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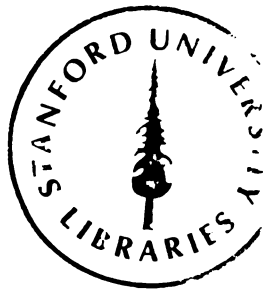


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GRAND
FEU
CERAMICS

TAXILE DOAT

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THE SNOW

Hard Porcelain Dish

Pate sur Pate and Grand Feu Glazes

By TAXILE DOAT

Reproduced from "Art et Decoration," By courtesy of M. Emile Levy, Publisher.

Grand Feu Ceramics

A PRACTICAL TREATISE ON THE MAKING
OF FINE PORCELAIN AND GRÈS

BY

Taxile Doat

*Of the Manufactory of Sèvres, France
Ceramist and Sculptor, Knight of the Legion of Honor,
Officer of Public Instruction*

Translated from the French by

SAMUEL E. ROBINEAU

WITH NUMEROUS ILLUSTRATIONS

AND

Notes on the Use of American Clays for Porcelain and Grès

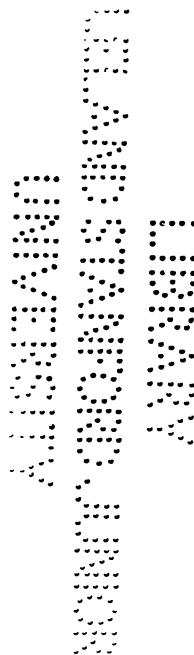
by

PROF. CHARLES F. BINNS

Of the School of Ceramics, Alfred, New York

SYRACUSE, N. Y.:
KERAMIC STUDIO PUBLISHING COMPANY
1905

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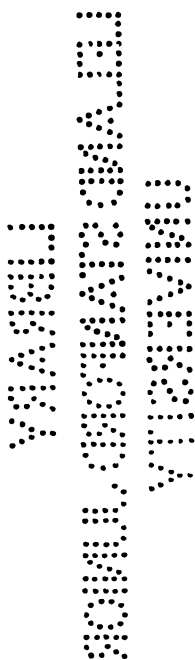


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AMERICAN CLAYS FOR GRAND FEU WARES

*By Prof. Charles F. Binns, of the School of Ceramics,
Alfred, N. Y.*

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Preface

THIS treatise, by M. Taxile Doat, the well known French potter, appeared in the form of articles in the **KERAMIC STUDIO** during the year 1903. The widespread interest with which the articles were received by potters and craftsmen in the United States, makes it desirable to reprint them in book form.

There has been in late years a remarkable artistic revival in pottery as in other crafts. This movement, which originated in France, has spread to the United States and is rapidly growing. The making of artistic porcelain, however, has been but slightly attempted in this country. It is probably because of the difficulty of the task that American artist potters, under the leadership of Rookwood and Grueby, have hitherto almost exclusively applied their skill to the producing of pottery fired at comparatively low temperatures, not realizing perhaps the intimate connection which exists between the quality of the body and the quality of the glaze and colors.

The problem of the making of hard porcelain, which was such a puzzle to the potters of the 18th and beginning of the 19th century, was long since solved, but the difficulty of decorating the ware at the high temperature at which it is made, has until lately been the great obstacle to the production of porcelains such as the Chinese knew how to make centuries ago. The difficulty was for a long time partly overcome by the decoration over the glaze at low temperatures, but the results were inartistic and unsatisfactory. It may in fact be said that this overglaze painting, more than any other cause, hampered for a long time the evolution of a truly artistic porcelain.

In recent years, the close study of the old Chinese wares has given rise to important discoveries, foremost among which

are those made by the Sèvres chemists, and by Dr. Seger of Berlin. These discoveries have resulted in a complete revolution in the making of porcelain by the introduction of an entirely new series of grand feu colors and glazes.

True porcelain can be made so as to fire as low as cone 8 (1290° C.), the point of fusion of feldspar, and as high as cone 17 (1470° C.), by modifying the proportions of its components, kaolin, feldspar and flint. At the extremely high temperatures the range of colors is necessarily limited, and the chief attraction of the ware is the beauty and purity of the paste and glaze, the decoration being used mainly to bring out the qualities of the body. The fine Copenhagen porcelains are a typical example of this method and it seems hopeless to try to improve upon the work done at the Danish factory.

At lower temperatures, the same which were used by the old Chinese for their famous monochrome glazes, the range of color effects is almost unlimited and the difficulties of firing greatly reduced. This plan, which has lately been adopted at Sèvres and by a number of potters in France, among them M. Doat, will appeal to the individual craftsman. All the formulæ and instructions given in this book apply to porcelain fired at cone 9 (1310° C.), and also to stoneware fired at the same temperature. Grès or vitrified stoneware, which has all the qualities of porcelain except the white color and translucency, is second only to porcelain for ornamental work, and is superior to it for architectural purposes and interior decoration.

M. Doat, speaking only of his own work, of the methods and materials he uses, mentions exclusively materials obtainable in France. As artists in this country will want to use native clays, two articles by Prof. Chas. F. Binns, of Alfred, N. Y., on native clays for porcelain and grès, are given as an appendix to M. Doat's treatise. They will be a most useful guide for the experiments which each individual worker will

have to make, in order to determine a body which suits his work. One of the great charms of grand feu methods is that color effects will vary with the different bodies used, and the field is so broad that each artist can give a personal touch to his productions, much more easily than with ordinary pottery. But to craftsmen who prefer faience to porcelain, the practical and thorough instructions given by M. Doat on throwing, pressing, casting, glazing, the making of saggers and the placing and firing of a kiln, will be as valuable as to the student of porcelain work.

KERAMIC STUDIO PUBLISHING CO.

January, 1905.

I write these articles with the view of assisting individual artists who are devoted to ceramic work and to render homage to the glory of the Manufactory of Sevres, to which I have belonged for the last twenty-six years. To Sevres and to my comrades I owe all my technical skill and the greater part of my art. The decorative compositions which I have executed there exceed three thousand and are placed in private collections and museums. I have refused many brilliant offers from foreign factories, but as I was unable to resist the passion of the ceramist and as a ceramist does not exist without his kiln any more than a violinist without his violin, I have established at my residence an experimental laboratory where I win from the fire the wares which have brought me a gratifying success.

TAXILE DOAT.



M. TAXILE DOAT

In his Studio at the Manufacture of Sèvres.

Part One

*A General Review of the Position of Porcelain at the
beginning of the Twentieth Century*

I—The Ceramic Movement in Europe in 1900

DURING the past century the Manufactory of Sèvres has been the promoter, or at least the most powerful factor in all ceramic evolution. Since its foundation it has been in France the radiant sun toward which workers in clay have turned their eyes, whether as investigators they sought to decipher the secret formulæ of the laboratory, or as artists they sought inspiration in work beloved of kings.

Sèvres after developing the beautiful *pâte tendre*, supplanting the hard porcelain of Meissen and the painting of polychrome flowers, created the charming works which are called *biscuit*, a creation which resulted from a failure to glaze the statuettes, as was done at Dresden. Undertaking also the execution of monumental vases, it gloriously kept at the head of the movement with its marvelous reproductions of paintings. This was a decorative mistake which delayed the coming of the *grands feux*, but nevertheless increased its renown and saved it from political opposition.

Sèvres delighted in this glorious mistake until it received in 1847 from Father Ly some of the productions of the Far East. Then cultivated minds understood that there was something else to do than to transmit to posterity, on indestructible material, a marvelous but unfaithful reproduction of the perishable works of painting.

Ebelmen by breaking some Chinese pieces studied the different stages of their manufacture and successful experiments gradually brought about a complete revolution in the processes of the decoration of hard porcelain. The growth had been slow but was irresistible.

In 1851 Sèvres sent to the London Exposition some of the results of its research, a series of cups and saucers decorated, like some Chinese pieces, upon the clay, before glazing, and like them covered with white or colored glazes. As to the colored pastes, they were inferior to the eastern examples, but they had the advantage of possessing more varied and richer colors, and under the feldspathic glaze they were protected

from all change. Regnault and Salvétat, their inventors, called them applied pastes or *pâtes-sur-pâtes*. They met with great favor. Every ceramist wanted to see this discovery and profit by it, but the secret was jealously kept.



Sèvres. Hard porcelain, date 1860. *Pâte sur pâte*, by M. Gely. Small piece.

While Sèvres was trying to adapt to hard porcelain the processes of the colored *pâtes* of soft porcelain and of Chinese glazes, ceramists in France and in Europe were working for the improved manufacture of soft porcelain.

Meissen confined itself to muffle painting, and Vienna, which after a glorious past was entangled in financial difficulties, had not the courage to undertake expensive scientific experiments.

Berlin continued to paint on its vases the Flemish scenes which the clever artists from Meissen, recruited by Frederick II, had brought with them.

Copenhagen followed the others, without having yet taken any interest in the Sèvres evolution.

The wars of Spain had ended in 1812 the celebrated mark of Buen Retiro.

Italy, which had seen the birth of the curious porcelains of the Medicis, of the fine majolicas of the Renaissance, of the soft porcelain of Capo di Monte, and as early as 1734 made hard porcelain under the dynasty of the Marquises of Genori, was still, in 1850, satisfied with the easy decorative results of muffle firing.

Practical England persevered in the improvement of its



Sèvres. Hard porcelain, date 1884. Small jewel box, enamel decoration by M. Paillet. Belongs to the Sèvres Museum. A replica of this box was presented to Madame Miolan Carvalho on her farewell performance of *Marguerite in Faust*.

soft porcelain, which had become phosphatic and was called by Brongniart "natural" because it contained only elements taken direct from nature. Being half way between the hard porcelain and the artificial soft paste, it had neither the difficulties of the first nor the losses of the second; adopted all over the Kingdom, it supplied the needs of a commercial idea which had been the incentive of its clever inventors, so that England was not interested in the new movement.

However, in France this movement was growing outside of the Imperial factory. Minds were on the watch. The Limousins, owners of the kaolin quarries, were extending their factories which gradually, by the durable qualities of their hard porcelain, were strangling their competitors, the glorious faience factories of the preceding century, Rouen, Nevers, Moustiers, Strasburg and Marseilles.

M. Solon was, through his presence in Sèvres, among the first to be introduced to the new discoveries and his clever work was displayed as early as 1860, while some inventive minds, inspired by the brilliant enamels of Palissy, were seeking new faience enamels. Avisseau 1845, Barbizet 1859, Pull 1855, and the Parvillées led by their works to the formation of the company of artists, which under the commercial name Theodore Deck attracted the attention of the artistic world and stood in the front rank in the Expositions of 1867 and 1878.

Near the exhibit of Theodore Deck in 1878, the Limousin chemist Peyrusson showed a palette of grand feu colors under the glaze of hard porcelain, a palette which I had been using since 1875, before I entered Sèvres, in the pâtes-sur-pâtes which I was engaged in producing.

From that time there was in France a sharp but stimulating rivalry between the partisans of grand feu porcelains and the friends of painting over glaze and of faience.

Toward the end of the Empire, Ch. Haviland entered the fight by establishing at Auteuil, near Paris, an experimental laboratory. A group composed of the artists Aubé, Chaplet, Ringel, Dammouse and of the chemist de Rabot formed around the master engraver Bracquemond. This group not satisfied with the decoration of hard porcelain or conscious of its difficulties, introduced the artistic grès (stoneware). But this new product did not meet with favor from



Copenhagen. Hard porcelain, grand feu underglaze decoration.
 Sea gull listening, medium size plate. Medium size plate, decoration executed with the American apparatus called air brush.



Copenhagen. Hard porcelain. Grand feu underglaze decoration.

the public, and the Auteuil laboratory was closed, after making a strong impression upon the ceramic world.

A commercial fact, insignificant in itself, awoke at that time the curiosity of collectors and the attention of artists. This fact was the continuous introduction into France by Mr. Bing of those marvelous Chinese ceramics, those single colors, enriched with brilliant glazes, that dominant quality of cera-



Copenhagen. Small piece of craquelé porcelain, called truité (speckled trout.)

mics, which reminded one of the glassy old porcelaine tendre of Sèvres and which had besides the penetrating charm of the delicate tones of the celadons of iron in imitation of jades, or the vivid effects of the flammés of red of copper.

The curiosity of students and of the public was also excited by their suggestive and bizarre names: mule liver, horse lungs, powdered tea leaf, orange skin, iron rust, etc.

Chaplet, after the closing of the Auteuil laboratory, had constructed a kiln for the production of grès, but carried away by the rage for flammé reds and wishing to devote him-

self entirely to his new work, he sold the grès establishment to M. Delaherche.

Deck and the Sèvres laboratory, working on the same lines as Chaplet, drew from their kilns a few beautiful pieces at great expense, but it was only in 1884, after the scientific regulation of reducing fires by Mr. Lauth, administrator of Sèvres, that the public was able to enjoy this new discovery in an imposing display of the most gorgeous flammés.

And at the same Exposition, a neighboring case contained the first white crystallization, the result of new experiments on glazes, especially on zinc glazes, which was to be the point of departure of the recent shower of these ceramic gems.

These new discoveries were rapidly bringing about the neglect of porcelain painting and the adoption of grands feux, when the Danish artists made their sensational appearance at the Exposition of 1889.

The Copenhagen chemists who had kept themselves posted on the experiments of Salvétat, Lauth and Peyrusson, and had known the works of Sèvres in 1884, exhibited at the



Cats. Vulture.
Copenhagen. Hard porcelain grand feu underglaze decoration.

Exposition Universelle a series of plaques and vases, decorated with grand feu colors under the glaze, which had a brilliancy and an appearance of easy execution unknown to pâtes-sur-pâtes. Their success was so much the more marked from the fact that the enemies of Sèvres took the part of Mr. Lauth, who, on account of difficulties with his personnel, had resigned his position, against Mr. Deck, who had replaced him, in a systematic disparagement of the factory.

However the success of Copenhagen had not prevented the triumph of the beautiful flammés which Chaplet was producing, nor of the clever grand feu palettes of Peyrusson and Giraud-Demay, nor of the series of my pâtes-sur-pâtes, a specimen of which had been acquired in 1882 by the Commission of Beaux Arts for the Musée du Luxembourg and was the nucleus of that section of fine arts which has been so wonderfully developed since.

This conquest of the Luxembourg by an object of art and the judicious distribution of honorific awards had stimulated the artistic world, when in 1892, at the Salon of the Société Nationale, Carriès, the sculptor, without any assistance from chemists and without financial resources, brought the grès cérame to perfection and commanded general admiration.

Then ceramists became legion, everybody wanted to model grès. This grand feu stoneware even temporarily eclipsed porcelain which had itself superseded faience. A virile material, grès developed a character of solidity and hardness which attracted the sculptors, while porcelain, with its milky brilliancy and air of distinction retained its admirers. An active struggle began between these two materials, both produced at the grand feu, and we will find them side by side at the Exposition Universelle of 1900.

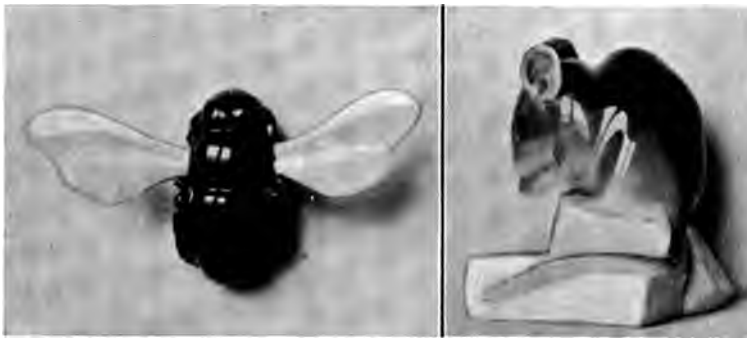
Sèvres would have achieved slowly but surely the complete reform of its decorative processes, even if the appearance of Carriès and Copenhagen had not stimulated it to completion, but these two factors were useful in this, that they provoked the magnificent French display of 1900.

At this time Carriès, taken away in the midst of his youth and talent, had like Palissy, numerous imitators, not gifted with the spirit of the master. These men were interesting, especially Jeanneney, because they fought for the good cause.



Copenhagen. Hard porcelain. Fish, white tinted with pink, black eyes.

Chaplet, first noticed in 1889, triumphantly reappeared with his flammé reds and his turquoises, covering a fine body with the curious chemical combinations of reducing atmospheres. The chemist Bigot took high rank with his large grès vases. Muller was firing at the same time his architectural tiles, and the works of the sculptors beloved by the public. He had restored the Hall of the Archers and the frieze of the lions in the Palace of Luze, and successfully carried out the large composition by Charpentier for the Monumental Gate. Pillivuyt and Giraud-Demay met with favor with their metallic glazes. I also produced successful associations of grès and porcelain with artistic effect, and I renewed the pâtes-sur-pâtes with a



Copenhagen. Hard porcelain. Horse fly, blue body, white wings.

Mouse on a lump of sugar. Mouse-grey glaze. The lump of sugar is unglazed.

series of fine mat glazes. Mr. Boissonnet showed interesting crystalline glazes on grès, and the exhibits of Haviland were made attractive by his fine flammé reds. Grès was everywhere, outside as well as inside the building. Even terracottas, cleverly concealed under the glaze, took the appearance of the popular product. The friends of muffle decoration and the faience makers were, however, yet a glorious legion.



Bing and Grondahl, Copenhagen. Porcelain Vase, subject "Growth."

All the Art Magazines and newspapers of the world have praised and exalted as it deserves, the aristocratic Copenhagen porcelain, of so pure a material and of such a captivating and peculiar art. In 1900 it found once more the admirers and enthusiasts of 1889. The masterly talent of the modelers asserted itself in a series of little animals, insects, fishes, rodents, etc., each more charming than the other. The painters had drawn their decorations from familiar scenes of animal life or from the wild poetry of northern landscapes.

Copenhagen offered besides a group of small cabinet pieces, covered with craquelés or with unexpected and scintillating crystallizations, without falling into the mistake of the large crystallized vases of Sèvres. The Copenhagen chemists had produced these glazes without any knowledge of the former discovery at Sèvres and they are entitled to all credit for being first to develop them and apply them to the decoration of vases.

The helpful influence of the Royal Manufactory of Copenhagen was manifest in all Northern ceramics and especially in the productions of Bing & Grøndhal, which notwithstanding a greater heaviness in shapes, could favorably compare with the wares of the Royal establishment. Sweden also, with the pale reliefs and the pink decorations of the Rörstrand porcelains, made a charming impression.

Holland, with Rosenburg, was represented by the twisted and bizarre shapes of a porcelain as thin as an egg shell, closely related to English porcelain and decorated with fancy paintings resembling more in technique the muffle fires than the grands feux.

England, which during the century had not been interested in the struggle for the conquest of high temperatures, had taken little part in the Exposition. However, the Doultons had constructed a large grès pavilion, in which was a great collection of pieces, and among them a few of real artistic and technical interest. But large pieces, like the great Diana vase, gave the impression of a pretentious richness and nothing more.

With a more modest exhibit, the factory of Pilkinton had beautiful majolicas due to the playful talent of Mr. Lewis F. Day and to the cultivated mind of Mr. Walter Crane, but the works of faience makers were not what we were looking for.

Minton had not thought advisable to send the pâtes sur pâtes of Solon, which in their transfer to the opaque English porcelain had lost all the precious qualities which they owed to the French porcelain. And if Staffordshire had been represented, we would not have found there any of the new technical processes.

Italy, as if exhausted by its antique creative genius, delighted in the repetition of the past, the exact copies of the



Berlin. Porcelain mantel-piece, overglaze painting.

Lucca della Robbia, Urbino, Faenza, Caffaggiolo and other wares which have a glorious page in the history of ceramics but nothing in common with the art of modern pottery.

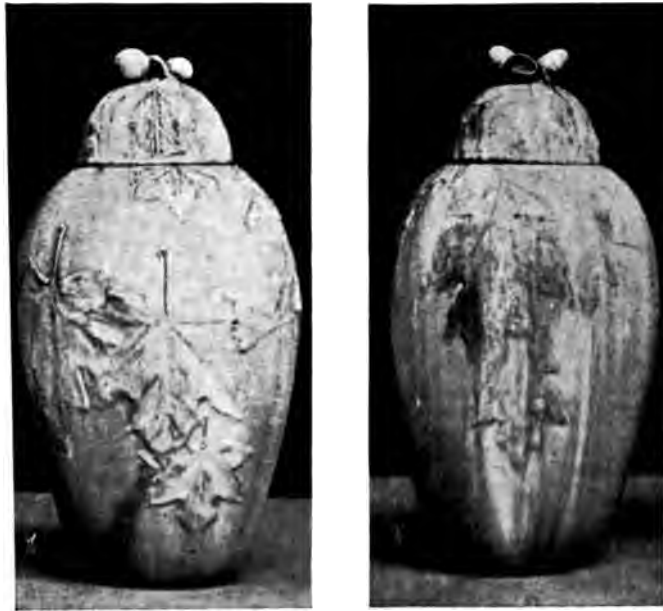


Fisher and Meig, Pirkenhammer, Bohemia. Hard porcelain, grand feu underglaze decoration. Medium size vase.

Russia exhibited a few grand feu pieces, among them some *pâtes sur pâtes*, which proved that the Manufactory of the Czar had once taken its inspiration from Sèvres, and some landscapes and decorations in the Copenhagen style, which showed it following now in the path of the Danish star. Other Russian factories had remained, for commercial reasons, indifferent to the application of the new processes.

Austria and Hungary had spared nothing to affirm their partiality for gaudy tones in the decoration and gilding. Their loaded pieces dazzled the eye without charming. It is so difficult to put on a little just where it is needed. But in the midst of this showy exhibit there was a pearl, the factory of Pirkenhammer, near Carlsbad. All the pieces, in a hard porcelain of remarkable plasticity, were decorated with charming taste at the grand feu, which made a singular contrast to the fireworks of its neighbors. The colored pâtes of the Hungarian factory of Herend were also in the very best taste.

Saxony, so flourishing at the birth of porcelain, persisted in enclosing itself in the style of a past century. Let us respect its lethargy.



Berlin. Hard porcelain. Two recent pieces showing the influence of 1900 and the transformation in the processes of decoration.

The Royal Manufactory of Berlin (Charlottenburg) exhibited master pieces of painting. Thinking that the paintings of Sèvres had been given up because they were not origi-

nal, it had asked for cartoons from celebrated artists in order to display the skill of its decorators. How useless was all this pictorial effort which could have been more successfully treated, and at less expense, on a canvas applied to the wall. Around a vast composition surmounting a monumental mantel-piece were large or small ornaments exalting the rococo Louis XV or the heavy romantic style of 1830. Fortunately the eyes and the mind rested on a few flammé and crystallized vases, which, timidly placed behind during the first months of the Exposition, were brought to the front toward the end, and on some pâtes sur pâtes on pink ground, of fine character, which will have a good and strong influence on future ceramics in Germany. This glimpse of red pearls drawn from the kilns gave us courage and we saluted the large composition, a master-piece of technical skill, as the bequest of porcelain decoration as practiced in the century just ended.

Japan replaced art by cleverness and its great display gave only the impression of unbearable coldness. China had remained deaf and had jealously kept for the eyes of adepts its treasures of idealism and good taste.

Among the imposing displays of the Belgian ceramists, the factory of Boch Brothers, of La Louvière, showed strong artistic tendencies, while it revealed curious and unique quadrangular crystalline glazes, with soft iridescence, due to the researches of its energetic technical director, Mr. Diffloth.

The United States, for which Mr. Bing had reserved a small room, had not taken part in the ceramic evolution. However, it would be unjust not to mention the potteries of the Rookwood factory, which is so brilliantly managed by the eminent Mr. Taylor, with their flowing glazes, so charming to the eye and pleasing to the touch, also the greenish faiences of Mr. Grueby, of a peculiar and attractive art.

This conscientious study shows that what dominated the ceramic Exposition of 1900 as a whole was the rational use of grand feu colors, the palette of which, necessarily restricted at first, has been markedly enriched in the last 25 years and makes new conquests every day. Also, as well on grès as on porcelain, the charming display of crystalline glazes; the invention of mat glazes, more near to the manifestations of nature, as nature is almost always mat, in fruit, flowers, plants,

shells, insects, etc.; the use of grès in monumental construction and the giving up, especially in France, of the overglaze muffle painting, which, if it had its use in a period of transition and expectation, has delayed the most important discoveries.



Grès tile with quadrangular crystals. M. Diffloth, La Louvière, Belgium (Boeh Bros.)

The Exposition has undoubtedly demonstrated the superiority of the mat effect of grès in sculptural works, the unquestioned supremacy of porcelain in everything which charms the eye by the beauty of its finish, and the unsuitability to our damp and disintegrating climates of the faïences, which can satisfy only the civilizations of more sunny climes. And we were glad to find that, notwithstanding storms, Sèvres is always in the first rank of the ceramic factories of the world, although it has in Copenhagen a most dangerous competitor, because, firing at a higher temperature, Copenhagen has a finer material, also because its artistic creations are generally, by their scrupulous observation of nature, closer to true art.



Sèvres. Frieze in grès, part of

the Ceramic Palace fragment.

II—Sèvres at the Paris Exposition of 1900*

THE Sèvres Exposition of 1884, where for the first time were grouped reds of copper, fixed blues and enamels rivaling the palette of Chinese ceramists, was quite sensational, but at no time before 1900 had the factory shown in its decennial (now quinquennial) exhibits such an ensemble of varied ceramics, new shapes, complex techniques, and work of art by the most celebrated talent. And at no time had the Laboratory met with such a succession of fortunate discoveries, whether accidental or scientifically deduced.

It must be said also that at no time had the passion for ceramics been so strong or outside influences so stimulating, and never had just or prejudiced criticism so persistently assailed the State factory, which was even threatened with suppression. A successful exhibition was absolutely necessary.

As the Ministry of Finances refused additional credit, the Sèvres administration went to work on its own resources. The first plan was the construction of an Exhibition Palace in grès outside, and porcelain inside, which, built in the center of the Champs de Mars gardens, would contain the products of the factory. Grès, which, since the works of Carriès, the regretted master, had conquered not only cultivated minds but the popular favor, was adopted in order to show the

*As it was impossible to take direct photographs of all the pieces illustrated in this chapter, so many having been disposed of, some of the illustrations are reproduced from "La Manufacture de Sèvres en 1900," published by E. Levy, 13 rue Lafayette, Paris.

possibility of applying on a large scale this first class ceramic material to the construction, and to the inside as well as the outside polychrome decoration of modern residences. Had not the Chinese built in Nankin a porcelain tower?

