaces reserved to exhibitors whose works have a mixed character, such as objects fit for teaching, for libraries, and for typographers. This vast gallery will serve as the center, while buildings, disposed in an amphitheater on the Trocadero, will contain exhibitions of agriculture, horticulture, the training of domestic animals, the products of agriculture and mineral exploitation, and engines relating to the navigation of rivers and seas. These buildings on the Trocadero will occupy a surface covering 512,500 square feet, with intermediate courts and gardens. On the summit of the Trocadero and in covered communication with the gallery, there will be a great saloon erected, able to hold 10,000 persons, comprising the tribunes, and which will be intended for concerts, for testing the musical instruments, for public *réunions,* and for the solemnities of the opening and the distribution of prizes. Between the Military School on one side and the quay on the other and the buildings of the Champ de Mars, gardens will be planted, and will contain *cafés* and restaurants, none of which will be suffered to exist under any pretext within the inclosure itself of the palace. The rectilinear disposition of the roofs in plan and section for the palace of the Champ de Mars will have the advantage of making an economical structure, and of allowing the buildings to be erected in haste and to be pulled down in the same way, as well as to be used afterwards for other purposes, so that the sale of the materials after the close of the Exposition will be easy and profitable. These constructions should be in iron, filled in with bricks and masonry. As to the buildings of the Trocadero, they could in most cases be built in timber, as also the gallery of communication. This gallery, well constructed, should be a fine architectural work of an original aspect, particularly at its passage over the bridge, where it could partly be arranged with trusses, leaving the arches completely independent.

"The beautiful outlines of the Trocadero give us a reason for erecting picturesque buildings, which will be crowned by the grand saloon, from the top of the platform of which visitors will enjoy a ravishing panorama."

AN OLD PROBLEM.

In a recent letter a correspondent asked for an explanation of the method of drawing a circle tangent to any three given circles. Intending to refer him to some good treatise on practical geometry, we examined the principal ones, and found that they contained no mention of this question. On making further investigation, we ascertained that it was a celebrated problem among the ancient geometers, and was



subsequently solved by Vieta, and later by Sir Isaac Newton. It is contained in some foreign works on geometry, and a solution is given in Hutton's "Mathematical Recreations," which seems, however, to be incorrect. It is probable, therefore, that the solution is not generally accessible; and as the problem is unusually interesting and instructive, we lay it before our readers, in as simple a form as possible. The problem itself may be of little importance, but the principles upon which its solution depends are of general utility in geometrical constructions.

The construction in question is one of a class in which the solution is best obtained by indirect methods, changing the nature of the problem by successive steps in order to simplify it. As it is not at once evident what those steps should be, it will be advantageous to make the supposition that the problem has been solved, and see if some conditions can be obtained which may be fulfilled by construction. If such conditions can be discovered, it will, of course, be easy to make the required construction. It may be added that this method is of general application to all intricate geometrical problems.

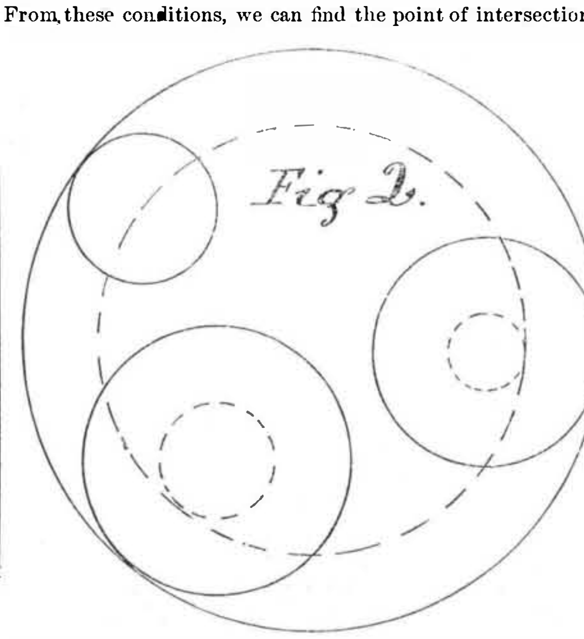
Referring to Fig. 1, the three given circles have their centers at A, B, C, with radii, A*a*, B*b*, C*c*. Suppose that D, the center of the required tangent circle, is known; it is evident that this will also be the center of a circle with radius, DF, passing through the center, A, of the smallest circle, and tangent to two circles with centers at B and C, and radii, BE, CF Hence, by the use of these auxiliary circles, the problem can be changed into another, in which it is required to draw a circle through a given point, and tangent to two given circles. Suppose this to be done, and draw the line, GHN, tangent to the two auxiliary circles; draw also the line, CBG, through the centers of the auxiliary circles, the line, GEF, through the points of tangency of these circles with the required circle, the line, GAL, through the center of the small circle, and the radius, B*e*. Then, from the principles of geometry, we obtain the relations :

$$\frac{GC}{GB}=\frac{GF}{Ge}=\frac{GF\times GE}{Ge\times GE}=\frac{GL\times GA}{(GH)^2}$$