Lack of funds prevented the carrying out of this great original plan. It was decided that only a fragment would be executed as a demonstrative piece. The sculptor Coutan, member of the Institute and Director of the Works of Art of Sèvres in 1894, took charge of the work. Keeping for himself the sculptural part which symbolises the Arts of the Fire, he secured the collaboration of the architect M. Risler, and with the help of the personnel they together executed the external



Sèvres. Monumental fountain in grès, decorated with crystalline glazes. After the designs of M. Sandier, the Director of Works of Art.

part of this fragment of the Ceramic Palace, the dimensions of which, about 38 feet high and 31 feet wide, were very imposing.



Sèvres. The Scandinavian Diana, by Frémiet. Large piece in hard porcelain biscuit, 4 ft. 8 in. One of the two biscuits made for the Elysée (Presidential House), the first pieces of that size ever made at Sèvres in biscuit.

This construction could not be undertaken with the known materials and a special grès was necessary, of a more common and less expensive clay than porcelain, but easier to work and fire than the stoneware of Provence, of the Beauvaisis or of the Rhine country. M. Vogt, the technical director, solved the problem by inventing a grès of a very fine paste, yielding easily to the thumb of the sculptor, keeping



Sevres. Fragment of the Ceramic Palace in grès, decorated with the whole palette of new grand feu colors. Size 38 x 29 ft.



Sèvres. Large piece in grès, a part of the decoration of the Ceramic Palace fragment. The largest piece which has been made in stoneware, with the exception of large oil jars made by the Spaniards. *S. H. L. L. L.*



Sèvres. Fragment of the Ceramic Palace in grès, decorated with the whole palette of new grand feu colors. Size 38 x 29 ft.



Sèvres. Large piece in grès, a part of the decoration of the Ceramic Palace fragment. The largest piece which has been made in stoneware, with the exception of large oil jars made by the Spaniards. *8 1/2 - diameter*



Sèvres. Fragment of the Ceramic Palace in grès, decorated with the whole palette of new grand feu colors. Size 38 x 29 ft.



Sèvres. Large piece in grès, a part of the decoration of the Ceramic Palace fragment. The largest piece which has been made in stoneware, with the exception of large oil jars made by the Spaniards. *5 ft. diameter*



Sèvres. Dancers, by Leonard. Hard porcelain bisquit. These figures, about one foot high, are to be used for decoration of a table, either scattered or grouped.

moist for a long time, easy to throw and model, impervious to water and consequently not liable to crack, resisting strong pressure, receiving well the most varied coloration, and, most precious quality, making possible the execution of large pieces. This point being acquired, there remained to find the mat or semi mat glazes and the enamels, which firing at the same temperature as the material, would make with it a harmonious whole, without any danger of crackling and scaling. This was the work of the chemist M. Giraud.

After numerous experiments and trials, the architectural fragment, enriched with the flammé and crystalline effects of the new grand feu palette, was erected piece by piece on the Esplanade des Invalides.

Having heard of the creation of this new material, the architect M. Thomas asked the factory to model in grès his frieze of the Palais des Beaux Arts, *The History of Art*, the designs of which had been made by M. Joseph Blanc of the Institute. The sculptor Barrias executed in relief this large composition, the apotheosis of Art since prehistoric times, and at the proper time the 4,500 pieces, covering a surface of over



Sèvres. Dancers, by Leonard. Hard porcelain bisquit. These figures, about one foot high, are to be used for decoration of a table, either scattered or grouped.

400 square yards, left the kilns to play their part in the decoration of this monument consecrated to Art. The figures are in relief on a turquoise background and display the wonderful variety of grand feu colored glazes.

Another important work was a monumental mantel-piece over twenty feet high, ordered by the Minister of Beaux Arts and executed by M. Sedille, which showed that grès cérame, created for outside architectural decoration, was also very suitable to the more delicate interior treatment.

While these architectural works were being carried out, the chemists completed the series of colored glazes, of grand feu colors over and under the glaze, red, blue, yellowish green, brown and black, together with the crystalline glazes which had been so successfully used at Copenhagen, and gradually the muffle firing was entirely replaced by the grand feu, rapid, rational, the only ceramic firing. However at this same time the old *porcelaine tendre* was reconstituted, with its rich translucent enamels, at low temperature.

In 1895, M. Coutan having resigned, M. Sandier became Director of the Works of Art. He discarded all the old forms



Sèvres. The Italian Renaissance. Fragment of the large frieze in grès of the Palais des Beaux Arts, sculptured by Barrias after the design of Joseph Blanc. The tiles are 0.20 by 0.25 met., (about 8 x 9 inches). The frieze represents the History of Art, Assyrian Art, Egyptian Art, the centuries of Pericles, August, Leo X, François I. Louis XIV, Napoleon I, and the modern republican period.



Sèvres. Mantel-piece in grès in the Museum of Decorative Arts, Paris.

which had become unpleasant because they had pleased too long, and replaced them by a number of new shapes of all sizes. For decoration, he substituted for the illogical principle of covering with opaque colors the white surface of the porcelain, the more sensible one of using colors only to bring out better the brilliancy of the white and precious clay.

After his own designs, he directed the execution of a monumental grès fountain 30 feet in diameter at the base, with a main column over 20 feet high, rising from a large basin, above which are three dancers by M. Boucher. A combination of many small basins and columns decorated with turtles, fishes, shells, water lilies, etc., and covered with the richest crystalline glazes, produced with the play of water a most pleasing effect.



Stèvres. The Wolf, by Valton. Small piece in grès biscuit.

M. Sandier also secured in Parisian studios decorative designs and statuettes which were to give the artists and artisans of the factory an opportunity to display their skill. Among the most remarkable pieces I will mention the two biscuit groups for the table decoration of the Presidential Palace, by Fremiet, the master sculptor, the Scandinavian Diana and the Athenian Minerva, which from a technical standpoint are truly marvels of manufacture; also the groups of dancers by Leonard, 14 charming figurines, well conceived



Geraniums.

Orchids.

Sèvres. Hard porcelain, medium size vases. Grand feu colors overglaze.
 Decoration by M. Lasserre.

for the decoration of a table, whether scattered or grouped; and the Danish Dogs, by Gardet, which before firing had the fine grey tone of the two marble pieces of Chantilly, but do not give such a pleasant impression since firing.

Among smaller pieces, better suited to biscuit, a material which finds its proper place between the large marble statuary



Sèvres. Porcelain plates decorated with grand feu colors over the glaze. This is the same process as the old overglaze painting, but firing is done at grand feu temperatures. These pieces have then stood two grand feu firings: the first to obtain a ware without flaws, the second for the decoration. They are typical of the complete reform of porcelain decoration at Sèvres.



The Cities of Provence. Large vase, *pâte sur pâte*, by Taxile Doat. Size 4 ft. 8 in.

and the small ivory carvings, one admired a wolf following human steps on the snow, by M. Valton; the charming Phryne of Theodore Riviere, the Parrots of Gardet and twenty other pieces in porcelain, biscuit or grès. All were on tables covered with laces or silk cloth marked with the seal of the factory.

Between rows of cases were the large vases, almost exclusively the work of the artists of the factory. The firers

had produced three vases 4 feet 7 inches high, in flammé reds of copper, as rare and beautiful as gems.

Among pâtes sur pâtes specimens were about ten pieces of mine, one of them a large vase, decorated with the "Cities of Provence" in the shape of medallions scattered among leaves of the orange tree, the favorite tree of the Mediterranean coast.



Sèvres. Small porcelain pieces. Grand feu decoration under the glaze. Typical of the new conventional decoration with motifs taken from nature.

Grand feu colors under the glaze adorned a vase of M. Fournier (virgin vine), grand feu colors over the glaze the vase (Peacock feathers) of M. Gébleux, and M. Bieuville in The Swans used the process of juxtaposed colored glazes.

Fifteen cases contained vases of all shapes, classical or fancy, in pâte tendre, hard paste, new porcelain and grès cérame, inkstands, powder boxes, cups, candlesticks, plates, table services and a thousand articles of ornament, proclaiming the beauty and whiteness of the finest of clays, the kaolinic clay.

The most beautiful pieces of all, in which the decorative motives taken from nature were best adapted to the shapes, showed the masterful art of M. Lasserre, the cleverness of M. Gillet, the fine designing of M. Uhlich, the imagination of M. Brecy and the talent of Mess. Trager.

Of course such results had not been obtained without a gigantic effort, and these pieces had not come out of the kilns



Sèvres. Diana's Game Bag. Hard porcelain, medium size vase, *pâte sur pâte*, by Taxile Doat.



Sèvres. Minerva's Lace. Hard porcelain, *pâte sur pâte*, by Taxile Doat.

as hot cakes would come out of a baker's oven. The number of broken, defective or unsuccessful pieces, although not unusual, had been considerable. A selection was necessary and was made under the direction of the Minister. Everything which reminded of the shapes or the technique and decorations of the past was intentionally discarded. No piece was



Sèvres. Table service. Shapes by M. Sandier. Decoration by M. Lasserre, with grand feu colors over glaze. Cream white background, decoration salmon pink.



Sèvres. Small porcelain pieces, decorated over and under the glaze. Top vases, M. Lasserre, M. Uhlich. Central vase, M. Trager. Two lower vases, M. Gobleux.

admitted which had any ceramic flaw or showed any artistic inferiority. Bronze mountings were cast out as illogical in ceramics, the famous "Sèvres blue" was rejected, also the vases with marble effects and even the paintings over the glaze.



Sèvres. Hard
porcelain. M. Gil-
let. Incised dec-
oration and
enamels.

Sèvres. Large vase, 4 ft. 7 in., by
M. Gêbleux. Grand feu colors over-
glaze.

Sèvres. Pâte tendre. Vase by
M. Vignol.

Notwithstanding this strict discrimination, it was more than 1500 pieces that the Sèvres factory offered to the great French and cosmopolitan crowd which during six months passed before this beautiful display. The sale of these objects

was authorized by special Ministerial decree, and its success exceeded all expectations. It amounted to more than 300,000 francs and orders were booked which meant three years of work without an increase in the personnel. Notwithstanding the high prices asked, as many as forty orders were taken for some pieces. The International Jury awarded by acclamation a great Diplome d'honneur for the factory, 3 grands prix, 10 gold medals and many others for the collaborators.

To-day all these marvels are scattered. Among the most important, the fragment of the Ceramic Palace has been erected



Sèvres. Virgin vine. Large vase, 4 ft. 8 in., by M. Fournier. Grand feu colors underglaze.

in a Parisian garden; the frieze remains on the Great Palace; the fountain, broken and mutilated during the night by vandals and unscrupulous collectors, has been demolished and its debris have been deposited in the cellar of the Galliera Museum where they will probably remain forever; the monumental mantel-piece was acquired by the Museum of Decorative Arts in Paris. A good part of the objects in cases were purchased by foreign Museums and the exquisite little pieces bought at high prices by collectors will long remain hidden in private collections, while public collectors will exhibit theirs to the renown of Sèvres and the propagation of French taste.



Sèvres. The Swans. Large vase 4 ft. 8 in., by M. Bieuville, juxtaposed colored glazes.

III. The Manufactory of Sevres—Its Organization

THE Manufactory of Sèvres has for more than a century shone with a matchless brilliancy. No factory equals its renown, no productions have exceeded the sum of its artistic wares. The glory of its name can only be compared to that of the most illustrious ceramic combinations of the world, whether called Athenian Pottery, Etruscan Ceramics, Hispano-Moresques, Italian Faiences, King-te-tchin, Hizen, Oiron, Rouen, Meissen or Delft. And, although most of these names sum up the efforts of numberless factories, grouped in one locality, none of these groups has achieved the splendor of the isolated Sèvres.

This splendor is due to its powerful organization, from artistic, scientific and financial standpoints.

Since its creation under Louis XV in 1753, Sèvres has received annually royal or national subsidies, which have increased in proportion to its development, its productions, and also to the vanity or generosity of monarchs. Originally, under Louis XV, its subsidy was 96,000 livres. It was increased to 100,000 livres under Louis XVI. The Revolution had to adjust its support to the disturbed finances of the time, but under Napoleon I, Sèvres received from the civil list 264,000 francs; under Louis Phillipe 300,000 francs, and Napoleon III gave it 350,000 francs from his privy purse, besides the variable subsidies made necessary by Expositions or by special undertakings.

After the terrible year 1870-71, the Manufactory became part of the Public Services, and received from the National Budget an annual subsidy of 500,000 francs, raised to 624,000 francs in 1880 and 652,000 francs in 1903.

This allowance is gradually paid out by the Minister of Finance, according to needs. It covers the expenses of the three departments, administrative, artistic, and technical, at the head of which are, since 1891, an administrator and two directors (artistic and technical), thus forming a triumvirate of direction. Before that time there was only one head, one administrator-director.



Old manufactory of Sèvres, built under Louis XVI, now High School for girls.

The general personnel consists of 175 people, but the number of collaborators is unlimited, every Frenchman having the right to submit designs and models which may be accepted by the triumvirate.

The administrative department is composed of the administrator, the two directors, the museum, the library, clerks and guards. Salaries vary from 1,200 to 12,000 francs. Besides their fixed salaries the members of this department have free lodgings, heat and light, and a pension when 60 years of age and after 30 years of service. Extra pay is also given to high members of the staff and the guards receive free clothing. All these advantages stimulate the devotion to the common work. The department is under the direct orders of the Administrator, who is named by Presidential decree.

The artistic department is managed by the Director of the Works of Art, who is selected by the Minister of Beaux Arts and assumes the responsibility of the artistic productions. He determines the prices of executed pieces, buys the plans of decoration, designs, statuettes and all works which he considers beautiful and useful for the diffusion of ceramic art or the good renown of the factory.

In order to determine the sale price of a piece, the sum paid to the artist is doubled, so as to cover the general expenses; so a vase for which the artist receives 500 francs will



New manufactory of Sèvres, built under Napoleon III, inaugurated in 1875.

be sold for 1000 francs, and only in cases of exceptionally successful pieces is the sale price increased in a larger proportion. Every executed piece is paid for to the artist, whether it comes out of the kilns successful, insignificant or broken.

Vases, the decoration of which is produced with the brush, remain unique pieces, whatever their cost; only modeled or sculptured pieces are reproduced.

The fixed artistic personnel has at all times constituted a brilliant phalanx, united and glorious, which has left imperishable creations or reproductions. But this company, which has at times reached the number of 50, has gradually decreased and includes now only 24 decorators, and hardly a dozen are designers, the others being only clever to interpret.

The artists engaged before 1880 are entitled to a retiring annuity, but this privilege having been suppressed after that date, artists now only enjoy monthly salaries, to which are added at the end of the year allowances for supplementary work. These are irregular but justified by the moderate salaries. With these additions salaries vary from 2,400 francs to 6,000 francs.

Until 1895 nine-tenths of the decorative projects came from the artists of the factory, and the statuettes which were to be executed in biscuit brought to the author only the purchase price. In order to extend and renovate the production and to attract more talent the purchase of designs outside of the factory was adopted for the Exposition of 1900 and



View of Paris from the hills of Sevres, showing the National Manufacture.

maintained since; also the allowance of 25 per cent commission for all works of statuary reproduced in biscuit. As a result, the creative activity which was before confined to the factory, now comes from the outside, and to this invasion is due the magnificent display of the Exposition Universelle of 1900.

Only the fixed and permanent personnel execute their own works in the factory. The occasional collaborators are not admitted in the factory to which they do not belong, but their models, if accepted by the triumvirate of directors, are executed by others in the working rooms.

The third department, which in point of numbers, is the



Working room for mounting.

most important, includes the laboratory, the kilns, the mill and all the working part. It is managed by the technical director, who is and has always been a distinguished chemist, and who has the help of another chemist, chief of the laboratory.

In this laboratory are mixed the colors, pastes and glazes, and in it constant researches are made for new discoveries. It is there that scientific reason takes the place of empiricism.

From this laboratory have come all the great ceramic discoveries of the century. There, were studied and determined the formulae of the *pâte tendre*, the hard porcelain, the new porcelain, the *grès cérame*. There, were created the

magnificent palette of the painters, the colored pâtes, the pâtes-sur-pâtes, the colored glazes, the flammé reds of copper, the crystalline glazes and quite recently the mat glazes, the under glazes, and the colors of grand feu over glaze. In this laboratory the process of casting large vases has been invented and the regulation of oxidizing and reducing fires has been determined. There the coloring oxides are scrupulously analysed to insure their purity, and all materials are carefully examined before being used.



Working room for large casting.

The different monarchs have in different ways manifested their interest in the Sèvres Works. Louis XVI liked to converse with Macquer. Napoleon I gave an order to Brongniart for the table of the Marshals, and this same Brongniart, who was for forty years at the head of the factory, created, according to the wishes of Queen Marie Amelie, a marvelously rich and fresh painting palette.

Napoleon III who said "thou" to the learned Regnault, sent frequent missions to China with the view of enriching the Sèvres Museum with the most characteristic specimens of Oriental art, and the laboratory with the materials and colors taken from the Chinese potteries by diplomacy, and sometimes by force (Mission Scherzer.)

Like the artists, the workmen were until 1880 entitled to a retiring annuity. Recruited among the best men of the ceramic industry and also among the best pupils trained in the work rooms, these artisans are exceedingly clever. The care with which they do the glazing, the placing of the kilns and the firing has considerably reduced the percentage of losses which is unavoidable in all ceramic fabrications, especially of porcelain, and their work is an important factor in the beauty of the Sèvres products.



Watching the firing.

There are seven kilns of different sizes. The moulders, finishers of biscuit, number 22, with salaries varying from 2,800 to 4,500 francs, and there are 15 throwers with salaries varying from 2,000 to 4,600 francs.

Outside of the table services made from stock models Sèvres accepts no orders. All the new models are due to the Director of the Works of Art, or to the inventive ideas of the artists. Under the monarchs, no piece was sold; all belonged to the kings, who gave them to friendly princes, to diplomats, high dignitaries, charitable institutions or to the Palaces of the Crown.

Everything has been changed since the Sèvres budget is

voted by the Parliament (1870). Although a few pieces are still offered as diplomatic presents, most of them go to the French Museums, and the others are offered for sale in a sales-room specially arranged in the factory itself. But hitherto, in order not to injure the outside ceramic artists or factories, the Parliament had forbidden the sale in public exhibitions or the creation in Paris of a store for the sale of the products. In 1900, on a ministerial order, a successful exception was made to this rule, and the factory, overruling all precedents, on the 1st of May 1903, opened a store on the Boulevards in Paris.



Drawing a kiln.

Moreover, in place of the jealous hiding of the discoveries made in the laboratory, which was characteristic of the administration under the monarchy, the present democratic government gives out every ten years all the new processes, and in order to efficiently support the efforts of the French ceramic industry, the Minister of Public Instruction has recently attached to the factory a School of Ceramics, where industrial superintendents are trained, and where after four years devoted both to practice and theory pupils receive the diploma of the School of Sèvres.

If one brings into comparison the position of the other

royal establishments of Europe which have only a nominal protection, like Rosenberg, Meissen, Minton, or a small subsidy, like Berlin (80,000 marks), Copenhagen. St. Petersburg, one will easily understand why with its model organization, its large subsidy which allows the purchase of the creations of great artists, free, unlike other State factories, from all pre-occupations of a commercial nature, established formerly in a palace built by Louis XVI on the edge of the woods of St. Cloud and Versailles, later on in a more modern palace due to a caprice of Napoleon III, having the prestige of a State factory and a personnel of eminent artists and artisans unhampered by the cares of material life and with an absolute freedom of presence or absence, one, I say, will easily understand why Sèvres has been this marvelous *ensemble* which for over 100 years has forced a universal admiration.

Part Two

*Technical Instruction in the Making of Grand Feu
Porcelain and Gres*

I.—Preparation of Gres and Porcelain Bodies

IN the introduction to this treatise I said that I would write for individual artists who are devoted to ceramic work, having only moderate means, but anxious to do something useful and to leave in the world some mark of their passage. Left to his own resources, the ceramist needs great energy to face without discouragement the many failures which his efforts to conquer the clay are bound to meet.

During my life, I have met a number of artists, who, frightened and disconcerted by prospect of failure, unfamiliar with the chemistry of colors and their difficult preparation, gave up the fight, without realizing their dreams, saying: "I also, could have made ceramics." As for myself I had the good fortune not to know the disappointments of the beginning. These are the only ones to be feared, because this art is so attractive that when one has tasted it, one cannot escape its fascination.

I will consider that my object has been reached, if I can help newcomers in this charming craft to avoid these times of trial and discouragement. They are the thorns on the path but at the end artists will find the reward of their work.

With a view to this result and in order to simplify the initiation to and understanding of the *grands feux*, I have purposely neglected in this work everything which refers to the manufacture of large pieces, and to mechanical and industrial production. I simply relate how I have succeeded in the practice of my art and tell of the means and tools I use. The reader will therefore find here, aside from general processes of fabrication used everywhere, in Europe as well as China, processes which, being my own, have given to my production its special quality and variety.

They will see also that I have endeavored to describe the various processes of the rich *grand feu* decoration in a practical and empirical way, without the use of scientific formulae and in simple and accurate language, with a profusion of details for the benefit of those who will take interest in them.

I will not speak of *faience*, because it is easy to find every-

where clay suitable for this ware, and because there are many merchants who sell colors for this variety of ceramics. Only the grès and porcelain capable of standing the higher fires will receive my attention.

The ceramist, in order to produce durable work, must first possess a good plastic body, which yields easily to the thumb or the hand. He may use a material which nature herself has composed and combined, as in Europe, the clays of Nievre, of Bauvaisis, of Provence and of Flanders, or he may make a mixture of clays coming from different places, as is done for the Sèvres grès. Every continent contains natural grès; it is the duty of geologists to study them and make them known.

The artist will prefer natural grès, because in the case of mixtures a very serious study of clays will be necessary in order to avoid long and costly experiments.

Grès-cérame (vitrified stoneware) in order to deserve this name must, after firing, be a solid, hard piece, impervious to water, without the help of any covering or glaze. It must be suitable for making objects of large dimensions, capable of receiving a varied coloration and a delicate and sharp relief ornamentation. These qualities, which Brongniart in his learned "Treatise of Ceramic Arts" gives to grès-cérame, make it closely resemble porcelain, from which it really differs only in the absence of translucency and whiteness. Grès and porcelain both belong to the class of ceramic products which are impervious to water. But the grès paste has, for the manufacture of large pieces, considerable advantage over the porcelain paste, it is easier to work, more plastic, easier to fire without warping, and is much cheaper.

The impermeability to water, which protects the ware from injury by frost, and the comparative ease with which it is worked and decorated, make the grès-cérame the best material for the outside and inside decoration of dwellings, in climates where frosts are frequent. It will eventually replace faience everywhere.

The grès which I have used most is that of Sèvres. It is easy to prepare and not expensive. Its composition is:

Clay of St. Amand,	9 k. 335 gr.
Clay of Randonnai,	4 k. 500 gr.
Ground sand of Decise,	4 k. 335 gr.

The clay of St. Amand can be bought from its owner, Mr. Poulain, à Argenoux, commune de St. Amand en Puysaie (Nievre), for 12 fr. (\$2.40) per 1000 kilos; the clay of Randonnai from Mr. Aubert, à Tourouve (Orne) for 10 fr. (\$2.00) per 1000 kilos.*

The sand of Decise being the property of the great faience factory of Creil et Montereau (Oise), must be ordered from the Director. I have paid 26 fr. (\$5.20) for 260 kilos, washed, ground and dried sand, or 10 francs (\$2.00) per 100 kilos.

The two clays St. Amand and Randonnai, coming from the bed in clods, are simply crushed dry with a hammer, until reduced to about the size of a nut. After being carefully weighed, the various elements are poured into a pail full of water. The clays will slake by themselves like lime. The mixture is left to rest for two days and is then stirred with a spatula and passed through a screen No. 60.

The screen is a metallic canvas made of brass. The nails which fix it to the frame must be of copper, to avoid the rust of iron nails. I get these screens from Mr. Louvier, 45 rue du Temple, Paris.

It is important to throw away only the refuse which does not go through No. 60 screen. It consists of particles of iron and a small quantity of organic matter.

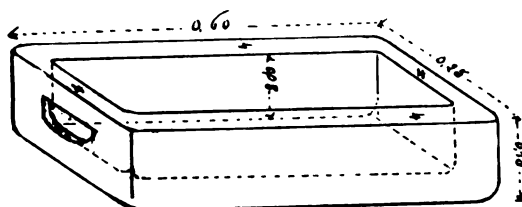


fig. 1

The above measurements in centimetres reduced to inches are about as follows:
24 inches long, 10 inches wide, 6 inches high; walls $1\frac{1}{2}$ inches thick, $3\frac{1}{2}$ inches deep.

As the mixture has been diluted with a large quantity of water to make it pass easily through the screen, it is left to rest

* It has seemed advisable to leave the weights expressed in French measures, as French weights are now generally used for pottery work. A kilo is 1000 grammes, 500 grammes make a French pound, differing only slightly from the English pound.

for two days, the water is then poured off and the mixture placed in a plaster basin (Fig. 1), which will absorb the remaining water. The paste gradually hardens, and when found sufficiently firm, it is taken by the thrower.

This paste will acquire the distinctive qualities of ceramic grès by being fired to Seger cone 9, or a temperature of 1310°C. according to the thermo-electric pyrometer of Mr. Le Chatelier. If fired in a reducing fire, it will be better vitrified in its mass and more impervious to water than if fired in an oxidising fire.

For all grès, especially if the pieces are of large size, the firing must be very slow and gradual at first, to avoid the cracking which a too rapid fire would cause.

This grès body is of a very fine grain. It is easily worked by pressing or throwing. It is even probable that it could be satisfactorily handled with the mechanical processes in use in factories. Its drying must be watched carefully, in order to avoid cracks and warping.

The shrinkage of this paste, both from drying and firing, is such that one must take in the mould a piece 1 m, 125, to obtain after firing a piece one meter high. This grès, invented at Sèvres, has been studied not only with a view to give the quality necessary to a good grès, but to make it as close as possible to the new porcelain, so that pieces can be made of grès and porcelain combined. Its constitution also allows it to receive with good results all the colored glazes which had been previously created for the new porcelain. It will fire at the same temperature, at the same cone and pieces of both materials can be placed side by side in the same sagger. It can be treated with the same glazes and the same processes of decoration, and, from a ceramic standpoint, excels porcelain in the point of the fabrication of large size pieces.

The necessity of making stands for my vases, and the wish to use only ceramic materials for every part of my productions, with the desire not to imitate the Japanese and Chinese who carve their stands in teak wood, marble or bronze, led me to adopt grès for the production of these stands, and I have always been careful to fire the porcelain vase and its grès stand in the same sagger.

I have experimented also on a simpler composition of grès paste, which has given me excellent results:

Clay of Randonnai,	80 kilos
Sand of Fontainebleau,	20 kilos

The sand of Fontainebleau is furnished to me by the factory of Creil et Montereau, ground and dried for 90 fr. (\$18.00) per 1000 kilos.

Both the sands of Decise and Fontainebleau may be bought from Poulenc Freres, rue Vieille du Temple, 92, Paris.

This mixture is handled in the same way as the first, and both have the disadvantage of developing, when they are fired in an oxidising fire, a yellowish tone, which gives them the appearance of faience or pipe clay. They acquire their beautiful grey blue tone only in a reducing fire.

As I fire alternately with oxidising or reducing fires, according to the effects I wish to obtain, and as I do not generally execute pieces of large sizes, I have adopted a third natural grès clay called Kaolinic Sand of Lange-Rollin (Nievre), owner, Mr. H. Caziot, 17 rue des Perrieres, Nevres.

It is highly important that this sand be very finely ground. It is very rich in alkali, which, in the shape of white muscovite mica, reaches nearly 6%. It is a complete material, which does not need any preparation or the addition of any other element. It keeps its fine ash grey tone in both fires. Its paste, of very fine grain, is silicious and closely resembles some Chinese porcelains. I have obtained with this grès very beautiful flammé reds of copper. It receives without crazing the glaze of the hard Limoges porcelain. Its shrinkage is somewhat greater than that of the Sèvres grès or the Limoges porcelain, and these shrinkages are deceptive, as it is difficult to accustom oneself to the fact that after firing a model may be reduced one-fourth.

In the Salon of 1902 I exhibited the first fine pieces made from that grès, and gave them to the Museum of Nevers.

The black clay of St. Amand en Puysaie, which is the basis of the Sèvres grès, is a natural grès clay, which may be used by itself, without the addition of any other element. It is very fine and plastic. With this grès Bigot makes vases 3½ feet high, bath tubs 5 feet 7 inches long, 33 inches wide and 24 inches deep. It is the material which Carriès used for his ceramics,

and which is used by his imitators, rose water ceramists, who have their wares fired in the kilns of any manufactory and who are legion.

Here then are four grès pastes, which are all easy, because they can be prepared in small quantities, say 40 lbs., which does not require a large outlay.

If in most cases the composition of grès is simple, it is not so with porcelain. The various porcelain bodies used in Europe are made of different elements. No natural porcelain paste exists.

I will not undertake here to make comparisons, or to give the composition of the various European and Chinese porcelains. I will only state that the extreme compositions of practically possible porcelains will be found between the following limits:

65 to 35 kaolin
20 to 40 feldspar
15 to 25 silica or quartz.

Kaolin is the plastic element, feldspar and silica are the fusible elements. The extreme combinations must receive, one a temperature of 1500° C (about cone 18), the other of 1350° C (cone 11), in order to vitrify, and from this fact the products are bound to possess different properties.

The first extreme combination, very rich in kaolin and consequently in alumina, will well resist variations of temperature, will receive the hard feldspathic glazes, on which a steel point has no effect, excellent qualities for table ware, but it will not permit a wide range of colors. The hard Sèvres porcelain invented by Brongniart and the Dresden porcelain are in this class.

The other extreme combination, with more silica and less alumina, fires at a lower temperature, which makes it possible to introduce as much as 16% lime into the glaze, so as to soften it and to obtain more varied and brilliant colorations. To this type belong porcelains from China, Japan, Russia, Bohemia, Limoges, that of Chaplet and my own.

Between these extreme mixtures all intermediate combinations can be used.

At the beginning I adopted the Limoges porcelain which is about half way between the two extremes. The paste,

carefully prepared, was bought from Mess. Lacroix et Ruaud, manufacturers of porcelain pastes, Limoges (Haute Vienne). They make four different qualities. I used to buy, and buy yet for certain pieces, the first of these four qualities, called FF (paste for figures and flowers). It costs 18 francs (\$3.60) per 100 kilos. It is passed through the screen No. 120. Its composition is:

Pure kaolin,	37, 27
Quartz,	27, 35
Feldspathic debris,	35, 36

The glaze which fits this paste is of the hard type, that is exclusively feldspathic. It is sold for 12 fr. per 100 kilos. After firing the porcelain is of a pure white and beautifully translucent. Its palette is rich.

Porcelains to be worth consideration must have many qualities. The paste must be translucent, hard, impossible to scratch with steel, homogeneous, very sonorous, completely vitrified, and when broken, must show a sharp angular break with a very fine and brilliant grain. In this condition it will be impervious to water and proof against injuries by frost, and will resist climates like ours in which humidity is a great disintegrating agent. These characteristics, especially translucency and vitrification, constitute the definition of porcelain. If one of them is missing, we have another kind of ware. If the paste keeps all these properties except translucency, we have a grès; if it is not vitrified, we have terra cotta, faience or pipe clay.

Porcelain paste should be prepared in a zinc vessel, in the making of which iron has been strictly avoided. Iron is the great enemy of porcelain, as particles of oxide of iron (rust) will make, on the brilliant white, black spots which cannot be removed, a serious flaw if it occurs on the decoration or on figures. After the paste has been in water two days, it is poured the same as grès into a plaster basin, and when the water is absorbed, one has a soft paste ready for modeling. During these operations one must be very careful to avoid the introduction of dirt in any form.

As a rule porcelain makers do not manufacture their paste themselves, as it requires a special and costly outfit. Only the great manufacturers, owners of quarries, have their mills to

grind the materials. Sèvres does not own kaolinic quarries but buys the best of the Limoges kaolins.

With the paste FF I made all my first ceramics. I used it from 1879 to 1895 and have very seldom had failures from any fact in relation to this paste and its glaze. But, after the creation at Sèvres of the new hard porcelain, called PN (porcelaine nouvelle), I found from numerous experiments, that it had among other advantages, that of firing at about 100° lower temperature, of allowing more rapid work in the execution of *pâte sur pâte* decoration without any flaws resulting from this rapid work, and also the great advantage, so long studied at great expense at Sèvres, of making possible the combination of grès with this porcelain and its glaze. I did not hesitate to adopt it, and was about to begin its preparation, when an engineer, Mr. Frugier, a pupil of the laboratory of Sèvres, fixed his residence at Limoges, 17 rue du Chinchauvaud, in order to manufacture the new paste, which he sells:

Porcelain paste, PN., dried and sifted, 15 fr. (\$3.00) per 100 kilos. Porcelain glaze, PN, 20 fr. (\$4.00) per 100 kilos.

The composition of this PN paste is:

Kaolin,	38
Quartz,	24
Feldspar,	38

and it fires at 1310°, Seger cone 9.

My present art production is made from this paste. The temperature at which it fires makes it possible to burn in the same kiln volatile mat glazes and the applied pastes, which need a hard fire to secure their translucency. It resolves itself to a question of careful placing of the kiln, the glazes at the bottom, and the pastes on the top.

The paste PN does not get out of shape easily, it has a brilliant whiteness and a milky translucency. It will stand many firings, an important quality in the saving of pieces which have not come successfully out of a first fire.

Mr. Frugier also prepares for casting, this same paste PN with the addition of a certain silicate, the formula of which I do not know, which makes it coagulate rapidly and allows one to take a piece promptly out of the mould.* This special

*This, according to Prof. Binns, is probably silicate of soda.—[Pub.]

paste is called Paste PN for Casting (in French, coulage) and costs 15 fr (\$3.00) per 100 kilos.

As all these descriptions of pastes might leave undecided those who wish to try an artistic production on a moderate scale, I will advise them to confine themselves at first to two materials, a grès paste and a porcelain paste.

I advise them to adopt the porcelain PN Frugier and the Sèvres grès. The PN glaze will fit both bodies. Both will fire in the same sagger at the same temperature, and can be treated with the same decorative processes, giving a variety of results.

After the difficulties of the beginning have been solved, the artist will be in a better position to experiment on the other bodies I have mentioned. And if one wishes to try only one material, he should without hesitation choose the porcelain, because it has over the grès the advantage of standing many refirings.

I will add, as a conclusion, that after a few successful pieces have been taken from the kiln it is easy to understand why one becomes a ceramist.

II.—The Making of Gres and Porcelain Forms. Throwing and Pressing.

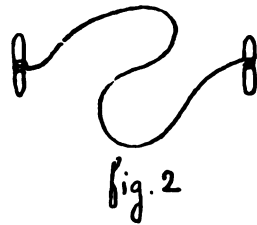
THE handling of grès, and especially of porcelain, presents difficulties which can be solved only by practice or with the help of a clever artisan. Pieces can be made by three different processes: *Throwing* and *pressing* for grès, to which should be added *casting* for porcelain. None of the details of this work must be neglected as an omission or lack of attention may absolutely ruin the finished piece, although there may be nothing before its passage through the fire to show that it contains a destructive flaw, any more than a flaw can be detected in a steel bar before it breaks.

However, one should not exaggerate these difficulties, as the mind gradually and easily gets used to the many precautions which must be taken during the handling of a piece.

When I commenced my experiments, I did not know how to throw, and I first learned to use the wheel.

Beating—When the soft paste has been taken out of the plaster basin it is necessary to beat it in order to make it thoroughly homogeneous and to expel all the air bubbles which may have been introduced during the first operations. In a ceramic body the forgotten air bubble causes, during firing, a blister or a pin hole. Formerly in factories the paste was trodden by the naked foot, but now the work is done by machinery. As machinery is unnecessary for small quantities, one should beat the paste, as I do, with the hands.

The paste is divided into balls or masses of 15 to 20 centimeters (6 to 8 inches) according to the muscular strength of the operator. Then the ball is cut in two, either with a brass knife, or better, with a fine copper wire such as is used to cut butter (fig. 2). The detached part is lifted with both hands to the height of the arm and thrown violently on the other part so that the two masses will penetrate each other. In order to increase this penetration one strikes a few



successive blows with the hands on the sides of the mass. This operation is repeated about twenty times, care being taken every time to oppose the sections to each other until, when opening the mass, no air bubble can be detected.*

During the beating the hands must be kept, not wet, but damp to avoid the formation of crust from the heat of the hand.

The beating of paste may be done, for grès, on a plaster slab 3 inches thick, and for porcelain it should be done on a slab of slightly porous stone, about 2 inches thick.

The slab I use is 25 inches long by 27 wide. Its surface is very smooth. It is solidly fixed on one side in the wall, and supported on the two other sides by a casing of bricks, laid flat, so as to insure their absolute fixity. The fourth side, or front, is open to leave free movement to the beater.

This wedging table must be kept very clean and carefully cleansed when one uses it for porcelain after grès.

Throwing—Throwing comprises *throwing proper* and *turning* or *finishing*. The tool to use is the antique potter's wheel. It is made of a vertical shaft turning in a cup fixed on the floor, the upper part being held by a collar. On the top is screwed a plaster cap on the flat side of which the thrower places the paste. This cap is called the head. Near the base of the shaft is a large balanced wheel, which the thrower pushes with the right foot to keep it revolving.

Everybody knows the potter's wheel. There are some in every city in the world and it should be easy for any one to become familiar with its working.

To throw a piece the thrower places near his hands an earthenware basin filled with a clear paste called slip. He puts the wheel in motion, throws with his right hand some slip on the wheel top, slides on that slip a plaster disc $\frac{3}{4}$ -inch thick, putting it exactly in the center, being sure that its center coincides with that of the wheel top. As soon as the water of the slip is absorbed by the plaster, the disc will be fixed by itself and will form a solid basis. Then the disc is also covered with slip, in the midst of which the ball of paste is thrown and fixed.

*This operation is called by the potter "wedging" and a convenient wedging table can be arranged, the top being of slate or smooth stone. A stationary wire strained from the front of the table upwards to a support at the back will greatly facilitate the work. [Pub.]

Taking the mass of paste between the hands, which he must keep constantly wet with slip, the thrower alternately raises and lowers it, pressing it between his hands, then between his fingers, pushing the thumbs into the center of the mass and opposing them to the fingers which are pressing on the outside. Sometimes with an effort, at other times by a slight touch of the hands, he gives to the paste a thick and heavy shape, following as closely as possible the curves of the shape to be made.

In the study of throwing the most difficult thing to master is the centering of a piece, which consists in making the center of the thrown piece exactly coincide with the center of the wheel head, so that they will revolve together smoothly. It took me three months and a good deal of patience to master this necessary detail. I advise to practice first with a small portion of clay and successively with heavier and more important pieces. This point acquired, the rest is nothing but an attractive play.

Closed pieces, those with narrow necks, are thrown in two pieces, which after the finishing are put together and fastened with slip. This operation must be done rapidly and with precision.

Throwing is the most important part of the making of a ceramic piece and its success depends entirely on the care with which it is done. Brongniart, in his excellent "Traité Des Arts Ceramiques" mentions all the precautions which must be taken. It would be too long to go over them in detail in this treatise. The thrower will become familiar with them by practice. I will simply say that the less plastic a clay is, the thicker it must be thrown, and that it takes many years of practice to become a clever thrower.

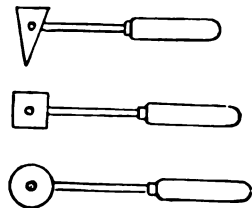
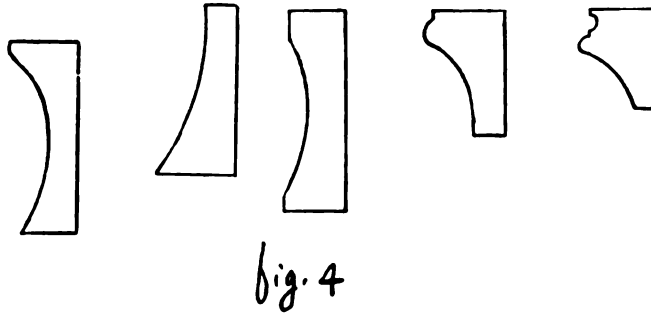


fig. 3.

Turning--When the thrown piece is firm, but not dry, it is placed again on the wheel and fastened with slip. Then it is perfected with turning tools. These instruments (fig.3) are steel plates, sharpened on the edges with a file, straight or curved, solidly fixed in a wooden handle and perpendicular to

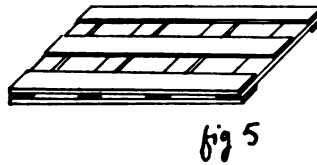
the angle of the handle. With these different turning tools the thrower perfects all the curves of the vase, keeping as closely as possible to the design which he has under his eyes. The piece is then subjected to the finishing process.

This consists in applying to the turned piece a scraper or steel blade with sharp edges, which has been cut with a file into the exact inside or outside outline of the model (fig. 4). The sharp edge of the steel removes the remaining excess of paste. This done, the piece may be finished completely by polishing it with a thin horn, a pad of rubber or a wet sponge.



Pressing—Pressing is the mode of fabrication by which the soft, but well beaten and homogeneous paste, is vigorously pressed with the thumb inside of a plaster mould representing the shape which one wishes to make. It is important to place an even coat of paste everywhere, whether it is put in small flat pieces or rolls. One must also with a wooden chisel indent with light furrows the two parts which must be joined, and in order to obtain a perfect adhesion, the edges of all the joined pieces should be wet with slip. Without this precaution there would not be adhesion of all the parts of paste successively applied in the mould, and cracks in firing would result.

The pressing done, and after the paste has become firm, the piece is taken out of the mould. The drying should be slow and even to avoid warping. Grès requires more care in this operation than porcelain. Grès is placed on frames (fig. 5), made of wooden slats, so that the circulation of air will act on all sides. To



do otherwise would be to take the risk of cracks and warping which would disastrously increase in the firing.

The pressing process makes possible the execution in grès and porcelain of large pieces, in which the carving in high and low relief constitutes the main decorative element.

The drying and the firing of these large pieces are not without danger because of the shrinkage. To diminish this risk, it is well to mix with the paste, in the proportion of 20 to 25%, a material which having already shrunk, will help to reduce the total shrinkage. This material is a powder made of the same grès, fired and pulverised and called "grog" by potters. With the help of this admixture Chaplet has executed plaques three feet in diameter, giving 2 feet 7 inches after firing. With the same process Bigot has successfully carried out a series of grès bath tubs made in one piece, and Jeanneney made in 1900 two enormous chimeras 3 feet 11 inches high. The high relief medallion which figured in the architectural fragment exhibited by Sèvres in 1900 was 5 feet 3 inches in diameter and 25 inches through in the thickest part of the relief. It was made of this prepared clay.

As a certain number of pieces cannot be made in one block, they are made in parts, and the joining and adjusting of these parts is called cementing.

In order to make a good cementing, the constituent parts of the piece should be put together dry, and when the adjusting has been well determined, furrows or hatchings are scratched on both surfaces to be joined, they are wetted with gum water and covered with a thin coat of slip, then it is cemented. Slip sets quickly and it is necessary to do this work promptly.

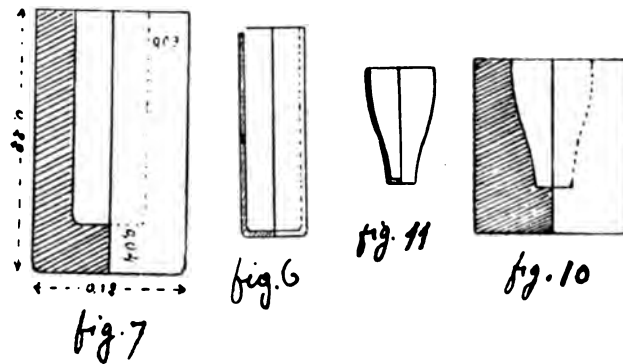
To render the cementing easier, its drying should be slow. This result is obtained by mixing with the slip a little gum arabic.

I do not think it necessary to go into further details for this part of the fabrication, as the makers of faience and common pottery are familiar with all its phases and can be referred to. Processes are the same with the new materials, but will require more care.

III—Casting.

IN presence of the many difficulties of the various processes for handling paste which I have described, which difficulties are overcome only by special training and long practice, I decided early to adopt the mode of fabrication called *casting* so as to obtain results more easily and surely. This process is very attractive. It is well suited to the work of individual artists, because it does not necessitate an expensive outlay and presents no serious difficulties. It requires only attention and care. It is adapted only to porcelain, not being suitable to grès. In this way the smallest as well as the largest pieces, can be obtained at will, vases two inches or nine feet high, with fancy shapes like the Rosenberg or the Dresden wares, the thickest ceramics of Chaplet and of Bing & Grondhal as well as the thinnest egg shells of the clever Japanese. It is simply a question of moulds, which are costly and cumbersome only for large pieces.

On account of my modest resources and of the little leisure which my work for the State factory leaves me, I have confined myself to works of small and medium size. The most important of my cast pieces is the triumphal vase reproduced in the learned Encyclopedia of Ceramics of W. P. Jervis. It is 16 inches high.



With this process there is no need of learning to throw, beat, turn and finish the paste. The thickness is acquired

mechanically with a perfect regularity. It is the triumph of the tyro and the joy of beginners.

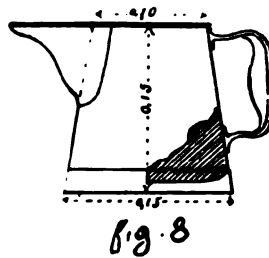
This mode of manufacture is based on the property which dry plaster moulds possess of absorbing water. If into one of these moulds, the liquid paste called slip is introduced, the water will be rapidly absorbed, the paste will become firmer and will be spread uniformly over the walls of the mould, following all the curves. When a sufficient quantity has thus been fixed on the walls, if the excess of slip is poured out, there will remain a coat of coagulated paste reproducing exactly the outside outlines of the piece and the inside of the mould.

Simple moulds are emptied through the top by turning them upside down. Those of medium and large size, which are complex and heavy to move, are emptied through the bottom.

By following the explanations given below, anybody wishing to attempt grand feu ceramics, may become in a week familiar with the operation of casting.

Let us take as an example of a small piece, the casting of the two shapes, (fig. 6 and 11). The mould will be simple, as no projecting part in the shape will prevent the piece from leaving the mould easily (fig. 7 and 10).

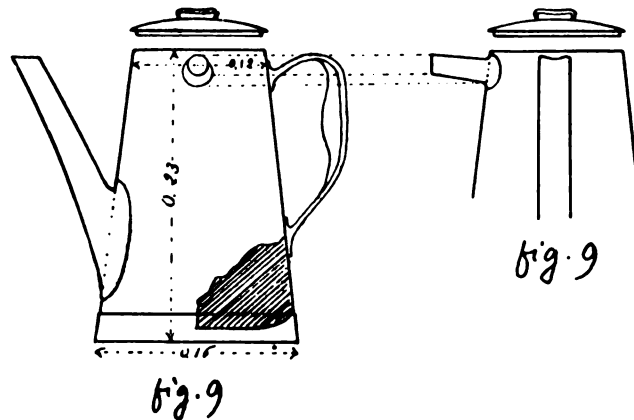
First, the slip, which has been passed through a screen No. 120, is prepared in a cylindrical pitcher with spout, having a large opening, so as to make cleaning easy (fig. 8), and containing at



least double the capacity of the mould, or in a common coffee pot (fig. 9). The slip is gently stirred with a wooden spatula, in order, a very *essential point*, to expel all the air bubbles, to dissolve all the clods and make the paste quite liquid without excess of water. It is called *well prepared* for casting, when it is semi-pasty, that is, when it contains just enough water to make

it fluid. If it has too much water, the slow time it would take for the water to be absorbed would be injurious. There is a happy medium which must be left to the judgment of the operator.

The slip is poured into the mould which is filled to the top. The absorption of water begins at once, and the slip which goes down gradually is constantly replaced so as to keep the liquid at a constant height in the mould. All the phases of the thickening of the paste can be watched easily, and when the thickness is judged to be sufficient, the mould is turned upside down, and the excess of useless slip poured out. One must carefully avoid jerks in this operation. During this pouring out, some slip is left on the edges of the mould. As soon as it has coagulated it is taken off with a wooden knife or with the fingers.



Gradually the water is completely absorbed and the shape, beginning to shrink, parts from the mould. The vase is made (fig. 11). The next day it is firm enough to be delicately taken out of the mould and put away to dry.

After using either the sun rays, or the action of a fire or of the wind, to dry the mould, the operation can be renewed. And the vases come out like cakes.

The disadvantage of the simple moulds which are emptied from the top, is that the least jerk will bring a deformation of the paste which is only firm, but not yet solidified.

If the shape to be made has one or many projecting parts which do not allow a simple mould, one out of which the cast piece can come by itself, one must use moulds in many

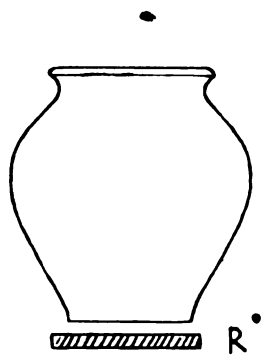


fig 12

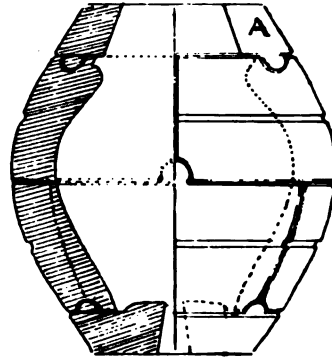


fig 13

pieces, which are emptied through the bottom (figs. 13, 15 and 20). This mode of operation is based on the physical law discovered by Galileo, that liquids tend to seek the same level in communicating vessels.

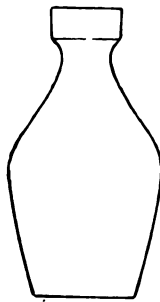


fig. 14

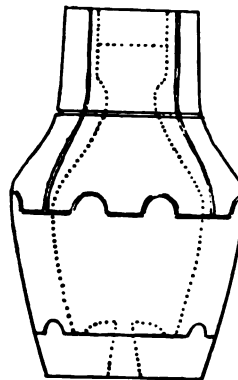


fig. 15

In this case it is necessary to construct an apparatus,

not very complex (fig. 16), which consists of a tank A and a lead pipe B. The tank is in zinc, of cylindrical shape and with vertical axis. It is 27 x 12 inches. It is placed about 5 feet above ground, solidly fixed to the wall or resting on a table. The cylindrical shape makes easier the stirring of the liquid with a spatula in shape of an oar (fig. 18), which is moved from left to right. The bottom of the tank is in funnel shape C to make possible the thorough emptying of the slip, and it ends with a brass union D, which connects it with the pipe. This pipe, which is 52 inches long by $\frac{3}{4}$ inch inside, is curved in its lower part and supplied with three copper faucets. The top one H enables the slip to flow into the pipe, the one at the other end E allows it to enter the mould, while the faucet in F is used to empty the apparatus.

The lower part of the pipe passes through a table T and the opening is on a level with the surface of this table. It is there that the mould M, thoroughly dried out, is placed. On the table rests a circular plaque in zinc Z, 20 inches in diameter, to facilitate cleaning (fig. 17).

In order to avoid the leaking of slip through the interstices between the mould and the table, a circular plaque of virgin beeswax V $\frac{1}{4}$ -inch thick, is kept around the opening (fig. 17), and is cemented with wax softened by the heat of the hand. Even then it may happen that streams of slip will escape, and to make the closing of the mould absolutely tight, a long and narrow wad of fresh clay R is rolled and placed on the wax all around the opening of the pipe. The mould being placed on this wad flattens it and makes the opening perfectly tight.

Before placing the mould over the apparatus, it is absolutely necessary to ascertain that all its parts join well, and especially that they are very tightly tied with one or more cords. If these cords were in the least loose, the pieces of the mould would come apart under the pressure of the liquid and the vase would be ruined.