From these conditions we can find a point, L, in the circumference of the required circle. so that, if the circle is drawn through the points, L and A, and tangent to one of the auxiliary circles, it will also be tangent to the other; hence the original problem can be reduced to the case in which it is required to draw a circle through two given points, and tangent to a given circle. Suppose the circle with radius, CF, is the given circle, and that the required construction is made. Through the point of contact, F, draw the straight lines, LFN and AF ; at N, draw a tangent, NM, to the given circle, produce the line, LA, to its intersection with the tangent at M; and from L, draw the tangent, LO, to the given circle. Then we will have the relations:

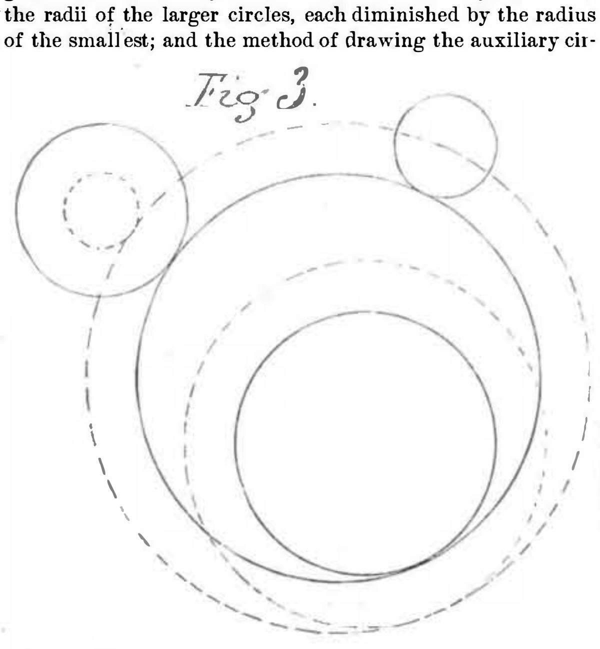
$$\frac{LA}{LF}=\frac{LN}{LM}, \text{ or } LA\times LM=LF\times LN=(LO)^2$$

From these conditions, we can find the point of intersection,

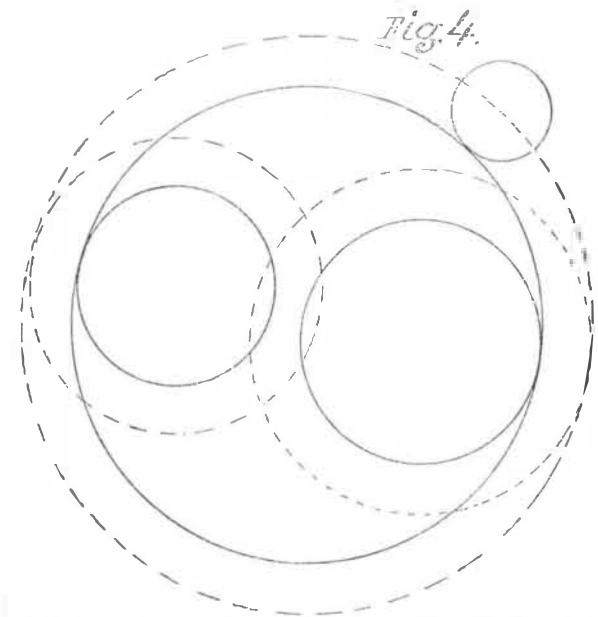


M, the point of tangency, N, and the point of contact, F, so that the original problem is finally reduced to the simple one of finding the center of a circle which shall pass through three given points, A, L, F. The reader may find it profitable to verify the geometrical principles which have been stated above. We now pass to the method of making the construction, having shown the principles involved. All the auxiliary constructions are given in the figure, except such a simple one as the bisection of a line ; but it has not been thought necessary to explain the methods of making them, as they will be found in an elementary text book. The reader will find it instructive to make the constructions as they are detailed below.