The well tied mould is put in place. The slip which has been passed through the screen No. 120 is poured into the tank, and is left there to rest a little while. To be sure that all the air bubbles have been expelled, the outside wall of the tank should be sharply knocked several times with a stick of hard

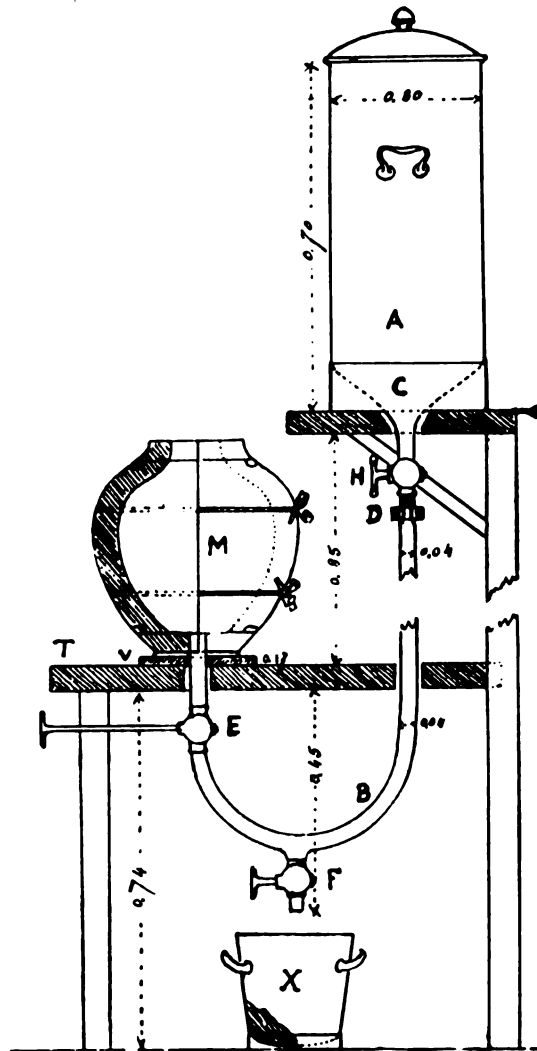


Fig 16

wood, such as oak. The air bubbles which may remain in the liquid then raise to the surface and burst. When one is sure that everything is in perfect order and in place, the casting proper is done.

The two faucets E and F remain closed. The faucet H is opened. The slip flows into the pipe and expels the air from it. It is necessary that not one bubble should remain in the pipe. Then the faucet E is opened wide. At once the liquid fills the mould. When nearly filled, the faucet H is almost closed, so that it will let in just the quantity of slip necessary to replace that which is absorbed by the mould. When the thickness of the coagulated paste is judged to be sufficient, and it is easy to follow the progress of the thickening on the false rim, provided there has been no overflow, the faucet H is entirely closed, and the two faucets E and F opened. The excess of slip flows into the pail X and both the mould and the pipe are emptied. The mould should be left to rest a good quarter of an hour, then with great care it is detached from the wax disc by lifting it, and it is carried without jerks on a table where it will stay until next day. If the mould is heavy, it should be lifted with a tackle block hanging from a swivel which turns on hinges solidly encased in the wall.

If another dry mould is ready the operation can be repeated until exhaustion of the paste. If there is no more casting to do, the faucet H is opened and the tank emptied in the pail. In this case the apparatus is immediately washed out with plenty of water, to avoid the settling of slip.

The mould containing the vase is carefully watched. If it is simple, the removal from the mould can be delayed indefinitely. But if it is in many parts, the shrinkage of the piece must be watched. It should be taken out after from 40 to 48 hours. The first time the hours and minutes of the different phases of the operation should be carefully noted, so that the next casting can be done without hesitation. At the end of 48 hours, the cords which fasten the mould are untied and each part is taken out in a regular order, the cone of paste B which has formed under the vase is carefully broken off and the newly made piece is placed on a plaster slab (fig. 12). This slab must be sprinkled with a fine sand, so that the vase will shrink on itself easily.

If cracks occur in some parts of the piece, it is because it has been left in the mould too long. If, on the other hand, it is taken out too soon, the paste, not being sufficiently coagulated, will sink on itself. It is therefore very important to give the greatest attention to the time a piece should remain in the mould, and this time varies according to the composition of the paste.

While the operations of casting and taking out of the mould last, one should carefully avoid touching the newly made piece, because the least contact will invariably cause a deformation of the outline in the firing.

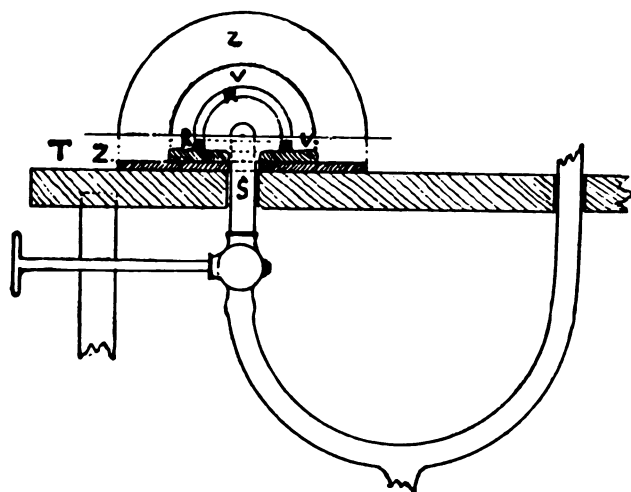


fig 17



fig 18

When the piece is thoroughly dry, it is finished on the wheel, and for this it is very useful to know how to use the wheel. If the shape is round a stroke of the turning tool will remove all the roughnesses and cut off the top rim which is called the "spare." If it is of fancy shape the seams should be removed by hand with sand paper.

If it has been cast from the bottom, the opening at the base must be closed. To do this, the opening is rectified with the turning tools and made circular. Then from a plaque of paste of the same thickness as the vase, a disc is cut out of the same

diameter as the opening to be closed. This disc is set in the opening, as described in article V (see cementing). As soon as the seams and imperfections have disappeared the piece is finished. There is nothing left to do but to decorate it.

With the paste PN specially prepared for casting by Mr. Frugier, the operation is done identically in the same manner, but there is the great advantage that the piece can be taken out of the mould *one hour* after casting. I use this paste for vases of eccentric shape, such as colocynths.

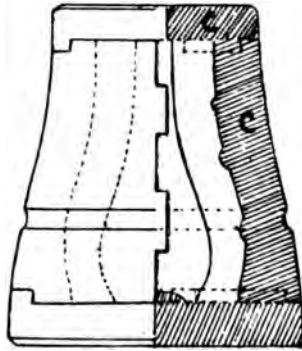


Fig 19.

In a well made mould, it is possible with this paste to cast a coffee pot with its handle, spout and feet, in one piece, without any cracks, and in one hour's time. The paste should be prepared as follows: From 160 to 180 grammes of water are added to each kilo of paste as is it received from the manufacturer. This mixture is well stirred and becomes a very fluid slip, which is passed through the screens 100 or 120. This paste will only keep all its qualities if it is shipped soft, as it comes from the mill, and to keep it in that condition, it should be placed in a cool place, a cellar for instance, covered with a cloth which is kept constantly wet.

If casting is a much easier process than either pressing or throwing, on the other hand it requires much care, and also some knowledge of the making of moulds.

The plaster moulds which are used for pressing are essen-

tially different from those used for casting, both in the way they are cut and in the preparation of the plaster.

For pressing (fig. 19) the moulds have generally horizontal sections, so that it will be easy to introduce the hand which must press the paste against the walls. Besides, the different parts of the moulds are held by a socket C which makes it impossible for them to move under the pressure of the hands. As the plaster must absorb very little water and also must resist the pressure of the thumb and fingers, it must be hard. This result is obtained by a special preparation.

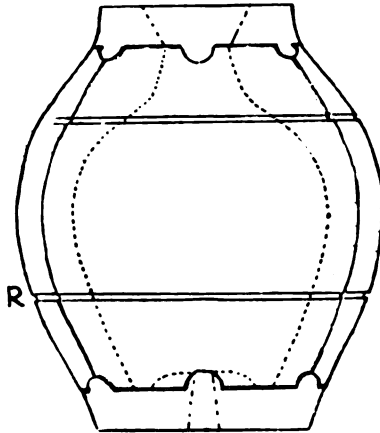


fig. 20

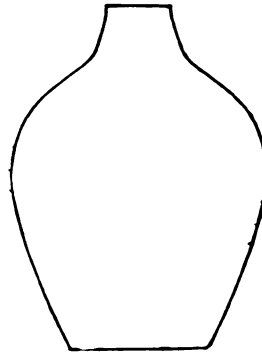
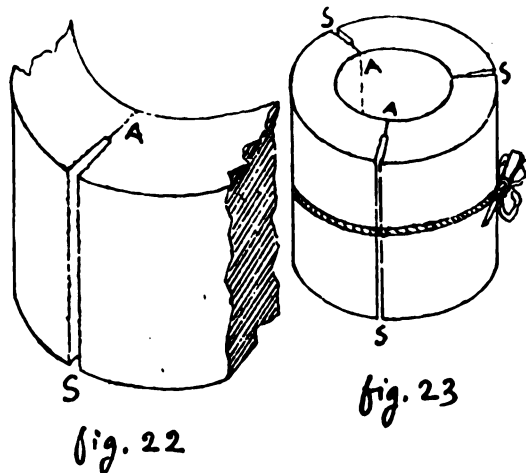


fig. 21

Plaster is said to be *made thick* when after water has been placed in a basin, the pulverised plaster is sprinkled into it with the fingers so as to avoid lumps, until the water is completely covered with it. Then it is beaten and left to set. It becomes firm and hard and possesses only such porosity as plaster always has. It is the ordinary preparation of plaster and suitable for pressing moulds.

But in casting, as the moulds must absorb the water of the slip promptly, they must be extremely porous. This excess of porosity is obtained by *making thin*. The operation is easy, but requires care and a little practice, as on the success of the mould depends that of the vase. The water is placed in a basin

and the plaster sprinkled with the fingers as before. But this time the water should not be entirely covered with plaster. Before it begins to work, at the very time when it is going to set, it is stirred and thoroughly diluted, then left to rest a few seconds, after which time a quarter of water is added, that is, a quantity equal to the quarter of the quantity used for the first mixture. It is well to measure this water. The object of this additional water is to delay the coagulation of the plaster, to prevent its hardening. Besides, lodging itself in the plaster, the water occupies room which after evaporation constitutes large and numerous pores. When ready to coagulate, the plaster is stirred again. It becomes then thick and pasty. It is in that condition that it must be used, but one must hurry up in making the mould or part of mould one is working on.



Casting moulds are distinguished from pressing moulds by the generally vertical sections (fig. 20) and by no necessity for the socket which holds the parts. For this reason they are less complex and less expensive. To be sure that the different parts of a mould will join well and will not move, grooves R are made with a gouge, outside, on top and bottom, if the mould is more than 6 inches high, in the middle only if it is smaller. In these grooves strong pieces of twine are firmly tied.

When a casting mould has been used many times, the

seams on the cast piece have a tendency to appear rather large. To avoid this, moulds with split pieces can be made (figs. 15, 22 and 23). In this case the mould maker divides the mould into two or three blocks on which he makes with a saw a large furrow S, being about 4-5 of the total thickness. In this furrow he places the edge of a cold chisel and gives it a sharp blow with a hammer. The part A which has not been sawed is split and its section is capillary. However, moulds with this angular section require more attention in the manipulation of pieces.

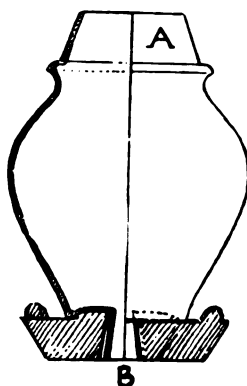


fig 24.

All casting moulds have a false rim. This is an extension of the top of the piece to be made (figs. 13 and 24). The part of the mould where this false rim A is, holds the slip, the level of which varies with the successive opening and closing of the supplying faucet, while the top of the vase will receive a uniform supply of slip and will have the same thickness as the other parts. The false rim in a cast vase must only be removed when the latter is thoroughly dry. It is taken off, either by hand with a very sharp blade, or on the wheel with a stroke of the turning tool.

Ceramic utensils must be entirely in zinc with tin solderings and if necessary copper rivets. Any particle of iron must be carefully avoided. If iron is not injurious to grès, it is most dangerous with porcelain. The plumbing must be in lead. If

oxide of zinc and oxide of lead are formed they have no injurious action on porcelain.

These utensils must always be thoroughly washed after each operation, especially when two materials as different as grès and porcelain are used. In their inside construction all angles, which are difficult to clean, should be avoided. So the pails instead of having a convex bottom like A in fig. 25 should have a concave one like B in fig. 26.

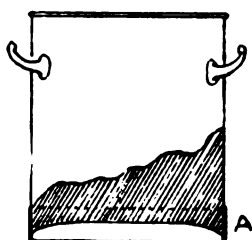


fig 25

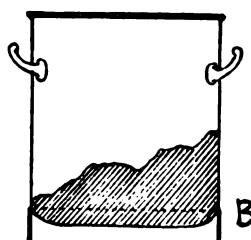


fig. 26

The tools and apparatus described in this article are those which I use every day. They are of my own design but have been constructed by Mr. Poyard, engineer, 48 rue des Cendriers, Paris.

The lead pipes must have no right angle, they must be everywhere of the same diameter, perfectly smooth, curved if necessary, but without any angles or roughness which would prevent the slip from flowing freely.

None of the details which I have mentioned must be neglected. They are the result of gradual improvements during a long practice of casting. By following them literally, beginners will avoid a good deal of trouble, expense and disappointment.

I will not speak of the casting of large pieces, the description of which would fill two long articles and would go beyond the object of this writing. I will simply say, as a matter of interest, that for large vases it is necessary to make a vacuum with an air-pump.

In conclusion I will advise the adoption of the paste PN Frugier for the porcelain pieces pressed and turned, and the

special paste for casting PN for cast pieces. The same glaze will fit both. The fusibility of the cast pieces being somewhat greater they should not be placed on top of the kiln.

For cast pieces of large or medium proportions the ordinary paste PN can be used advantageously, the special paste being mostly useful for small pieces and fancy shapes which are not easy to take out of the moulds.

The first pieces obtained with this casting process will be the most powerful stimulus for the operator.

IV—Glazing.

THE glaze is a vitrifiable covering which is deposited on a ceramic piece to give it the glossy appearance, which decorates it so harmoniously and is a joy to the eye as well as a pleasure to the touch. It must essentially harmonize with the material which it covers and be vitrified at the same temperature. If it covers a common clay like the faience clays, which are burnt at a comparatively low point, its function is mainly that of protection. Such a piece keeps its porosity, remains sensitive to the action of water, consequently also of frost, and is destructible. It is only when covered *in every part* with the vitreous glaze and kept in a place where it will be protected from atmospheric variations that it will reach a certain age.

If, on the contrary, the clay is vitrified at such a temperature that after firing it will be proof against the action of water and frost, the glaze has its logical function. It is an ornament. In that case it may indifferently cover part or the whole of the piece without any risk for the latter, which is everlasting. This is so with grès and porcelain, and for this reason they are the ceramic materials par excellence.

Take a faience and examine it. It is glazed all over, for the least point which would be uncovered would be the open door for the destructive humidity. Consider porcelains and grès in their splendid variety, whether Oriental or Occidental, the glaze is used according to the fancy of the artist and the bottom is always uncovered, because the impermeability of the body has given it the right to longevity. The secret of the superiority of these two products is there.

Though faïences can be covered with lead and tin glazes, grès and porcelain require a feldspathic and calcareous covering. But whatever its nature, the ordinary glaze, improperly called white, must be colorless, brilliant, translucent and limpid. It must spread uniformly over the parts which it covers without producing blisters or crackles. Its fusibility and its dilatation must agree with the firing temperature of the body. Too much and too little fusibility are the sources of a

number of accidents injurious to the piece, not very marked perhaps when it is without decoration, but most unfortunate if the piece is richly ornamented. Crazing is the most common of these accidents with the French porcelain which is very rich in alumina. It is caused by a greater shrinkage of the glaze than of the body, or vice versa of the body than of the glaze. Crackles occur during the cooling off and are announced during the opening of the kiln by a sharp and metallic cracking noise. It is then of the greatest importance that there be harmony between the body and the glaze, and they are hardened or softened, as the case may be, by reducing or increasing the fusible element, potash, soda and lime for the glaze and for the body, the plastic element, clay.

There is no rule, no scientific basis on which to establish this relation, this same coefficient of expansion of both substances. The only guides are experience and trials. The action of the fire itself may be the cause of crackles. I use three glazes with a basis of copper, a very sensitive metal, which craze outrageously in a reducing fire and acquire all their limpidity and richness in an oxidising atmosphere. And it will be the reverse with others.

These accidents and their known causes have induced the Orientals to produce the intended crazing, called "truité," with its close net of crackles which so happily decorates some of their products.

Beginners will do well to do as I did, to adopt the glaze which is sold with the body they buy, and which fits it. Both are determined by a series of experiments which it is the duty of merchants of clays to make. They have every inducement to constantly control their product which may vary according to the purity of the quarry veins. By buying a prepared glaze artist potters will avoid much unnecessary trouble.

Having adopted for my own production the hard silicious Sèvres porcelain called PN (porcelaine nouvelle), and wishing to have a glaze which would fit both porcelain and grès, I use a glaze of the soft type, called calcareous, which has long been studied at Sèvres for this purpose. Its composition is:

Fontainebleau sand	43
Bougival chalk (craie)	33
P N biscuit	24

It is the glaze which is furnished by Mr. Frugier, but the sand can be bought from the factory of Creil et Montereau, the chalk from Poulenc Freres, 92 rue Vieille du Temple, Paris, and the biscuit can be obtained by grinding and pulverizing unglazed fragments of P N body. This source of supply makes it unnecessary to speak of the washing, grinding, screening and the general preparation of this glaze, which requires a special outfit.

There are five different ways to put the glaze on grès and porcelains: Painting with oil, immersion, spraying, sponging and painting with water and gum.

1—If the piece is in the condition of *biscuit*, that is, fired but unglazed, like a Wedgwood, the powdered glaze can be fixed on its smooth surface, hard like flint, only by using a fat and sticky medium. This medium is the fat oil of turpentine, which is mixed with the glaze on a rough glass with a palette knife. The mixture is blended with a brush on the vase in successive coats, each being duly dried out on a stove or near a fire.

If the piece has been fired and glazed but it is found necessary to fire it again, either for additional decoration or to remove the flaws of the first firing, the reglazing should be done as before, but of course with thinner coats according to the amount of glaze which is already on.

2—If the piece is baked, that is, if it has already such solidity and porosity as have been given to it by a gentle fire it can be glazed by any of the processes mentioned before, *except the fat oil*.

Glazing by immersion is done by dipping the baked piece in a bath, which is constantly stirred in every way, so that the glaze will be held in suspension in the water and that the heavy parts will not precipitate to the bottom, as they naturally tend to do. To make easier this suspension in water of all the matters which constitute the glaze, some kitchen salt, or better, vinegar, should be thrown into the bath in the proportion of one measure of vinegar for 8 to 10 measures of glaze. Vinegar has over salt the advantage of provoking a fermentation of the glaze which makes it easier to use.

The dipped piece, being porous, absorbs the water and the glaze is deposited on its surface. The quick or slow passage

through the bath will determine at will the thickness of the glaze. If the piece is thoroughly baked, four seconds are sufficient for a good dipping. All the uneven or missed spots due to the touch of the fingers or to the running of glaze should be very carefully retouched with a sharp blade and a brush. If salt is used, it is important to avoid mineral salt which contains iron.

The action of both salt and vinegar is to hold in suspension the constituent matters of the glaze while the immersion lasts, and to avoid the deposit of the heaviest parts, which form a very hard crust at the bottom of the tubs. Zinc tubs are corroded after a few years by the action of this settling. The best tubs are of copper or grès.

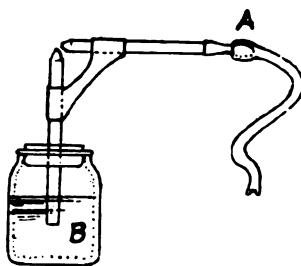


Fig. 27

3—If the piece is raw, the immersion which would soften it is impossible, or at least the manipulation would be very difficult. In this case, one has recourse to the atomizer, the sponge or the brush.

The atomizer is an instrument (Fig. 27) which sprays the liquid glaze contained in a glass under air pressure on the vases. As I have no motive power for the air pressure, I use a blacksmith's double action bellows worked by hand (Fig. 28). One branch of the atomizer is fixed to the rubber tube of the bellows, the other plunges into the glass jar B containing the glaze. The vase is placed on a revolving table, which is set in motion with the left hand, while with the right which holds the glass the spray of liquid is scattered over the vase.

An assistant should work the bellows. To save this trouble, I keep the table T which supports the vase (Fig. 29)

revolving by means of the clock work of an old roasting-jack which is among my heirlooms. The top of the little table has a groove for the passage of a rope. I can thus work the bellows with the left hand and graduate the strength of the spray at will.

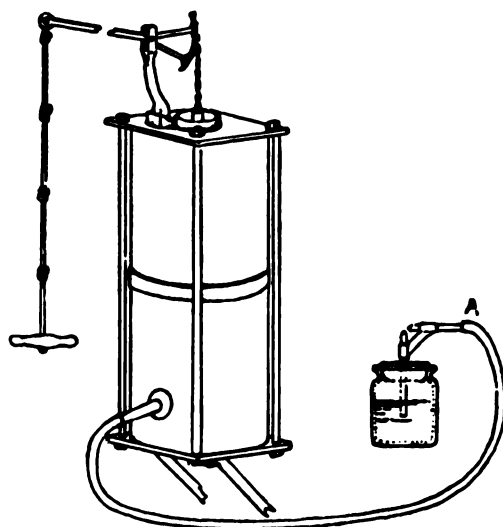


fig 28

Chinese potters spray their pieces with a long bamboo tube which is filled with glaze. One of the openings is covered with a fine gauze. They blow vigorously through the other end, thus spraying the pulverised glaze.

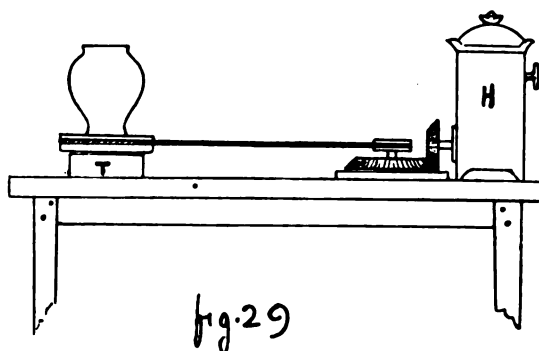


fig. 29

Spraying has over immersion the advantage of avoiding the necessity of baking the piece and also that of making a much more uniform glazing with the many pulverized coatings. But the process is slower.*

4—Sponging consists in mixing the glaze with a mucilage of gum arabic and water, which is applied in successive coatings with a very fine sponge, with close pores. This process makes it possible to shade the glazing, to obtain the cloudy effects so characteristic of old Korean potteries, and to avoid, when such effect is desired, the coldness of a too regular glazing.

5—I have kept for the last the glazing with a brush, which sums up all the other processes and, although slower, may in almost all cases be advantageously substituted for them, whether the pieces are raw, baked, biscuit fired, or glazed.

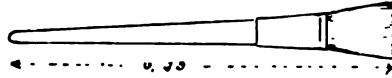


fig. 30

The sable brush must be flat, short, of different widths for the different size surfaces to cover, with a round handle 10 to 12 inches long (Fig. 30). Its ring must be of brass, with copper nails. The medium is a mucilage of the precious gum tragacanth. A handful of gum is enough to glaze fifty large vases. A few chips of gum are infused in warm water and left to dissolve two days, when the mucilage is screened to insure its perfect dilution.

If the vase is biscuit fired, a very, very thin first coat is put on and dried in the open air or in the sun. The second coat may be thicker with less gum, the third thicker yet, and the fourth must complete the glazing. It is most important that each coat should be put on only when the previous one is thoroughly dry, and all rapid drying by fire should be avoided, as it invariably causes cracks and blisters.

When the piece is raw or only baked, three coatings are

*The sprayer sold for \$10 by the Croxall Chemical Co. of East Liverpool, Ohio, is very satisfactory for uniform spraying. The air brushes of Thayer & Chandler, Chicago, with needle attachment, are very fine but more expensive.

sufficient, the first thin, the second thick, and the third thin again, just enough to even up the work.

This brush process is slower, but it makes it possible to reserve certain parts of a piece which is to have two or three different glazes, mat, glassy or metallic, as is the case in most of my ceramics, and is economical from the fact that not a particle of glaze is lost as happens with the atomizer. As glazes do not always come out successfully and are expensive, this is a point which is of no small importance to beginners.

There is another glazing process called *salt glazing*. It is suitable only to grès and can only be used if all the pieces in the kiln are grès. Toward the end of the firing, marine salt is thrown into the fire hole. For each 40 cubic inches of capacity of the kiln, and according to the desired effect, from 200 to 800 grammes altogether should be thrown in three equal parts, every fifteen minutes, into the fire hole. Of course salt glazed pieces must be placed free in the kiln, not enclosed in saggars.

As a conclusion to this chapter, I advise the artist potter to adopt as I did, the glaze P N of Mr. Frugier, which fits the body P N of the same merchant. He will also choose for glazing, as I did, the brush and gum tragacanth. It will be well for him to bake all his pieces, so as to make them less brittle, to simplify the handling and glazing, especially the inside glazing. To glaze the inside of a piece, the glaze should be poured rapidly into it with a funnel, and it should also be quickly poured out four or five seconds later.

Figure work requires double care, and while three coats of glaze are sufficient over the other parts of a piece, over figures six very thin coatings should be given.

Pieces to be refired will be glazed with the fat oil of turpentine, after the spot to be retouched has been carefully cleaned.

In the manipulation of matters which are used with water, rust, dirt, and all fat substances over which the water runs, should be carefully avoided.

Before glazing, the artist should brush the pieces, or better, clean them, either with hand bellows, or with the strong wind from the atomizer, if necessary with sand paper.

By arranging all his pieces together and getting them ready to all pass through the same operation at the same time, he will gain time, which, say the English, is money.

V—Kilns.

A KILN is the ceramist's main implement. Neither the ceramic artist nor the professional can do without it. Only amateur potters will be satisfied with using the ordinary kiln, the kiln of somebody else, because they have not the courage to do the work, or because they are ignorant of the construction, or fear the difficulties of handling a kiln.

Without any reservation I will introduce my readers to the details which belong to the successful working of the kiln, but will not speak of all the trials which I had to make in order to solve the numerous technical questions which I long ignored, for, though in the center of the Sèvres establishment, I was confined to decorative work, and paralyzed by the "*Everybody in his place*" rule of large manufacturing centers.

Kilns, the history of which it is useless to give here, have varied in shape according to the centers of ceramic production: horizontal, semi-cylindrical and with up draft in China; vertical, cylindrical, with up or down draft in Europe; horizontal, square and with up draft in certain parts of Central and Southern France; vertical, cylindrical, some with up draft, some with down draft in the Sèvres factory, which however possesses a square kiln with two fire mouths and down draft.

Whatever the shape, and whatever the country which uses it, a kiln is invariably composed of three parts: the fire mouth, the firing chamber and the chimney for the escape of smoke, flame and of the gases formed by combustion.

All the vertical or cylindrical kilns of Sèvres and most kilns in Limoges and Europe contain two superimposed chambers, simply parted by the vault of the lower one. The upper one is called the baking chamber, and in this chamber the ware is subjected only to an imperfect firing, called hardening or baking. Each chamber of the kiln has its own door.

Grès kilns, which are generally horizontal and square, have no baking chamber. There was none in the kiln used by Carriès. The vertical porcelain kiln of Chaplet and mine have none. The former is with up draft, mine with down draft. The baking chamber is not necessary, but it has the advantage

of making possible, with the same fuel and at the same time, a double operation: the grand feu firing of the pieces which are ready for it, and the baking of pieces for the next firing, as in the baking chamber the heat reaches only 830°C., while in the firing chamber it may register 1470°C. or more.

There is no fixed size for kilns. This will vary according to the needs or wishes of the potter. Grès and porcelain can be fired in a kiln having only 32 inches diameter and 28 inches height from the floor to the crown, and with only one fire mouth, as well as in the gigantic industrial constructions measuring inside over 12 feet in height and 15 feet in diameter, and having ten fire mouths all around.

The firing can be done either with coal or wood. If only white porcelain and grès are to be fired, one may use coal, the economy of which is manifest; but if the pieces are decorated, economy is no more an advantage, as the gases from coal are injurious to colors. All trials made so far with coal for grand feu colors have given either bad or comparatively inferior results. I have had a painful experience with this in the kilns of the Parisian suburbs. Orientals, not knowing coal, use wood. Limoges, Germany and England use coal. The three factories of Copenhagen, Berlin and Sèvres, fire with wood.

Notwithstanding my first disappointments, when I resolved to do my own firing, I constructed a kiln with fire mouths for coal. From 1879 to 1894 I had my pâtes sur pâtes fired at a large Limoges factory. I used to send them to Limoges, after baking, well packed in sawdust in boxes. But as I knew that I could do better and more, I decided in 1895 to construct my first trial kiln, notwithstanding my limited resources and the consciousness of the difficulties which would assail me. I had to face the following problem, which will also have to be faced by all isolated artists. Having received my experience in the execution of decorative compositions on porcelain, I had to become initiated, at the lowest possible cost, to the technical difficulties of the different processes which belong to the production of grand feu ceramics, and to acquire the necessary skill in each of these processes: turning, modeling, coloring, plaster moulding, glazing, chemistry and firing. To solve this problem, I constructed on rue de Bagneux, in Paris, the small coal kiln of which I will speak (Fig. 31, 32, 33, 34, 35.)

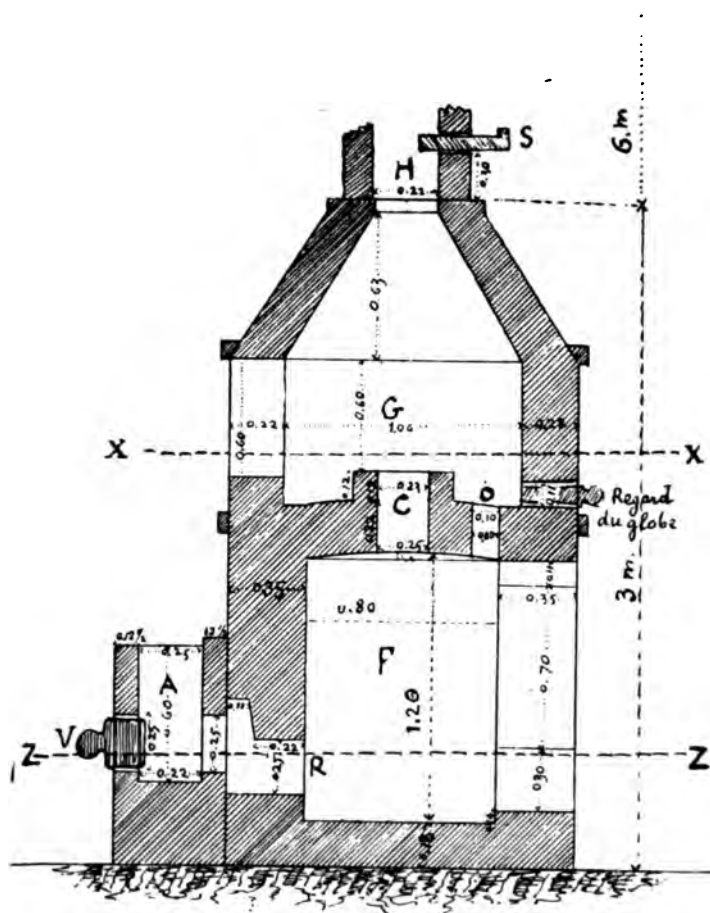
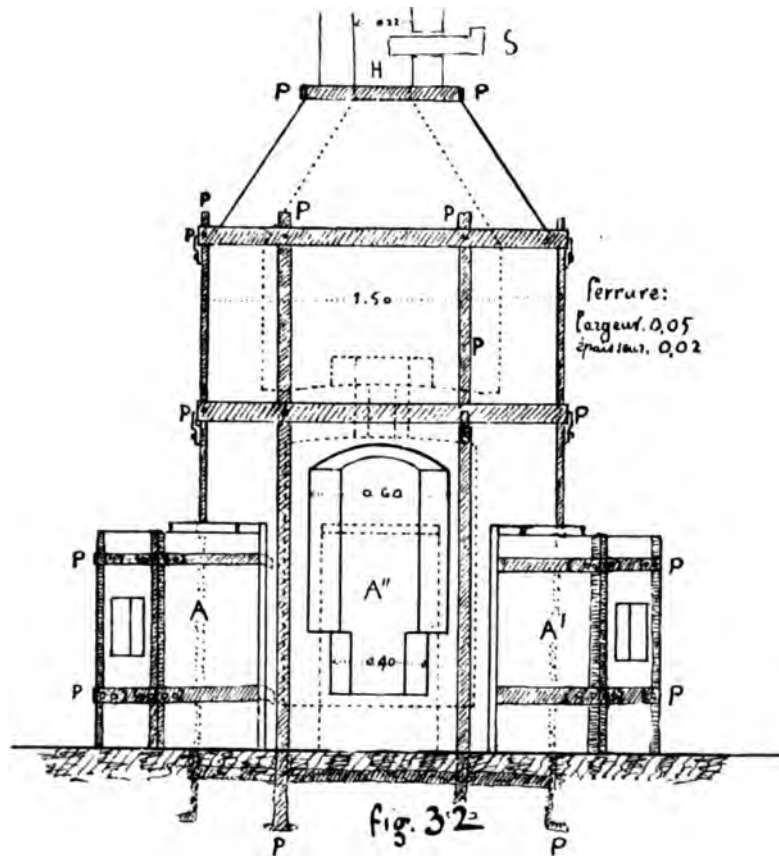


Fig 31

Four à la houille

Four, kiln. Houille, coal. Regard, spyhole. Globe, baking chamber.



Four à la houille.

Four, kiln. Houille, coal. Ferrure, iron braces. Largeur, width. Epaisseur, thickness.

Cylindrical, with vertical axis and up draft, having both firing and baking chambers, and three fire mouths for coal, this kiln was ideal from the standpoints of easy handling, rapid firing, economy in construction and fuel. It was during three years my field of study. By practicing with it, I learned by my own experience, to well conduct a firing, to make good saggers, to become familiar with the thousand precautions needful in the placing of a kiln, and with it I decided upon the final adoption of the ceramic bodies which I use to-day.

With the plans, sections and dimensions which I give*, anybody who wishes to obtain the results which this kiln gave me, and to spare, not time or labor, but money, will find it easy to build. Artists in better circumstances will probably prefer to do without this trial construction.

The firing chamber F ends in a spherical vault pierced by square openings (Fig. 31 and 33), and a central chimney, through which the lower chamber, where the firing of porcelain is done, communicates with the upper chamber G, where the baking is done. This upper chamber is surmounted by a cone ending in a rectangular or cylindrical flue H placed in the axis of the draft, to allow the escape of the products of combustion; it is the chimney.

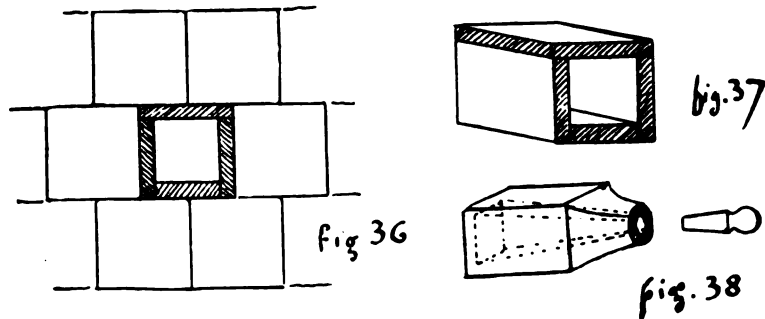
At the bottom of the firing chamber are symmetrically placed the three fire mouths A, A', A'' (Fig. 34). In R (Fig. 31 and 35) are the openings through which the flame enters the kiln. The relation between the surface of these openings and that of the openings O and C for the entrance into the baking chamber, is 3 to 1 according to the rule.

The progress of the firing is watched through only one spyhole in the door of the firing chamber, made about at two-thirds of the height of the door. This spyhole is roughly made by four rectangular tiles (Fig. 36 and 37). It is closed with a stopper (Fig. 38) in fire brick, in the axis of which a hole has been made which is itself closed with a round piece of glass or a small biscuit stopper.

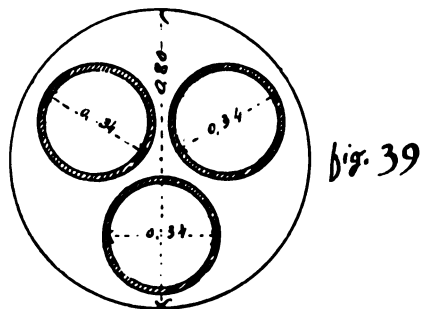
The firing chamber is 4 feet high from the floor to the

*We reproduce the cuts as they were sent by Mr. Doat with French terms and measures. The measures are in metres and decimal fractions of metres, which can be easily converted into inches, one meter being equal to 39.37 inches.

crown, and 32 inches in diameter, which makes it of easy access to the placer. It can contain three piles of saggars (Fig. 39 and 40) having $13\frac{1}{2}$ inches outside and $11\frac{1}{2}$ inches inside diameter. Twenty medium size pieces or fifty small ones in porcelain or grès can be fired in this kiln. Plaques 24 inches in diameter are easily placed in it, and three pieces 24 inches wide and 14 inches high can be fired one above the other.



I used to burn from 500 to 600 lbs. of Grimsby (England) coal, at a cost of about \$10 a ton delivered. A firing then used to cost me about \$3 in fuel, and as I did all the work myself, the total expense of the firing was not over \$6, and the results in white, biscuit, bas reliefs Wedgwood style, etc. could be worth as much as \$600.



The Grimsby coal, free from slag and with its long flame, is an ideal coal, because of all European coals, it is the one which resembles wood the most closely. It is sold in blocks

or in small nuts. The white ashes of the 600 lbs. burnt could be held in the hollow of my hand.

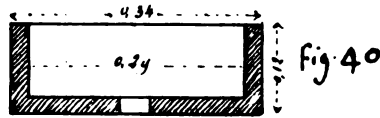


Fig. 40

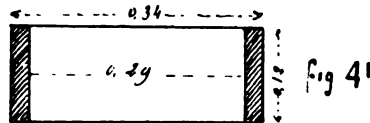


Fig. 41

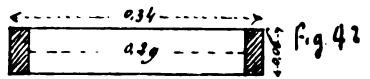


Fig. 42



Fig. 43

The construction of that kiln cost me about \$200 (1000 francs, being exactly fr. 438,60 for labor, fr. 444 for material and fr. 105 for iron braces.) The inside walls and the fire mouths in direct contact with the flame, were in fire bricks of the English brand Carr, the balance in fire bricks of the French

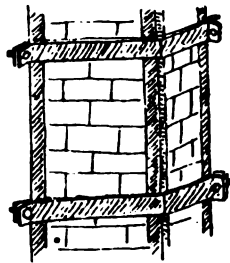


Fig. 44

brand J. The advantage of this combination was an economy, but it was offset by the lack of homogeneity in construction, the two bricks of different brands being of different size and thickness. If it were to be built over, it should be made en-

tirely either of Carr bricks or of bricks of the French brand J B, which are sold by Mr. Boucher, rue Troyon, Sèvres (Seine et Oise). This hard brick is easily handled and behaves well in the firing. It is the brand adopted by Sèvres and by most porcelain manufacturers of France.*

The iron braces P consisted of supports $1\frac{1}{2}$ inch wide and $\frac{3}{4}$ of an inch thick, and of bands $1\frac{1}{2}$ inch wide and $\frac{3}{4}$ of an inch thick. But I found this bracing rather weak and it should be strengthened.

The outside height of the kiln, from the floor to the crown was 9 feet 10 inches and the chimney measured from the crown of the kiln 19 feet 8 inches. This chimney was braced in the angles, at every three feet, with iron bands bolted together (Fig. 44). The damper S (Fig. 31) was about 12 inches from the lower part of the chimney.

The Grimsby coal was used both in blocks and nuts. During my first experiments I had tried Cardiff coal, but it crumbled to pieces in the fire mouth, thus choking it too easily. The Grimsby remains in block while burning, which allows a free circulation of air and an active draft.

A firing lasted about 18 hours with a gradual increase of heat and feeding of fuel. The *slow firing* during the first four hours was obtained by feeding every half hour a block of coal about 6 x 6 inches. Then came the *active firing* lasting four hours more, when a block of coal was fed every twenty minutes until the fire mouth was full. At that time I commenced the *demi grand feu*, lasting five hours, during which I used only nuts fed every fifteen minutes with a hand shovel. During the last five hours I made the *grand feu* firing, keeping the fire mouths full of nuts and blocks, fed alternately, so as to avoid choking.

The spyhole, placed at two thirds of the height of the door, made it possible to observe and follow the progress of the firing, by watching the Seger cones. I stopped at the bending down of cone 10.

To make these explanations more easily understood, I reproduce (Fig. 45 and 46) the records of two fine coal firings.

It will be noticed that the changes in the opening and closing of the fire mouths are just the opposite of changes in the

*High grade fire brick can be procured from the Harbison Walker Refractories Co., Pittsburg, Pa., or the Laclede Fire-brick Co., St. Louis, Mo.

chimney damper, when oxidising or reducing firings are needed. But I will treat this point fully in the article on firing.

The peculiar feature of this coal kiln is that it has no iron grate, the two little bricks BB' (Fig. 35) being used to hold the fuel. When the fire mouth gets choked, one may wait until the fuel is consumed or one may bring about the circulation of air with a poker, which is introduced in the fire mouth not through the top opening, but horizontally through the stopper V (Fig. 31). Anyway, if properly handled, the alternate feeding of nuts and blocks prevents choking, and the two bricks which are at the opening of the fire mouth into the firing chamber, prevent the fuel from falling into the kiln.

It is important while the firing lasts, not to go to sleep, and, should this happen, not to try to catch up by increasing the feeding of fuel. The results would be disastrous. A kiln is regulated like a lamp, which can be moderated or pushed at will.

As I had constructed my coal kiln in order to become familiar with the handling of a firing and to determine the adoption of my ceramic bodies, half of it was filled with white vases, either cast, pressed or thrown, without decoration, but modeled with different pastes; the other half contained bas reliefs Wedgwood style and biscuit figures Sèvres style, the sale of which not only covered all the expenses of firing but left me profits which I invested in new trials. As the kiln had up draft, the white pieces were placed in the lower part, so as to get the benefit of the highest heat, and the biscuits, which required a lighter fire, to avoid the glassy appearance, were placed in the upper part of the firing chamber, and every time pieces for the following firing were baked in the baking chamber.

After I had logically and scientifically determined the porcelain and grès bodies which were best suited to my work, I stopped the period of trials, I destroyed my first kiln and built my second one, in my residence, at Sèvres. Experience having taught me that the up draft has the great disadvantage of compromising seriously the results by brutally striking with the most intense heat the bottom of the piles of saggars, thus making them liable to occasionally sag and to disastrously shake the other piles, also that the heat being unevenly distributed,

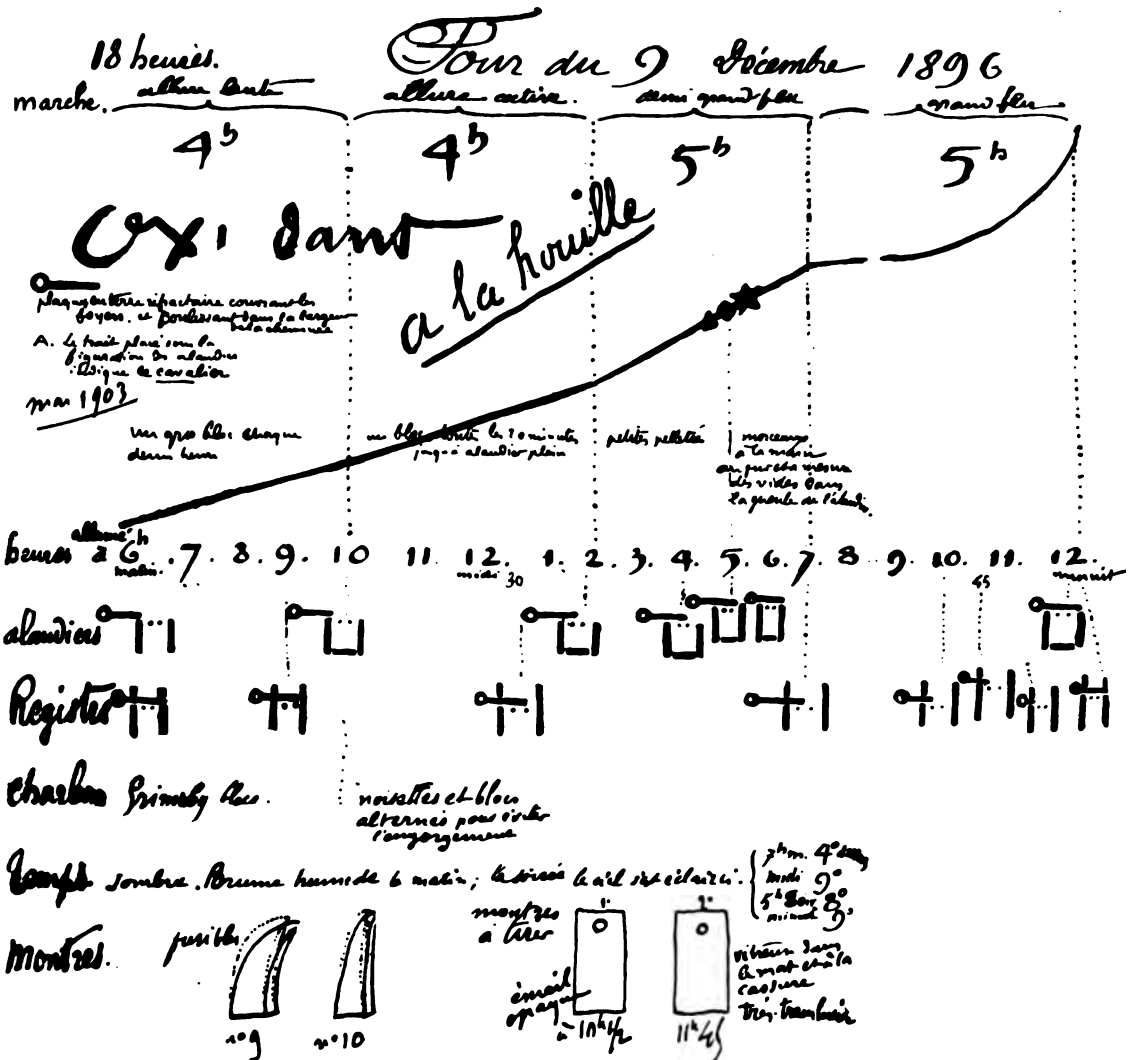


FIG. 45.—Alandier, fire mouth; *Registre*, chimney damper. *Montres fusibles* Seger cones. *Montres à tirer*, trial pieces. *Noisettes* or *guillets*, nuts of coal. *Houille* or *charbon*, coal. *Cavalier*, fire mouth stopper. *Temps*, weather. Both firing and baking good. Firing stopped at bending down of cone 9 for cast pieces. Spyhole and cones placed in the middle of the kiln. The dotted lines on cones show the bending at the time the firing was stopped, the full lines the bending when the kiln was opened. (After firing is stopped, even in the absence of fuel, there is a rise of temperature for which allowance must be made.) This firing was oxidising in its results, reducing at first, oxidising at the end. During the reduction the fire mouths were wide open and had an excess of fuel, the chimney damper was closed. Toward two o'clock, when the time came for the firing to become oxidising the fire mouths were gradually closed and the damper gradually opened. (The dash with ring above the figure for fire mouth represents the plaque of fire brick which covers the fire mouth and slides in and out. The dash at bottom represents the stopper V [Fig. 31.]) At the opening of the kiln two biscuit pieces were found warped, and a piece which had not been sufficiently protected was found stuck to its support. At 10:30 P. M. the trial pieces showed the body to be opaque; at 11:45 P. M. they showed a good translucency and a thoroughly vitrified body. The star shows the time of the brightest light in the kiln. The weather was dark and foggy in the morning, cleared off in the evening.

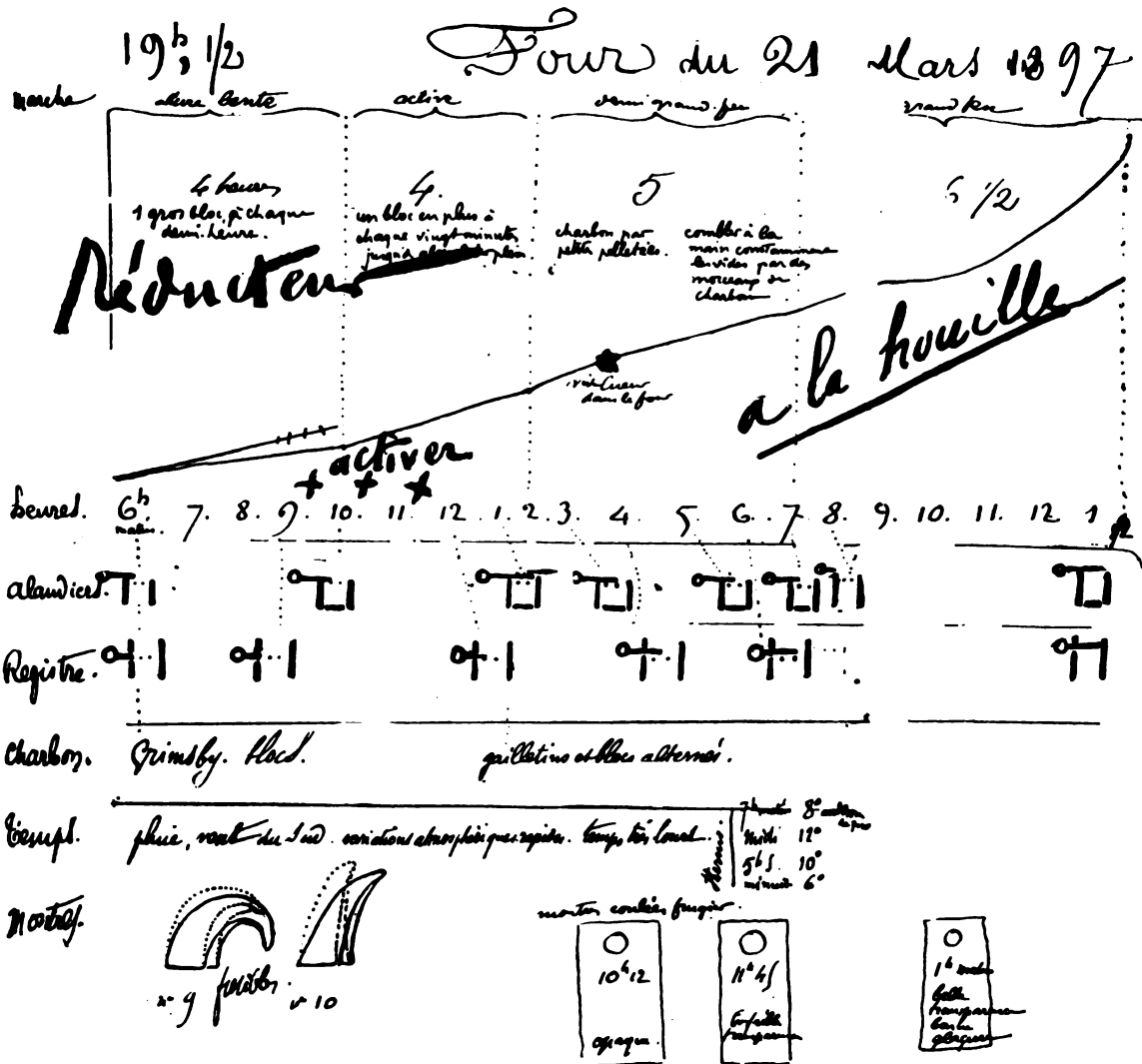
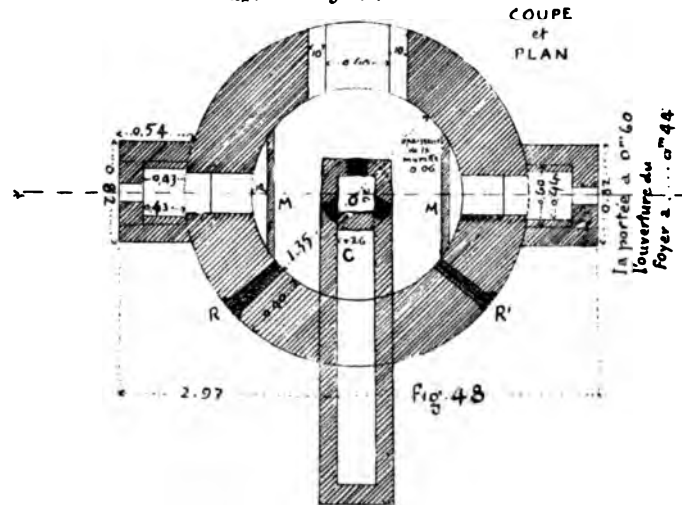
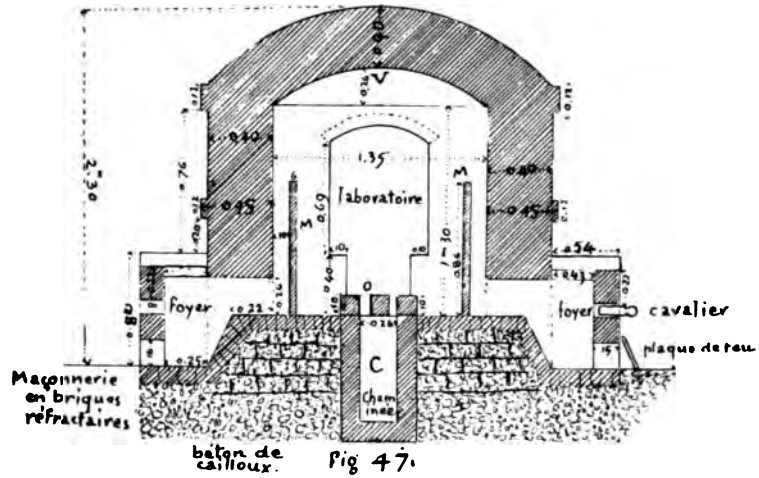


FIG. 46.—Very good results. The upper half was biscuit, the lower half glazes. The spyhole was placed lower than in the firing of Fig. 45, about one-third of height of the kiln. Cast pieces were placed above the cones and were good; turned and pressed pieces placed below the cones were very good, figurines placed at bottom were good. One piece broken, two others warped because they did not rest flat on their support. A biscuit piece with a hollow base should have been filled with sand to support it. The cones being placed lower than for firing Fig. 45, the firing was stopped at good bending down of cone 9, which is equivalent to a slight bending when cones are in the center of the kiln. At 10:12 A. M. the trial pieces showed the glaze to be opaque; at 11:45 P. M. a feeble translucency; at 1:00 A. M. good translucency and fine glaze. The firing was reducing; fire mouths opened at first closed at the time of the fusion of the glaze and gradually opened to give the greatest amount of heat by accumulation of fuel. Inversely the chimney damper was gradually closed with the progress of the firing. In oxidising, closed fire mouths, open damper; in reducing, open fire mouths, closed damper. On account of very heavy weather the grand feu period was very slow, draft poor; toward the end weather became better and draft more active.

there is between the upper and the lower parts of the kiln a difference of temperature which is sometimes more than $50^{\circ}\text{C}.$, I adopted the down draft.