We have given the three circles in full lines, with centers at A, B, and C. It is evident that the problem admits of several solutions, as the tangent circle may touch the given circles externally, internally, or some of them internally and some externally. Several of these cases are illustrated in Figs. 2, 3, and 4. In any case, the first thing to do is to draw two auxiliary circles, whose centers are coincident with the centers of the two larger circles, and whose radii are such that a circle drawn from the same center as the required tangent circle, and passing through the center of the smallest of the given circles, will be tangent to the auxiliary circles. In Fig. 1, where the given circles touch the tangent circle externally, the radii of the auxiliary circles are the radii of the larger circles, each diminished by the radius of the smallest; and the method of drawing the auxiliary cir-



cles for different cases is illustrated in the other figures. In whatever manner the tangent circle is drawn, after the auxiliary circles are properly proportioned, the rest of the construction is the same for all cases; so that, in the remainder of the explanation, reference is made to Fig. 1.



Having drawn the auxiliary circles, with radii BE, CF, draw IH, tangent to both circles, and produce this tangent to its intersection with a line, CBG, drawn through the centers of the auxiliary circles. From G, the point of intersection, draw a straight line through A, the smallest of the given circles, and prolong it indefinitely. Next find the length of HK, the side of a square whose area is to the area of the square constructed upon GH as the line, GI, is to the line, GH. Then, considering GA to be one side of a rectangle whose area is equal to the square constructed upon HK, find the other side, GL; and the point, L, so determined, will be a point of the circle whose center we wish to find. We have now reached that part of the problem in which it is required to draw a circle through the points, L and A, and tangent to the circle whose radius is CF. Produce the line, LG, indefinitely; and from L, draw a tangent, LO, to the given circle. Find LM, the second side of a rectangle of which LA is the other side, and whose area is equal to the square constructed upon LO. From M, so determined, draw a tangent, MN, to the given circle, and connect the point of tangency, N, with the point, L. F, the point in which this last line cuts the given circle, is the point of contact of the given and required circles; so that it only remains to find D, the center of a circle passing through the points, A, L, and F.

We have been greatly interested in bringing the above problem to its present shape, in which it can be readily illustrated by a single figure, and many of our readers may be equally interested in repeating the construction. It will be necessary to use great care in all the steps, in order to secure satisfactory results. As it is not improbable that there are other solutions known to some of our readers, we may add that we will be glad to hear from any of them who think they can improve upon the method explained above.

Cleaning Silver Watch Dials.

Take about a teaspoonful of saltpeter and mix it with about two dessert spoonfuls of finely powdered charcoal ; willow coal is the best. Let these be ground together with a little water on a piece of slate, with the blade of a knife; then by the aid of a camel's hair pencil, spread a portion of the mixture evenly over the surface of the dial, which must then be laid on a piece of charcoal ; and with a blowpipe and the clear flame of a lamp or gas jet, it must be made just red hot, and kept so till the wet powder has ceased to fly about ; it must then be thrown from the charcoal, hot as it is, into a mixture of sulphuric acid and water (in the proportion of about one fluid ounce of acid to three half pints of water) ; it will then have a snow-white appearance, and must be washed with brush and soap in clean soft water and put into fine sawdust, or, what is better, rose wood raspings, till quite dry.

New Drawing Instrument.

The Hartford Curve Scribe Company has recently exhibited to us an ingenious instrument for drawing curves and scroll ornaments, for use of designers, wood carvers, etc. It consists of an attachment to the ordinary compasses, in which is a small wheel, the periphery of which rests on the paper in place of the pen or pencil point. So long as the plane of the wheel is at right angles to its axis, it describes a complete circle when the compasses are turned ; but the slightest inclination from that angle causes the line drawn to curve out or in, according to the direction and degree in which it is moved from the right angle. It is an efficient instrument for its purpose, and will be found a great help to pattern makers and designers. See advertisement on another page.

The East River Bridge.

The question of continuing work on the East river bridge will shortly be argued before the United States Circuit Court in this city. A lessee of one of the United States bonded warehouses, situated on the river side above the piers of the bridge, has presented a petition for an injunction, restraining the Mayors of New York and Brooklyn, the bridge company, and others interested from building the bridge "over the East River at the hight of 135 feet above mean high water, or at any other hight that shall obstruct, impair, or injuriously modify the navigation of said river." The petitioner declares that the structure would irreparably injure his business.