This second kiln, which I use now (Figs. 47, 48, 49, 50), is of the cylindrical vertical type, possesses two fire mouths placed in the same axis, and no baking chamber. I have left



Four au Bois.

Brique réfractaire, fire brick. *Laboratoire*, firing chamber. *Beton de cailloux*, pebble foundation. *Cavalier*, fire mouth stopper. *Regard*, spyhole.

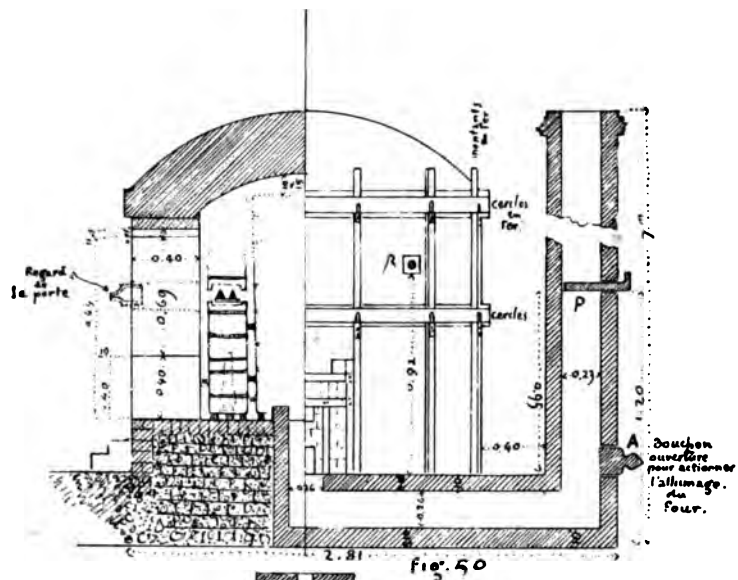


Fig. 50

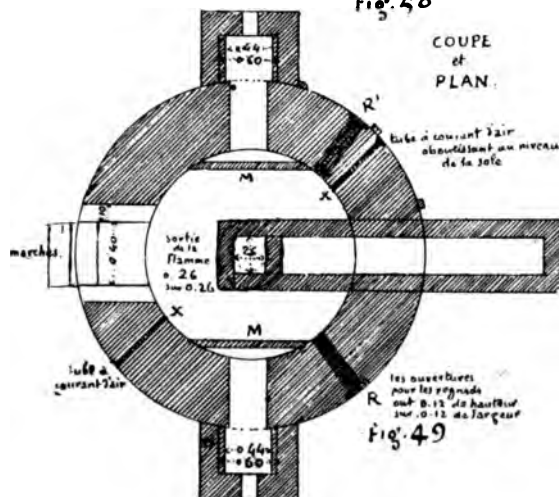


Fig. 49

Four au bois.

Cavalier, fire mouth stopper. *Regard*, spyhole. *Bouchon*, stopper to start the draft when lighting the kiln. *Tube à courant d'air*, tube for air draft on the level of bottom of firing chamber.

out the latter on the ground of economy. I am thus obliged to do a special firing for the baking of pieces, but the construction of a baking chamber would have made necessary a raising of my studio and the expense of chimneys in the thickness of the walls. I lose on this account a certain amount of heat, which somewhat increases the time of firing, but the kiln being reduced to its simplest form does not need such costly repairs, and is easier both to repair and handle.

When coming out of the fire mouth which is on a level with the floor of the kiln, the flame is violently thrown on a small wall M, cemented on both ends to the inside wall of the kiln and forming with it a segment of a circle (Fig. 47 and 48). This little wall being placed opposite the fire mouth, has a protective action, and besides it directs the flame, by stopping it and raising it toward the crown V (Fig. 47), from which it comes down between the sagger piles to reach the opening O of the chimney C, through which it escapes. While passing through the chimney, it strikes the only damper P (Fig. 50) the function of which is to control it. The heat, being better distributed in the firing chamber, becomes more homogeneous through the more intimate mixture of the gases of combustion. There is only a difference of about 20°C. between the top and bottom, so that the saggars do not suffer so much and do not need so much repairing and replacing. Three spyholes, two fixed ones R, R, and a movable one (that of the door), allow one to follow the phases of the firing on every side, by watching the Seger cones.

As in the coal kiln, the chimney is braced with corner bands bolted together, two feet apart from each other. The fire mouths are solidly braced with iron (fig. 81) and the kiln is strongly circled, the bands being $\frac{3}{4}$ of an inch thick and 20 inches wide. They rest on two iron supports $2\frac{1}{2}$ inches wide and $1\frac{1}{4}$ inches thick. The construction is made exclusively of fire bricks, brand J.B., cemented with a cement called in French *coulis* and made of

Earth of Provins pulverized 20

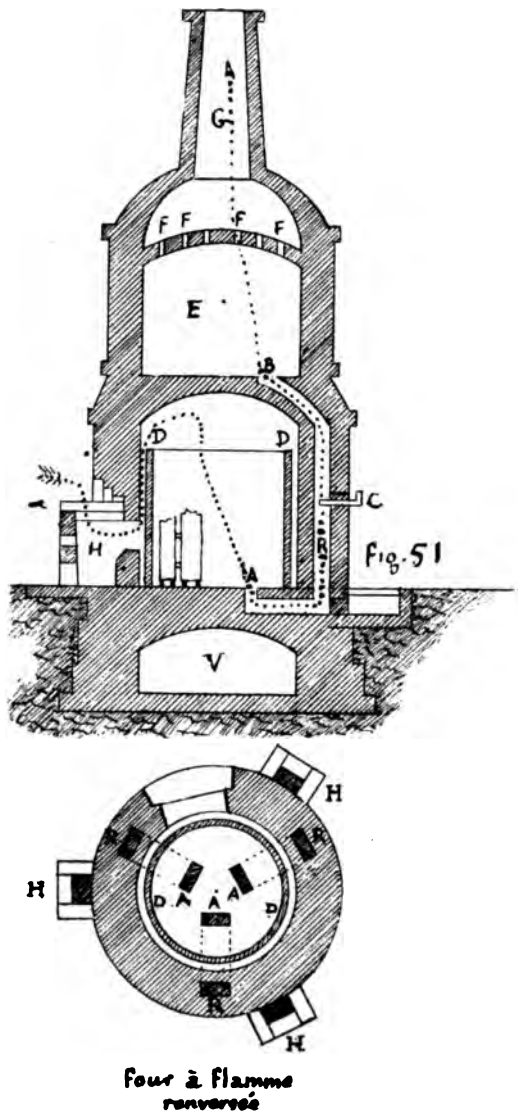
Grog of pulverized saggars 80

This *coulis* is sold by Mr. Ducouroy, Ivry-Port, Seine.

The damper is placed so that it can be reached by hand, being about 3 feet from the ground.

The most regular of the Sèvres kilns, an elevation of which

I give (fig. 51), in order to emphasize the simplicity of mine, is built of J.B., has three fire mouths H, three chimneys R, constructed in the walls of the kiln; their three rectangle openings are in A and they join each other in the baking chamber



through the openings B. Each chimney has a special damper C acting directly on each fire mouth. Here the small wall D is circular. The baking chamber E ends in a vault pierced with many square holes F, through which the flame enters the central circular chimney G.

In vertical kilns the pressure of the gases of combustion against the inside walls of the kiln is such as to make it necessary to use strong iron bracing, to enclose and strengthen the outside masonry of the kiln and prevent its bursting. Besides, in order to protect the construction against injuries by humidity, a small vaulted room has been built under the kiln in V.

The cost of this Sèvres kiln is about \$1,600, but its construction is of the best in regard to accuracy, solidity and even elegance. In opposition to this, I can give the details of the cost of my kiln, the figures of course applying to material bought in Paris:

Construction	Fr.	984,85	
Material	"	425,30	
Iron braces	"	458,65	
			Fr. 1,868,80

or in round figures \$400.

Each firing consumes from 5 to 6 *steres* (cubic metres) of wood, equivalent to $1\frac{1}{2}$ to $1\frac{3}{4}$ cords, or on the average $1\frac{1}{2}$ cord, the cost of which in Paris is about \$24. The expense for labor, various materials, etc., being on an average \$40, brings the total cost of one firing to about \$64.

The kiln can hold 80 pieces of medium size. After three firings repairs to the average amount of \$6 are necessary.

Contrary to kilns with up draft, the temperature is higher at the top than at the bottom of the kiln.

As will be seen the cost in construction and fuel for such a kiln is far above that of the first kiln, and one will easily understand the reasons which made me adopt coal for my trials, notwithstanding the injurious effect of this fuel on decorated pieces.

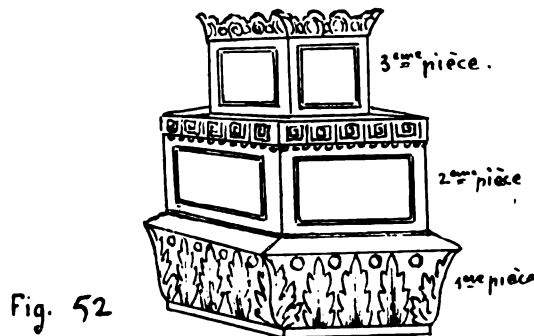
There is an innovation which I will mention, although it is somewhat outside the limits of these articles, the adoption by the porcelain industry of gazogene kilns, the kilns of the future. Glassmakers and metallurgists have already derived great

profit from these kilns which have the great advantage of economy in fuel and regularity in firing. If they are not more generally used for porcelain, it is due to the very large expense of installation. However a gazogene kiln is in use in Berlin, and another, of the Siemens type, has been established in Limoges and has given good results. The fuel is peat. The great economy in firing is due to the fact that the heat can be controlled at will, and that the reducing atmosphere can be instantaneously changed into oxidising, and vice versa.

The conclusion of this chapter is that those who have only limited resources, and are not expert ceramists, will do well to limit their expenses to the cost of the small coal kiln, the fire mouths of which, at the end of the trial period, can be transformed at a small cost into fire mouths for wood. But those who have sufficient resources, can avoid this trouble, by adopting from the beginning the plans of my wood kiln, to which they may add, if wanted, a baking chamber, keeping the same dimensions but having the chimneys built in the wall itself.

VI—Saggers, Placing and Setting.

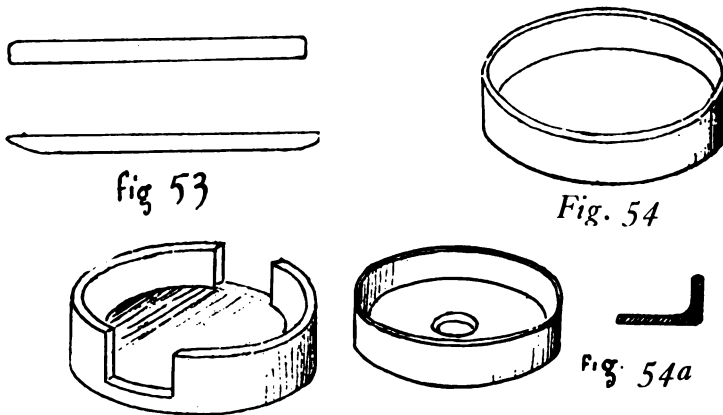
WHEN grand feu ceramics, grès or porcelains, are decorated and glazed, they must be set in the kiln for firing. The operation of setting consists in arranging the pieces in the lower room of the kiln, either free or enclosed in protective cases. When they are of grès biscuit, not covered with glaze, they can be fired on top of each other (Fig. 52), provided however that open passages for the flame have been left around them on all sides. During the firing the flames envelop and play upon these pieces, depositing unevenly on their surface a part of the alkalis, potash and soda, which the burning wood produces. These alkali salts do not injure the grès body in the least, on the con-



trary, they give it the warm reddish brown tone so pleasant to the eye, and the semi-glaze which increases its permanence and density. Moreover, in some cases, in order to accentuate this coloring and glazing, a few pounds of sea salt are thrown into the fire mouths during the firing. The free setting of grès biscuit pieces in the kiln has thus the double advantage of producing this surface quality and making it possible to use the whole capacity of the kiln without losing any room.

It is not so with porcelain. The salts from the burning wood, if deposited on the pieces, would give them an unpleasant brownish tone. If the porcelain pieces are decorated and glazed, the effect of the salts is disastrous, causing a series

of spots, consequently of flaws. It is therefore necessary to protect all porcelains, during every firing, whether in biscuit or glaze, as well as the glazed grès, and this protection is secured by hermetically enclosing them in fire clay boxes, which are called "saggers." The operation is called placing and is very important, as every thing which has to undergo the high temperatures of firing, must be arranged in the kiln with order and symmetry. The protective pieces are called, according to their shape, *saggers*, *rings* and *bats*.



The saggers are boxes with bottom (Figs. 40, and 54a). The rings, as the name implies, have no bottom (Figs. 41, 42 and 54) and they are used to raise the height of the saggers in accordance with the size of the pieces placed therein. The bats are round plaques or discs, which are placed on the bottom of the saggers to support the ware to be fired. They must be perfectly true to avoid their warping, which would involve that of the piece they support. These bats for sagger bottoms (Fig. 53) must be distinguished from the similar pieces which are used for covers (Fig. 43).

The material which is necessary for this careful placing in saggers is a source of trouble and a continuous expense for ceramists. It must be prepared in great quantities and made into varied shapes, cylindrical or oval, according to the ceramics to be protected. It constitutes the largest expense of all manufacture, large or small, because these utensils for firing

must be made with clays of first quality, easy to work and at the same time infusible. They must be capable of standing repeated firings without softening or cracking, as their softening would cause deformation of the ware, while their cracking will be accompanied with the projection of *grains* of dirt, which may glide over the round surface of vases, but will irreparably adhere to the glaze of plane surfaces, such as plates, plaques, bowls, etc.

The ideal material for this work would be an absolutely refractory clay of high plasticity, making possible repeated passages through the fire. But it is the geologist's work to find such a material for ceramists, and this ideal clay has not yet been found.

The paste to be used for saggars cannot be exclusively made of plastic clay, the drying of which would be too slow and very difficult. It is necessary to shorten the clay with an admixture of grog made from the same paste already fired, pulverised or in grains, according to circumstances, pulverised for placing material proper, in grains for the making of blocks for the doors and especially for the covers of the fire mouths, also for all utensils in direct contact with the incandescent heat of the fire mouths.

At Sèvres, where all the placing material is given the greatest care, the composition of the paste varies in proportion of grog and clay, according to the use which is to be made of it. Here are the Sèvres formulae:

Outside material in contact with flame

Clay of Provins	30
Clay of Sezanne	20
Grog	50
	<hr/>
	100

For inside bats

Clay of Dreux	20
Clay of Retourneloup	15
Crushed sand of Fontaine- bleau	32, 5
Finely powdered grog	32, 5
	<hr/>
	100

For cover bats

Clay of Dreux	21
Clay of Retourneloup	21
Very coarse grog	58

100

The clay of Provins is bought at Provins (Seine et Marne) from Mlle. Chevallier-Baillat, 25 francs per 1000 kilos (\$5 a ton); the clay of Sezanne from Madame Vve Parisot, à Sezanne (Marne), 16 francs per 1000 kilos (\$3.20 a ton); the clay of Dreux from Mr. Gasselin-Gigan à Brissard, commune d'Abondant, arrondissement de Dreux (Eure et Loir), 100 francs per 1000 kilos (\$20 a ton), higher than bread. The clay of Retourneloup is bought from Mr. Charles Collet, of Retourneloup, 40 francs per 1000 kilos (\$8 a ton).

After each firing, there is a certain quantity of placing material broken so that it cannot be used any more. The fragments and debris are ground in a mill and if the selection of these fragments has been carefully made, one will obtain grog for each kind of clay mixture, which can be used either as powder or in grains the size of wheat or the size of peas.

These technical details will enable the reader to realize the complication and expense of a careful manufacture like that of Sèvres, and also the impossibility of an ordinary and especially an isolated ceramist adopting this perfection of material.

For my part, having no mill at hand, I use, after many trials and failures, a grog made of all kinds of saggars, which is sold to me by the Ducouroy firm, 50 rue Nationale, Ivry-Port (Seine) for 60 francs per 1000 kilos (\$12 a ton). And the only formula for my placing material is:

Powdered clay of Provins	60
Ducouroy grog	40

100

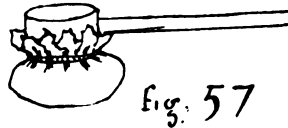
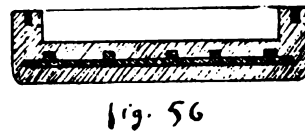
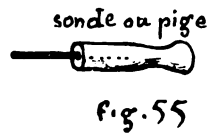
At the beginning of my work I had fixed to the ground in a corner of my studio a cast iron plaque with checkered surface, and with a pestle I crushed the sagger fragments to make grog, but it was a slow and painful process which beginners should avoid.

The different phases of the making of saggars are the same

as for porcelain, but with less care. Some are cast, others shaped on the wheel.

Before using, the paste must be carefully manipulated by hand and beaten. If the wheel is used, it should not be the same wheel which is used for porcelain so as to avoid any mixing of materials so different. The thickness of the sagger must be the same at every point, but the inner angle should be slightly rounded (Fig. 54). The bats are fashioned in lens shape with a slight depression toward the circumference (Fig. 53). The thickness is tried with a small instrument called a *pricker* (Fig. 55). It consists of a point stuck in a round wood handle 1 inch in diameter.

It is very important to watch the drying of saggars, the edges losing their moisture more quickly than the centre. After being left two or three days in a draft, or subjected to a



very mild heat, as soon as they can be detached from the plaster discs which support them, they must be turned upside down, to avoid the warping of the edges, as the regularity of saggars and rings is the main condition for a good setting of the kiln.

In my own work both saggars and rings are thrown, only bats are cast. This casting is done in plaster moulds which differ from porcelain moulds only by their simplicity and thickness (Fig. 56). They are held by iron braces in their thickness to increase their strength, and on the upper rim to diminish the wear caused by scraping.

After having fashioned a thick plaque of clay well beaten by hand and of the size of the mould, it is pressed in this mould with a pad made of old sponges enclosed in a piece of sheepskin (Fig. 57). This pad fixed to a wooden handle is kept

constantly wet. To make the loosening of this disc of soft paste easy the inside of the mould is first sprinkled with sand ground to an impalpable powder.

I insist on the special care necessary for the making of this placing material.

Before being used it must be thoroughly dry, and even have received a beginning of firing. It is then baked at the same time as porcelain pieces are baked, when there is no baking chamber in the kiln, or it is placed in the baking chamber if there is one, during an ordinary firing.

The placing of porcelain constitutes an important operation which requires great attention. It is in no way as simple as the placing of faiences and grès, and is peculiar to the kaolinic clay which must be preserved from contact with the flame. It consists in setting in the kiln the pieces already enclosed in saggars, and no one setting will resemble another; at each firing, everything varies according to the number and especially the size of pieces. To a piece of each size corresponds a certain size sagger, which of course will make necessary a different arrangement of the piles, unless one executes the same pieces repeatedly or does not make any piece which exceeds certain dimensions determined in advance. But in any case, the setter will have to employ skilful modifications and make unexpected arrangements every time in order not to waste any room, to well balance the pieces, to safely superimpose the saggars with the help of a plumb line, to lute them solidly to each other, and to know from the decoration of pieces what part of the kiln is most suitable for them.

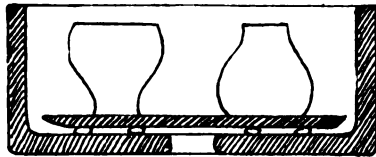


Fig. 58

The operation of placing in saggars and setting go together. The placing should be done on a table arranged as close as possible to the door of the kiln. As soon as a piece is placed, the sagger is at once set.

1st. Placing is easy when the piece is in the shape of unglazed biscuit. In this case it is sufficient to rest it on the fire clay bat (Fig. 58). And to be sure that there will be no adherence between the two, the bat should be covered with a thin coat of infusible wash. This wash is a very refractory powder made of

Pure calcined alumina	50
Washed kaolin	50*

2nd. Placing is somewhat complicated when, notwithstanding a broad and solid base, the piece is glazed. The part of the bottom which will rest on the bat should be carefully scraped and brushed to remove any glaze which may have been left after dipping, atomizing, brushing or any other mode of glazing. Without this precaution the piece and the bat would get stuck and in parting them violently, one would risk losing or at least seriously damaging the piece. As in the first case, and in every case for that matter, the bat should be well washed with the infusible powder.

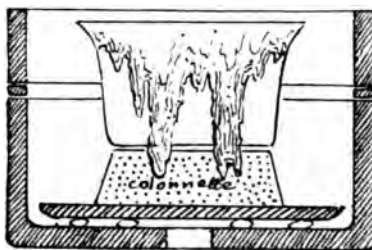


Fig. 59

3rd. Placing requires special care when the piece, whether of narrow or large base, is covered with flowing glazes. Then it should rest some distance from the bat on a small cylindrical column (Fig. 59) resembling a ring about $\frac{3}{4}$ of an inch thick, the height of which varies according to the more or less flowing tendencies of the glaze. This height will be from $\frac{3}{4}$ of an inch to as much as 2 or $2\frac{1}{4}$ inches. The little columns will receive the excess of glaze. They are thrown on the wheel and it is absolutely necessary to use the material of which

Another very satisfactory wash for high temperature is made of bone ash 50, flint 50.—(PUB.)

the vase is made, because of the shrinkage which would be different if two different materials were used and might cause the piece to fall from its support. The little column is strongly washed under its base and especially on top on the part which is in contact with the vase.

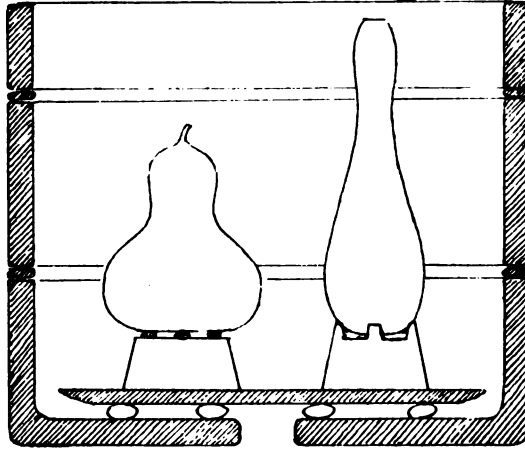


fig. 60

4th. Placing becomes an art when the piece is of such a shape that the flowing glaze must cover it everywhere as in the case of my vases made from fruit forms (Fig. 60). The supporting must be done so that after firing, the vase will be detached without accidents from the excess of glaze in which it is steeped. To do this, I make a bat of the same material

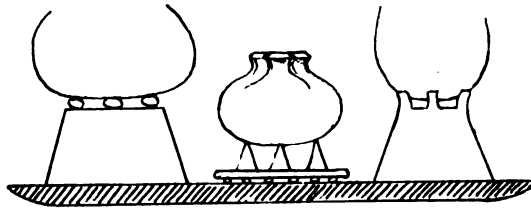


fig. 61

and the same diameter as the piece to be fired. This bat is strongly washed, and on the wash, I place at equal distances, 3, 4 or 5 small truncated cones $\frac{3}{8}$ to $\frac{1}{2}$ inch high, the points of

which are washed. On these cones the vase stands (Fig. 61). The glaze flows on to the cones and from the cones to the bat, and the bat having the same shrinkage as the vase there is no displacement of the latter. When taken out of the kiln, it is easy to detach it from the points without any damage.

In the first case described there is no loss of pieces; in the second very little is caused by the placing; in the third losses are 30%; in the fourth they reach the disastrous proportion of 50%, because the vases being balanced on 3, 4, 5 or 6 small columns, if the least displacement of the bung occurs, the equilibrium is destroyed and the piece falls (Fig. 62). This



Fig. 62—Example of a piece which has fallen during the firing. These three pieces stuck to each other and to the bat, forming one mass and they cannot be parted without breaking. Every care had been taken in the placing.

easily happens as porcelain shrinks in the proportion of 10% of the natural height (Fig. 62 bis); grès shrinks 12%. To this shrinkage must be added the movement of shrinkage in the placing material and the tendency of the kiln to yield to the pressure of combustion gases. One should understand that in the kiln everything plays, works, moves, and if the setter has

not used the plumb line or has not an experienced eye, the rushes of heat from a too rapid firing may act on the piles of saggars so as to shake the vases like a house of ginger bread.



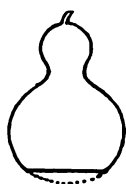
Fired

Baked

Raw

Fig. 62 bis.

It will be seen that everything threatens the destruction of the works of daring ceramists, if they do not display in their fight against the fire a good deal of skill and thoughtful patience. But all these precautions will readily occur to the mind of a man who risks in the fire six months of artistic work and all the money accruing from former sales.

*fig. 63*

At Sèvres and elsewhere pieces made from fruit forms are cut off below (Fig. 63) so as to give a broad base and avoid losses. But in my opinion this solving of the difficulty is a mistake, the fruit having its interest and structural beauty in the attachments of the stem. To suppress this

attachment by cutting is to destroy the main decorative quality of the fruit. To this method of securing results I prefer the chances of a 50% loss, which allows me to obtain unique and splendid ceramics.

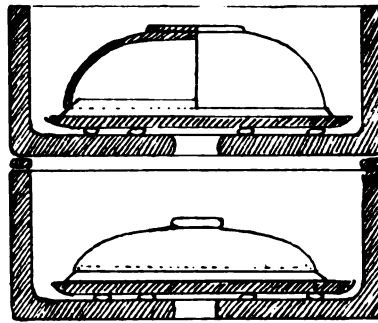


fig. 64

Pieces with large opening such as bowls have a tendency to warp on the edges. To counteract this, the piece is turned upside down and it rests on its large opening (Fig. 64). This will make necessary a second firing for the glazing of the edge which has been left bare in the first firing. In this second firing, the piece having undergone its shrinkage cannot warp any more and will rest on its foot (Fig. 65).

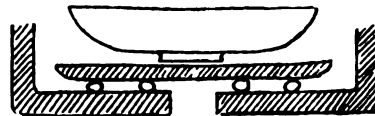


fig. 65.

I insist on the necessity of washing (covering with infusible wash) all the points of contact of pieces with their supports, because a porcelain body, when softening and vitrifying at its highest point of firing, has a tendency to adhere to the support. If the firing is not hard this will not be very noticeable, but if there has been a little too much heat all pieces not sufficiently washed are stuck, and must be detached with blows of a wooden

hammer. I have lost some fine pieces for neglecting this detail in the midst of all the other placing precautions.

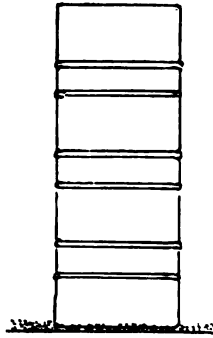


Fig. 66.

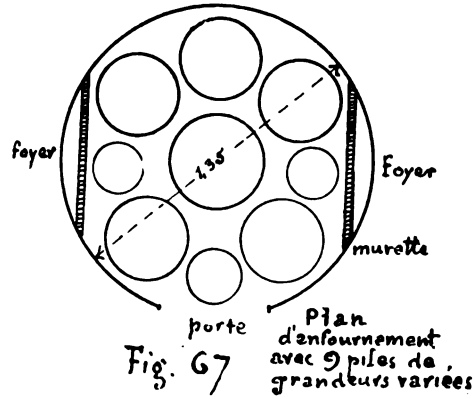


Fig. 67

Foyer, fire mouth—Murette, wall in front of fire mouth—Enfournement, setting.

When set on top of each other, the saggars form columns which are called bungs (Fig. 66), and reach to the top of the firing chamber. Each bung must be built, from bottom to top, of saggars having the same diameter. The solidity of the bung is secured by that condition. The number of bungs varies according to the size of the kiln and the diameter of the saggars. Three bungs of saggars one foot in diameter found room in my first small coal kiln (Fig. 39).

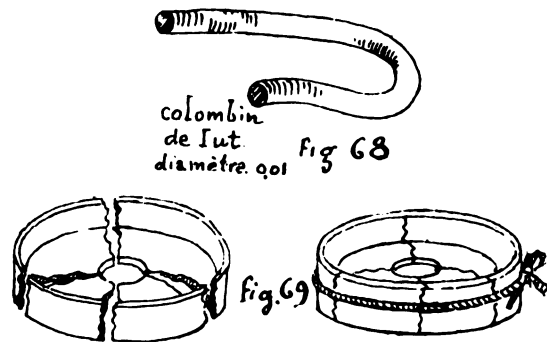
In my wood kiln (Fig. 67) there are regularly nine bungs of different sizes to allow the placing of a great variety of shapes and to better distribute the spaces reserved to the passage of the flame. I say regularly, because I have limited myself to certain sizes of pieces. If I exceeded these sizes I would have to construct a larger kiln, to have a much more cumbersome material, also assistants and workmen, etc., which is not my purpose, notwithstanding the tendency of all ceramists to build castles in the air. My setting is, with slight variations, always about the same.

Plan of setting in a kiln having 1m, 35 diameter (4 feet 5 inches), (Fig. 67):

The bungs have between them a space of 4 inches and 2 inches near the fire mouths. Their vertical position is established with the plumb line; it must be perfect. Notwithstand-

ing these precautions, the saggars would not keep their balance if they were not cemented together by the means of wads of *lute* (Fig. 68) placed between each sagger and ring. This clay is made of

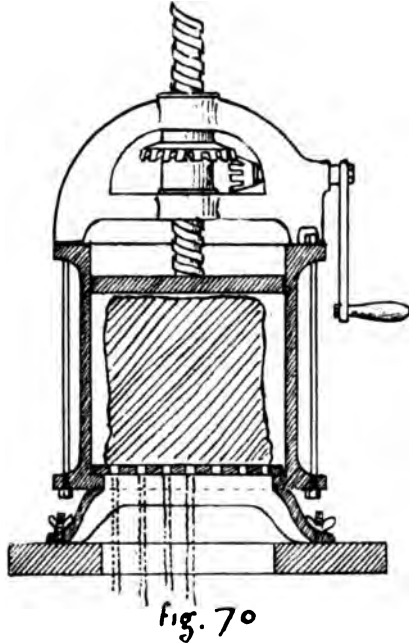
Clay of Provins	30
Common yellow sand of Villebon	70



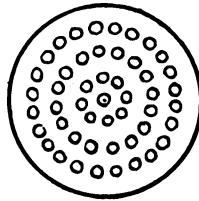
It is the most valuable help to the setter; it gives regularity and solidity to the bungs. This clay, fresh when it is put on, dries very rapidly and at once gives rigidity to the bung. As soon as the lute is dry, one removes the ropes which hold together the fragments of broken saggars and rings, which have still some usefulness. This is left to the judgment of the setter. Sometimes broken saggars are better than new ones, but they must be held with ropes (Fig. 69) so as to be easily handled, and not to lose any piece, as the reconstruction of saggars from mixed fragments is worse than a Chinese puzzle.

The lute can be made by rolling the clay by hand in the shape of a rope about $\frac{1}{4}$ inch thick, but it is a slow way. Machines can be bought from Mr. Faure, engineer at Limoges, or from Mr. Wenger, Hanley (Staffordshire, England), the latter \$20 delivered at Hanley. As this price is high, I have solved the difficulty by employing an American machine made to make meat juice, which bears the mark "Enterprise Mfg. Co., Philadelphia" (Fig. 70). The bottom has been removed and replaced by an iron plaque (Fig. 71) in the shape of a movable disc $6\frac{1}{2}$ inch in diameter, pierced with 50 holes about $\frac{1}{4}$ inch

diameter. The vertical cylinder is filled with soft paste, which is forced through the holes by a screw-press acting on the cover. The wads of clay are gathered under, ready for use.



The sagger at the base of a bung may or may not rest on the bottom of the kiln. In kilns with up draft, it rests on the bottom (Fig. 72) which has first been covered with a layer of



sand one full inch thick so that the sagger will have the whole surface of its base well supported. In kilns with down draft, this bottom sagger should rest on three small bricks

placed in the shape of a triangle, so that the flame will freely circulate under the bung (Fig. 73). The large center bung, being on the opening of the chimney, must be raised a little more than the others (Fig. 74), to allow the flames to flow freely into the chimney.

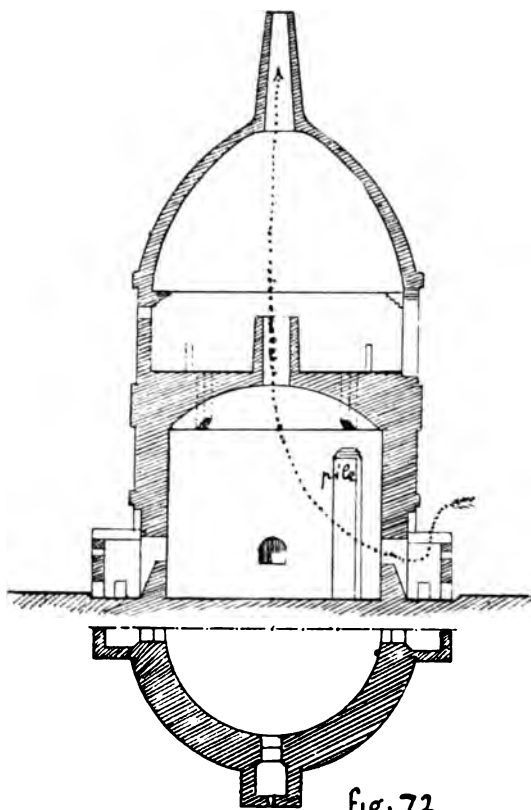


fig. 72

Four à flamme
directe

These columns of saggers which are 4 inches distant from each other and sometimes more, are supported between themselves and also between the bungs and the sides of the kilns, by *props* (Fig. 75) made of fragments of old rings and cemented, not with lute, but with fresh firebrick clay. Thus propped the

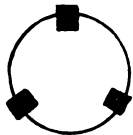
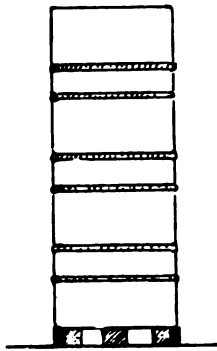


fig. 73

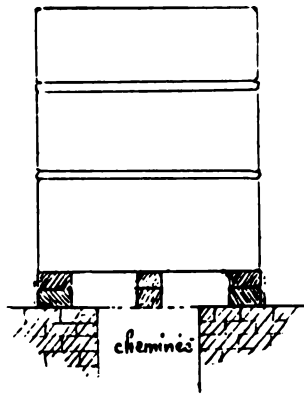


fig. 74

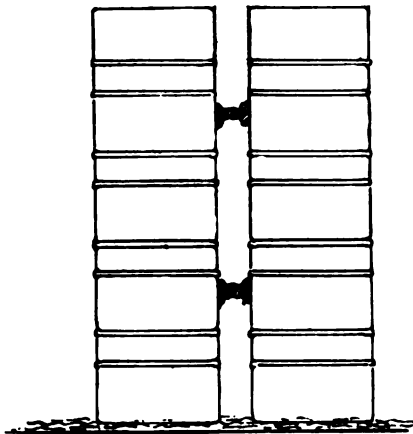


fig. 75

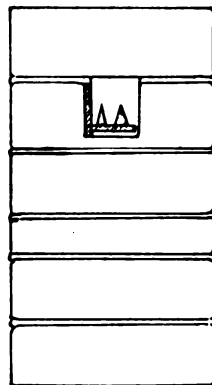


fig. 77

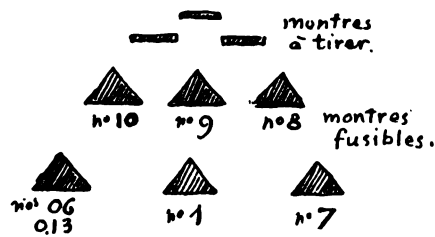
piles constitute a stable, unshakable block, with the necessary spaces for free circulation of the flame and its correct distribution in every part of the firing chamber (Fig. 76). To neglect any of these precautions is to risk the displacement or a collapse of a bung, with the irretrievable loss of the pieces it contains. And notwithstanding these precautions, unexpected accidents occasionally occur.



Fig. 76. Plaster model of a porcelain kiln built in 1835—up draft—four fire mouths.

The bung placed in front of the door must contain the sagger for the cones. This sagger is placed at $\frac{3}{4}$ (Fig. 77) of the height from the bottom to the vault. The cones and trial pieces are arranged so that they can be easily watched during

the whole firing. This is a very important point. Here is the arrangement which I use:



Cones 06 or 013 are placed on the left; then cone 1 and on the right 7, between 7 and 1 place 8; 9 comes next, then 10 on the left. When the time to observe 9 and 10 has come, cones 06 and 1 have disappeared and cannot hide the others. The trial pieces are behind.

To prevent the cones from accidentally falling during the firing, it is well to place around their base a wad of lute (Fig. 87).

When in a small kiln one has to fire only two or three large pieces, they are placed in large saggars which are set across the top. This consists (Fig. 79) in resting the sagger or saggars which contain the large pieces on 2, 3, 4 or even 5 bungs, which need not have the same diameter, but must have the same height. First large balls of lute are placed at equal distances on all points of contact with the bungs. On these balls is placed a large covering bat and on this bat the crossing sagger is set, perfectly level.

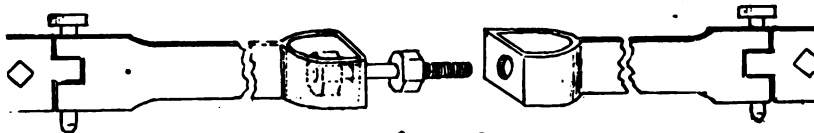


fig. 78.

When the setting is completed, the doors are closed with two brick walls the outside of which is covered with a coat of clayey dirt or mortar made of damp sand mixed with clay.

Clay	50
Common yellow sand	50

These two materials are found everywhere.

At Limoges and even at Sèvres, a space of 4 to 5½ inches only is left between the two walls, so that the first wall is as much as 5½ and even 7½ inches inside the wall of the kiln. I think that it is more correct to give to the door the exact thickness of the wall of the firing chamber, thus increasing the general resistance to pressure and preventing as much as possible the loss of heat through the door which is so well known to firers. This I do and the space between the two walls is filled with dry fine sand. The object is to increase the thickness of the door and to hermetically close it so as to prevent infiltration of air during the firing. This sand is made of fragments of lute which are gathered after firing and ground.

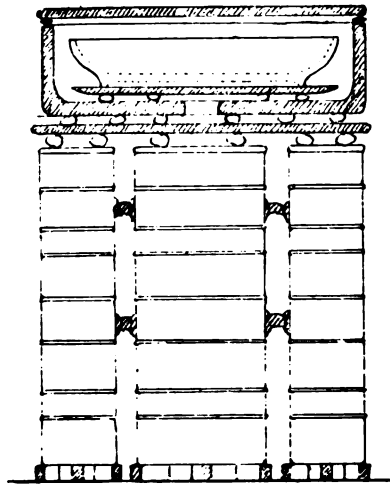


fig. 79

While constructing the door, when two-thirds are built, the movable spyhole is placed across the two walls, in the axis of the center of the cone sagger (Fig. 77). This spyhole is in the shape of a square box. It is in fire brick and open at both ends. The outside opening is closed with a stopper of the same material which fits it well. This stopper is pierced with a hole closed with a piece of white glass through which the different phases of firing may be watched (Figs. 36, 37, 38).

The baking chamber is closed only by one wall strongly washed with mortar. It has no spyhole.

When the door is completed, the two movable parts of the iron bracing which goes over the door, are closed (Fig. 78). These two parts are on hinges and are tightly stretched by means of a strong bolt.

As a conclusion to this article, I will advise the beginner to make his placing material, or have it made, with the materials I have mentioned, until he has found their equivalent or better materials in his own country. The chapter by Mr. Charles F. Binns satisfies me that it will be easy to find these. To avoid severe disappointments, the beginner will do well to follow my instructions closely. He will first bake his placing material, will learn the placing of simple forms, fire without giving too much attention to the exact filling of saggars. He will stop his bungs about 4 inches from the vault of the firing chamber and will prop them solidly. He will fix up some machine to make lute and will give the utmost care to his first setting. With a little practice every precaution to be taken will come to the mind naturally. At each setting he will take into account the different degrees of sensitiveness of the glazes, so that some will be placed in the hottest parts, others in the parts of less intense heat in the kiln. As the base of the bung is less hot and more oxidising as a rule he will place there the colors which need for a good development a very oxidising atmosphere, like those based upon cobalt, manganese or chrome, or the colored glazes, the fusibility of which causes them to flow easily.

VII—Firing: Neutral, Oxidising, Reducing.

THE fuel adopted for decorated porcelains is wood. Trials with coal have so far given only negative results, whatever the claim of some ceramists, who, in words have solved every problem but whose exhibited works do not reveal any solution at all. What matters anyway in an artistic production the extra expense of using wood? The important point is to have a tractable fuel. Until the coming of a chemist who will obtain with coal the fresh and brilliant palette which wood affords I will confine myself to the fuel of which I am about to speak.

The two principal species of trees are oak, the king of the forest, and the humble birch with its gay white bark. The kind of oak generally adopted for firing is the young oak, the bark of which is used by tanners. This tree falls by itself under the action of the sun, after longitudinal incisions have been made in it by foresters. But whether young or old, small or large, straight or knotty, oak can be used. Large trunks are cut into sticks of equal lengths. Large sticks are fed during the first part of the firing; those of medium and small size during the second part or *petit feu*. It is important to throw into the fire mouths charges of equal volume to obtain the necessary regularity in the increase of heat.

Oak has been adopted in Limousin, Vierzonnais, at Sèvres and by all artists who decorate their works with *grand feu* colors, because on account of its close grain, it burns slowly and evenly. Its action is progressive, without rushes. Birch acts quite differently. Large trunks must be discarded, because of the slow work of splitting them. Birch four and five years old, in medium and small sizes, is the best. It must be sound, straight, without knots or rotten spots and perfectly dry. It should be cut two years before being used.

It is sawed in two, its length being about 45 inches (this, 1m, 15, is the length generally adopted for the cutting of wood

The combustion of kerosene oil does not produce any gases injurious to porcelain colors, and in this country where oil is cheap, oil kilns may prove to advantageously replace the wood kilns. (Pub.)

in the French forests). These sticks are then split into pieces of even size. For instance, a stick $3\frac{1}{2}$ to 4 inches in diameter will be split into six pieces; that of 2 to $2\frac{1}{2}$ inches into three; that of $1\frac{1}{2}$ to 2 inches into two only. A regular splitting allows one to feed evenly and regulate the combustion. During the *grand feu* firing, birch is used exclusively. Its loose grain allows it to burn instantaneously when placed on the hopper of the fire mouth. It gives a long, clear, intense flame.

The basis of 45 inches being adopted for French cuts of wood, the wood will be cut with two or three sawings, according to the width of the fire mouth, as any false cut and consequent loss of wood must be avoided. The fire mouths of my wood kiln being $17\frac{1}{2}$ inches wide, oak is divided into four pieces by three sawings. It could be divided into only three pieces with two sawings, but its division in four allows me to fill the fire mouth better. Birch is divided into two, each piece being then from 22 to 23 inches long.

I have said elsewhere that after 3 or 4 firings repairs sometimes of importance must be made to the kiln. The new masonry must be dried out. To obtain this result, a brazier is lighted for two days and two nights in the firing chamber. This brazier is made of placing rings superimposed about an inch apart. When the kiln is entirely new this brazier must burn for about 10 days, as it is most important to have a kiln perfectly free from moisture. This drying is effected with coke.

Whatever care is given to the construction of a kiln and to the firing, it is impossible to have the same temperature in every part of the kiln. Naturally, the part which is close to the fire mouths is subject to a higher temperature than the part where the flames leave the firing chamber. I have stated that there might be the enormous difference of $50^{\circ}\text{C}.$ between the temperatures of the bottom and the vault of the kiln. It is extremely important to reduce this difference and to get as nearly an even temperature as possible by a progressive firing, without any rushes of heat. The firer should be constantly on the watch, especially during the *grand feu*.

The kiln is lighted by placing ten pieces of split birch in the bottom of the fire mouth, crosswise. On top are placed two round sticks of medium size oak. At the same time the

stopper of the opening A at the base of the chimney (Fig. 50) is removed. A handful of chips or kindling wood is lighted there to displace the column of cold air which is in the chimney and to start the draft. The fire mouths are covered with a sheet iron plaque (Fig. 80) in the middle of which is a long iron stem for a handle. The draft is immediately established without any smoke getting into the room. If there is a baking chamber, the opening for starting the draft may be established in the door of this at the foot. Chips and kindling wood should be kept burning there until the draft is well started.

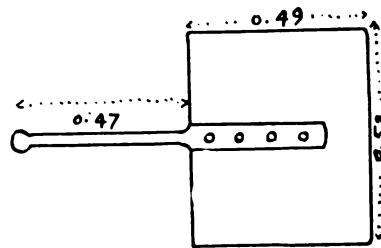


fig. 80

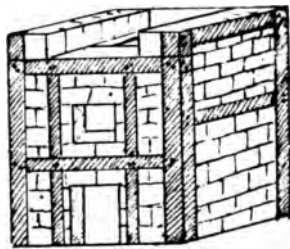
The time of firing a porcelain kiln is divided into three distinct divisions: the *drying*, the *petit feu* and the *grand feu*, or *slow*, *active* and *grand feu*.

The object of the drying is to remove all moisture which the kiln itself or the placing material may contain, either from dampness in the ground or in the atmosphere. I give the records (Figs. 89 and 90) of two of my wood firings so that it will be easier to follow every phase and to understand better the action of the different parts of the kiln.

The *drying* lasts from 3 to 4 hours during which, every half hour, two large sticks of oak from 7 to 12 inches thick, or their equivalent, five round sticks about 2 inches thick, are placed crosswise and in good order, in the bottom of the fire mouth, as close as possible to the firing chamber. After three hours, one more large stick or its equivalent in small round sticks is added at the same intervals.

The drying being finished, one begins the active firing or *petit feu*, during which the heat must gradually penetrate the

masses of placing material and the pieces they contain, all sudden rushes of heat which might cause cracks being carefully avoided. The *petit feu* is obtained by feeding one more big stick of oak or its equivalent in small round sticks every twenty minutes, without any special order. After seven to nine hours of this firing, the entire mass of the porcelain and the saggars has been penetrated and there is nothing more to fear with regard to breaks and cracks. The firing can now progress boldly until the fire mouth is full. By keeping it thus full, the kiln soon becomes red, as can be noticed by looking through the door spyhole. When the kiln has changed from dark red to cherry red, the *grand feu* has begun.



Armature de
l'alandier au bois

Fig. 81

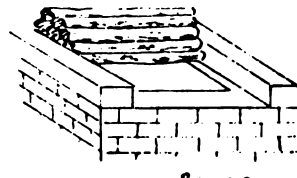


Fig. 82

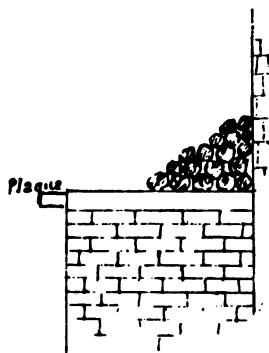


Fig. 83

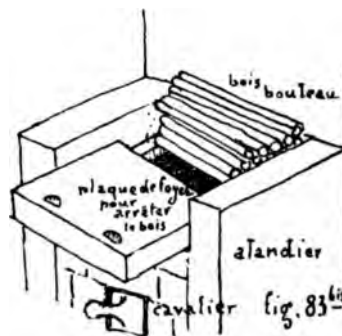


Fig. 83bis

Before one becomes quite familiar with these two phases of the firing and has learned by practice to obtain the cherry red in the time mentioned, it will be important to start the

grand feu only after the cherry red has completely pervaded the kiln. I reach my results in a definite time with a mathematical precision which beginners cannot expect to secure but with observation and care in feeding they will soon be successful.

The drying and *petit feu* together generally take less time than the *grand feu*.

For the *grand feu* oak is discarded and birch used. The latter is not thrown into the fire mouth, but carefully placed on top of the latter, on the hopper (Figs. 82, 83 and 83 bis.) Every five minutes regularly a handful of about 10 birch sticks is placed against the side of the kiln, and all openings caused by the combustion must be promptly filled. From that time to the end of the firing, the fire mouths must not be lost sight of, as they must be constantly fed. The sheet iron plaque over the fire mouth is replaced by a fire brick plaque which rests on the hopper and supports the necessary amount of wood.

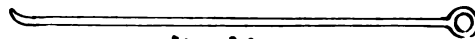


fig. 84

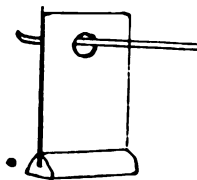
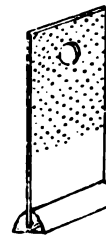


fig. 85



la pointillé
indique
la partie émaillée
montre dite :
à tirer.

fig. 86

Once in a while, every two hours, and toward the end every hour, one watches through the spyholes what is happening in the kiln. One sees through the white glass the fusible cones which successively curve and melt when the temperature of the kiln reaches their point of fusion. Behind the cones are three trial pieces which are rapidly picked up with an iron rod slightly curved at the end (Figs. 84 and 85). This rod is introduced through the opening of the spyhole, after the stopper

of the latter has been removed with the help of wet cloth. The trial pieces show the true condition of the kaolinic matter. When with the help of these two tests and his experience, the firer judges the porcelain fired, he stops feeding fuel, slides two large fire brick plaques over the fire mouths to close them, hermetically closes all openings and cracks with mortar, and stops the air drafts if any should have been established. The firing is over.

Since the invention of hard porcelain, firers have invariably used, in order to determine the condition of the porcelain, pieces placed in the middle of the kiln and called test or trial pieces. They are little tiles of baked porcelain about 2 inches long and 1 inch wide, with a large hole in the upper part. This upper part alone is glazed. To allow them to stand up, these test pieces have their foot wrapped in a wad of lute which gives them a large and solid basis (Fig. 86). Sèvres and the porcelain industry keep using these pieces which alone show the true condition of the ware. I do the same.

In 1882 the German chemist Seger conceived the clever idea of adding to these trial pieces fusible cones which can be seen during the development of the firing and which relieve the operator from the uncertainties and anxiety which formerly assailed him during the finishing hours. Simultaneously discovered at the factories of Berlin and Sèvres by chemists who were not aware of their similar work, these cones are made of fritted material of different fusibility. They have the shape of a triangular pyramid (Fig. 87). I will not undertake to describe their scientific composition; it will be sufficient to say that their successive melting indicates clearly if the same temperature is reached at the same time in all parts of the kiln where these cones are placed. Ceramists have so much appreciated the services rendered by these cones that their use has become quite general.

I order the cones direct from the makers, Seger & Cramer, Berlin, at the cost of fr. 5, 65 (about \$1.10) per hundred.

The standard adopted for the numbering of the cones is the melting point of cast iron 1150°C . This is called cone No. 1. Numbers go from 1 to 32, which is the melting point of platinum 1770°C . Numbers which register temperatures lower than cone 1 are preceded by a cipher. They go as far down

as the dark red registered by cone 022, or 590° C., the melting point of bright liquid gold. There is only about 20° difference between the successive cones. After many trials I have adopted the following cones for my firing:

For reducing fire	For oxidising fire
Cones 06	Cones 013
1	1
7	7
8	8 (fusion of feldspar)
9	9
10	10 (Sèvres hard porcelain)

In reducing fire, cone 06 corresponding to the point of fusion of the glaze, marks the limit of reduction in the kiln. No. 10 indicates the temperature at which porcelain is fired and the firing should stop.*

In an oxidising fire, cone 013 marks the point at which

*In the United States, Prof. Edward Orton, Jr., Ohio State University, Columbus, O., manufactures Seger cones and sells them for one cent apiece.

LIST OF PYROMETRIC CONES AND THEIR MELTING POINTS

Manufactured by Edward Orton, Jr.

Cone No.	Deg. F.	Deg. C.	Cone No.	Deg. F.	Deg. C.
010	1742	950	12	2498	1370
09	1778	970	13	2534	1390
08	1814	990	14	2570	1410
07	1850	1010	15	2606	1430
06	1886	1030	16	2642	1450
05	1922	1050	17	2678	1470
04	1958	1070	18	2714	1490
03	1994	1090	19	2750	1510
02	2030	1110	20	2786	1530
01	2066	1130	21	2822	1550
1	2102	1150	22	2758	1570
2	2138	1170	23	2894	1590
3	2174	1190	24	2930	1610
4	2210	1210	25	2966	1630
5	2246	1230	26	3002	1650
6	2282	1250	27	3038	1670
7	2318	1270	28	3074	1690
8	2354	1290	29	3110	1710
9	2390	1310	30	3146	1730
10	2426	1330	31	3182	1750
11	2462	1350	32	3218	1770

the glaze is getting into a condition to be affected by carburets, when all reduction must cease and the firing remain strictly oxidising to the end. Other cones show the progress of the firing. These cones, blunt and long in Germany, large and pointed at Sèvres (Fig. 87), being silicates of alumina, resemble in their chemical composition the kaolinic products which the kiln contains.

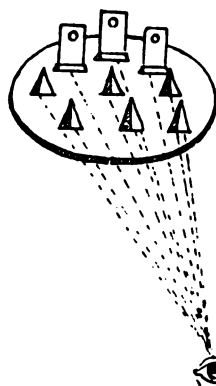


Fig. 88

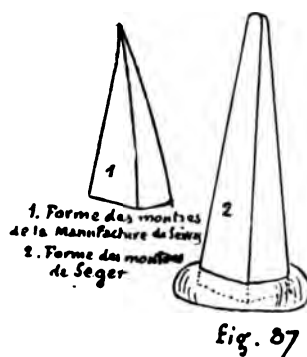


Fig. 87

Whatever the advantages of these fusible tests, which one can see but not touch, they cannot be depended upon entirely to determine the exact moment when the firing should be stopped. It is necessary to use for this the trial pieces which can be examined after their extraction from the kiln. These pieces alone show the exact condition of the porcelain, its color, its translucency, the quality of the glaze and allow one to judge whether the firing should be stopped or continued for perhaps a quarter of an hour, half an hour, sometimes an hour.

The regulation of the firing may be done in three different ways: *ordinary* or *neutral*, *oxidising* and *reducing*. Neutral firing has always been and still is used by all porcelain manufacturers. It is the "go as you please" of empirics. It is easy to understand that if one throws wood into the fire mouths, little at first, more towards the end, the point of firing of kaolinic matter will sooner or later be reached. At Limoges, in Saxony, at Sèvres and everywhere that porcelain was made, the main result sought for was the brilliant whiteness of the ware. (This whiteness caused the public to prefer porcelain

to earthenware against which porcelain makers had made a bitter fight. The whiter the porcelain the better it was adapted to decoration with the only palette known at first, that of the muffle fire.)

Manufacturers had observed that when, during the firing, there was an excess of smoke the porcelain had an unpleasant greyish tint. It was therefore absolutely necessary to avoid this smoking of the kiln. On the other hand the time of firing, with the labor and expense involved, always seemed too long, and it was important to push the fire so as to reach the end as rapidly as possible. Tossed between these two extremes, porcelain makers had succeeded in regulating the firing in an abnormal and empirical way, by selecting the wood, dividing the feeds, forcing into large fire mouths all the fuel they could stand, but at the same time airing the kiln everywhere with strong drafts, as if it were burning in the open air, with a violent wind. And as with this excess of fuel, the live coal accumulated in the fire mouths, and formed clinkers, every two hours they were cleaned out. This severe operation, the taking out of the coal which had accumulated and obstructed the openings, scorched the skin of the firers, but they did the work bravely, as this coal was one of their perquisites. As soon as the fire mouths were clean, they became active again and the smoke disappeared to give place to the oxidising atmosphere. With this regular cleaning of the fire mouths, porcelain makers succeeded in obtaining very pure white after 30 to 34 hours firing. The oxidising action was strong but not complete, as it was active only at times. When the palette of *pates sur pates* was created at Sèvres, the cleaning of the coal was practiced regularly to preserve the oxidising atmosphere so necessary to the development of certain colors, such as the yellows of uranium, the pinks, mauves, turquoise and blacks which owe their brilliancy to this atmosphere. As the oxidation was insufficient this was remedied by the creation of air drafts through fire brick tubes X passing through the walls of the kiln (Fig. 49). These tubes conveyed an excess of oxygen to the inside of the saggers where the colors were, which certainly, when it worked well, improved the tones wonderfully. But success depended on the stability of these tubes. If in their moving surroundings, they became dis-

placed by a movement of the bungs or were obstructed by some unexpected cause, the flow of oxygen being imperfect, the colors did not come out with all their brilliancy, the decoration remained grey and dirty. I have seen many finely decorated pieces on which the air draft had failed to act.

The air draft, led into the channel at the bottom of the bung, follows it without any break to the top, ending outside after crossing the vault of the firing chamber. The points of entrance and exit of the air being fixed, at each firing these air passages must be carried between the bungs in the same way.

This empirical firing could not stand the investigation of serious and learned minds, trained in the logic of exact sciences. The Sèvres chemists, applying to ceramics the scientific processes which were used in metallurgy, solved the question of a purely oxidising or a purely reducing atmosphere by the relation of the sections of the chimney to the fire mouths.

Oxidising (Fig. 89)—If a *narrow fire mouth* corresponds to a *large opening* for the exit of the flame, the fuel is completely consumed under the action of the strong draft which the narrow fire mouth produces. As wood consumes only the amount of air necessary for its complete combustion, there rushes into the kiln an excess of air which devours the unburnt gases which may have been introduced. The atmosphere of the kiln is then called *oxidising*. As it is necessary to constantly increase the feeding of fuel in order to reach the high temperatures for the firing of porcelain, one has to face the following problem: the temperature will be lowered if, when feeding little wood, too much air is left to penetrate the kiln, or the oxidising atmosphere will be lost, if with an excess of fuel the smoke invades the firing chamber. There is a happy medium which practice alone will teach. It would be impossible to finish a firing if one tried to have an absolutely oxidising atmosphere all the time, while the contents of the kiln would be irreparably damaged if the reducing atmosphere was kept from beginning to end. The characteristics of an oxidising fire are, inside of the kiln, a brilliant white light, without any trace of flame or smoke, and outside, the absence of flame on top of the chimney. When a rush of flames is produced by the fall of

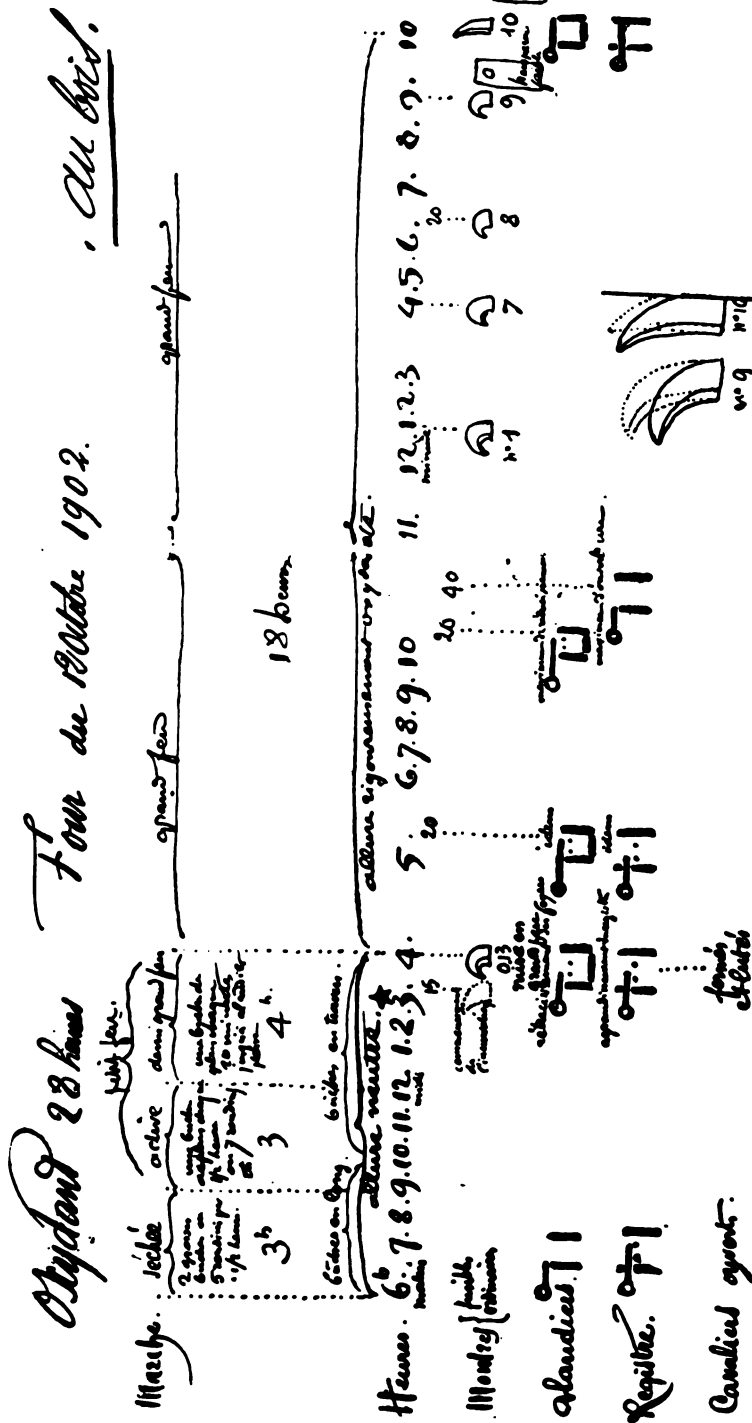


FIG. 89.—Oxidizing firing in 28 hours.—Neutral firing until fall of cone 013, including the drying period, 3 hours, the active period, 3 hours, the demi-grand feu, 4 hours. After the fall of cone 013, oxidizing firing for the grand feu period lasting 18 hours. After 18 hours of fire mouths open during the neutral firing, closed and cemented with mortar at the fall of cone 013. Fire mouths open at first, partly closed at the fall of cone 013, this closing gradually increasing until at 10:20 o'clock it reached its maximum, before the fall of cone 1. Chimney damper partly closed at first, opening at fall of cone 013 and after until the maximum was reached at 10:40 o'clock. Before cone 013 either neutral or reducing action will have no influence as the fusion of the glass begins only at that cone. But after cone 013 it is necessary to pass to oxidizing firing, however slow. One of my more recent oxidizing firings has lasted only 25 hours. It will be noticed that in my early coal firings the change of atmosphere was not well established. The two wood firings are types from which, as a principle, one should not depart. After a few trials the firer will have his kiln well in hand. Some very fine pieces in this firing, 19, three of which were large, out of 36. A red fired large plaque broken (when there are many red fired pieces in the kiln the drying should last 5 hours.) The air draft has worked well, yellows and pinks very fine. Strong wind all day, fine rain in the evening, after midnight, clear, cool weather, very active draft. One stere oak and 4 stere split wood used.

Reduction 23.30

Four du 18 Juillet 1902



FIG. 90.—Seches, drying; Montre fusible, cone; Montre a l'air, trial piece; Registre, chimney damper; Alandier, fire mouth; Cavalier, stopper of fire mouth, marked by dash at bottom of fire mouth figure; Defournement, drawing of the kiln; En l'air, on top; Au milieu, in the middle; En pied, at the foot; Pelard, young oak; Bouleau, birch; Sier, French measure for wood, equal to about 1/2 cord; Bois, wood.

Reducing firing in 23 hours, 30 minutes.—Fine reduction up to the fall of cone 06, perfectly oxidizing firing afterwards and to the end. Stoppers of fire mouths open, but in place, to the end, not cemented with lute, so as to let the air go through. Dotted lines on cones 9 and 10 show their position when the firing was stopped, full lines their position as found when the kiln was opened. This firing is a typical reducing firing. Chimney:

damper closed but opening gradually up to cone 06; afterwards entirely open. Fire mouths open at first, then closed $\frac{1}{2}$ up to the fall of 06 (Damper and fire mouths are divided in three parts marked by notches, sometimes the opening or closing from one notch to the next is too much according to the weather which may or may not be favorable to the draft; in this case the damper or the fire mouth plaques are placed between two notches; this is left to the judgment of the firer.) After the fall of 06, the reduction had to be avoided, the fire mouth was closed half, then two thirds, up to the end, in order to obtain a completely oxidizing firing.—Very fine results, 26 good pieces out of 32. A few biscuit pieces blistered, a little too much firing. No. 10 having bent forward so that I did not notice it. Pâtes sur pâtes very fine. Reds a little smoky but very fine. In the morning weather was cloudy and stormy until noon; in the afternoon weather very hot.

a burning load of wood in the fire mouth, these flames should be blueish.

During an oxidising fire, the neutral firing which allows a rapid increase of heat, is adopted until the fall of cone 013, when it is necessary to begin oxidising, because unburnt gases which would be deposited on the pieces would produce with the colors a pyrochemical combination which would injure or destroy them. It will be easily imagined that this kind of firing is much slower than the neutral or reducing ones. It lasts 3 or 4 hours longer.

Crystalline glazes are obtained only in a purely oxidising fire. Oxidising firing gives a slightly ivory tint to white porcelain.

Reducing (Fig. 90)—If on the contrary to oxidising, a *large fire mouth* corresponds to a *narrow opening* for the exit of the flame, the draft is insufficient and the wood which has accumulated in the fire mouth does not burn completely; carbonic oxide and carburets of hydrogen escape from it, and in the shape of a sooty smoke whirl in the kiln, mixed with the flame which then takes a reddish tint. This is the reducing atmosphere. It gives a greyish tint to porcelain. It would be dangerous to maintain the flame in this condition of saturation with smoke during the whole firing. It is necessary to keep this atmosphere only up to the fall of cone 06 inclusively. In this case the unburnt gases help the colors. They are deposited on and combined with them at the time of the fusion of the glaze. As soon as this vitrification is obtained, the fall of cone 06 occurring at about $\frac{2}{3}$ of the time of firing, one must change to oxidising to clean the kiln of all the carburets, which cannot have a good action any longer. If the reduction was continued much longer, the colors would lose their brilliancy and become blackish.

One will understand how important it is to handle these two firings well, the same colors developing in an entirely different way according to the condition of the atmosphere. So celadon of iron, a delicate jade green in reducing, remains greyish in oxidising. Red of copper, of crimson color in reducing, becomes opale or spotted green in oxidising. Uranium is black in reducing, yellow in oxidising, etc.

Through the handling of the chimney damper and of the

plaques on the fire mouths (Fig. 89 and 90), it will be easy to put into practice the theory which I have just explained. These fire mouth plaques are of the same material as the saggars but fired in the hottest part of the kiln. They must have the same length as the hopper of the fire mouth, and be half as broad as long.

The characteristics of a reducing atmosphere are, inside, flame striated with waves of soot which dim the view, and outside, on top of the chimney, a cap of red and black smoke, formed by the unburnt gases.

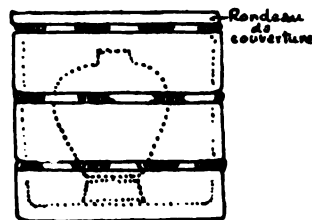


Fig. 91

It is only in the reducing atmosphere that the fine flammé reds are produced. Their development is made easier by the arrangement of saggars. Instead of being entirely cemented with lute, openings from $\frac{3}{4}$ of an inch to 1 inch are left in the wads of lute which hold the saggars together, so that the flame will penetrate the latter and deposit carburets on the cupric glaze (Fig. 91). It is not necessary to saturate the kiln with smoke to obtain fine reds. A light cloud of smoke maintained up to the fall of cone 06 will do. The name of *flammés* has been given to these pieces because, contrary to other pieces, they are subject to the flame during the firing. Reducing firings are from 3 to 4 hours shorter than oxidising, but neither requires the cleaning of live coal out of the fire mouth, this being necessary only in neutral firing. When the coal has accumulated in the fire mouth, while reducing, it is left to burn out, the feeding of fuel being diminished until then.

By faithfully following these instructions, every detail of which has its importance, ceramists will be able to obtain from the fire the finest crimson reds as well as the most delightfully frosty crystalline glazes.

Those who have a baking chamber in their kiln will not

need to give special attention to the baking which will be done while firing. But those who, like myself, have no baking chamber, will proceed as is done for an ordinary firing, without however cementing the saggars with lute. If they want a light baking, they will stop when cone 013 is beginning to curb; if they need a strong hardening, they will stop when cone 013 has completely fallen.

As a conclusion I will call the attention of firers to the following essential points: to obtain a reducing atmosphere, the fuel must be accumulated in the fire mouth, and the exit of the flame must be checked as much as possible. Inversely, for an oxidising atmosphere, just enough fuel must be fed to the fire mouth to allow the progressive increase of the heat and the flame must have perfect freedom of exit.

It is necessary also to adopt a rational feeding of the fuel, and when one of the fire mouths is choked, not to take the coal out, but to even it up, or temporarily diminish the feed, which will give the fire mouth time to absorb its excess of live coal.

VIII—Drawing the Kiln

THE drawing of the kiln is the time of great excitement for ceramists. The fever which has taken hold of them during the preparation of art pieces grows with the progress of the work to reach its climax during the drawing which is the best lesson for future work as well as a succession of childish joys and disappointments. When the firing is finished the kiln is left to cool off during four days. The fourth day the stoppers of the three spyholes are withdrawn, also the stopper A for circulation of air. (Fig. 50). The covers of the fire mouths are loosened and lifted; the chimney damper alone is kept closed to avoid a draft which might affect the pieces. The fifth day the doors are loosened and the sand between them gathered. This sand will be screened for future use.

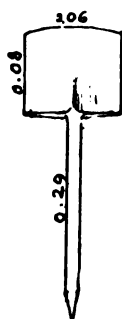


Fig. 92

I generally take the pieces out of the kiln eight days after firing. As each piece is taken out, the placing material is put in order. Broken saggars are temporarily tied with twine (Fig. 69), so that their pieces will not be lost and a few days later this material is thoroughly overhauled. It is cleaned with an instrument called a dressing iron (Fig. 92), the three sharper angles and the angular end of which allow one to remove the vitrified scoriae which may adhere to the saggars.

Most of the pieces of placing material are broken during the firing, but a large part can be used again, as for instance when,

in saggars, the cracks extend only from the heel to the center, and when, in rings, the cracks are distant from each other. Bats broken in two can be used again, but when broken in three, they should be thrown away.

Whatever care has been taken in the casting of bats, many get out of shape and they should be made true so that the porcelains will always rest on a flat surface. The grinding of a bat is an operation which has for its object the removal of all inequalities and hollows. To do this, two bats are rubbed against each other, while the two faces in contact are from time to time sprinkled with grès sand.

Although the white glaze remains where it has been placed, colored glazes which are more fusible, are apt to constantly overflow. To overcome this defect, small columns are used for supports, as I have explained in the article on placing. ✓ After firing, these columns are stuck to the piece, the glaze having flowed over, and they must be detached. If they have been strongly washed with the infusible wash, a sharp blow with a wooden hammer will be sufficient to detach them, and nothing remains to do but to wear and polish the foot of the piece by rubbing it on a steel disc sprinkled with wet grès powder; or it will be easy to find a wheel to do this work, the faience makers using the same instrument.* As I have no power, I polish my pieces on a wheel resting on a wooden support. This operation requires some patience.

I have said elsewhere that the pieces of placing material were violently cracked and broken at each firing. This causes grains of fire bricks to get stuck to the fused glaze. These grains making flaws in the ware must be removed with a carborundum wheel. It is useless, however, to speak of this work which is the same for porcelain as for faience.

Sometimes cracks occur on glazed pieces. If the crack is not too deep, it is possible to fill it. For this filling, pulverized biscuit of hard porcelain is mixed with gum arabic. This paste is worked with an ivory or wood spatula and forced into the crack. After it has dried it is filled again, then it is covered

*Carborundum wheels made specially for pottery work are sold in this country. Care should be taken to buy the proper size of the carborundum grain.—(PUB.)

with gummed glaze and refired in the same conditions as before. With colored glazes, cracks disappear.

Unglazed biscuit never being refired, the cracks must be filled in the same manner, but without refiring. The biscuit flour is then mixed not with gum, but with silicate of soda.

Porcelain has the great advantage of standing 3 or 4 firings without much risk, and even of acquiring more brilliancy at each refiring. It is then easy to repair pieces on which have appeared grains, thinness of glaze, cracks, blisters and even raising of paste, as is often the case for flammé reds of copper when their firing has not been done properly. I have seen Sèvres pieces refired three times. Chaplet has shown me some fine flammé reds obtained at the sixth firing, and I have in my collection ceramics which have stood four firings.

As a rule grès does not stand a refiring well. All the trials I have made with this material have been disappointing. However, when the grès piece has been fired without glaze the first time, in biscuit, one may, with a chance of success, refire it with glaze, but in both cases the firing should be oxidising. It is on a second firing, the first of which is made in biscuit, that crystalline glazes on grès are obtained.* Grès will not stand a second reducing fire. On the contrary porcelain behaves well in many refirings with both atmospheres. But one point must be borne in mind. In order that the refired piece may change its appearance, it must reach a higher temperature than it had in the first firing; its modification by a new pyrochemical combination is possible only on that condition. If it has been fired at the bottom of the kiln it must be refired on top (the hottest part), or if it has been fired on top, it must be refired with a new coat of glaze. In this case it is the new glaze which changes the appearance of the vase.

Pieces decorated with mat or bright glazes can be modified, but those which have been decorated with *pâtes sur pâtes* will keep forever the effect acquired in the first firing. So the *body* colored yellow by uranium, which has turned black on first firing through lack of oxygen, will never again become yellow; its combination in black is permanent; but, the cupric *glaze*

*The distinction between "baking" and "biscuit firing" should be borne in mind. The former is at cone 013, the latter at cone 9 or 10—Pub.

which has turned green through lack of reduction, will become red on its second passage through a reducing fire.

It is evident that when a piece is refired, one must give it supports and columns which have been fired, as there will be no more shrinkage.

After the firing chamber is emptied, the baking chamber is opened. There pieces have been placed in saggars without lute and without supports or bats. The temperature is comparatively low, but this baking is sufficient to give to pieces the solidity which makes their handling easy, while it increases the porosity necessary for a good glazing. All the placing material must pass through the baking chamber before being fired. It is easy to understand that a raw sagger could not stand any load, and that being somewhat larger than the fired one, it could not be placed on top of it.

IX—Grand Feu Colors—Colored Slips—Pates sur Pates

I have now reached the most interesting part of the grand feu art, the colors. Whether a painter, a sculptor or an architect, the ceramic artist must also be a chemist. He may produce the finest models of sculpture or the most beautiful decoration, he may fire in the most even and experienced manner, but he will not succeed if he has not at his service a palette of colors which suits his work. But the palette of the grand feu is not like that of the petit feu; for the latter, one may go to any of the merchants who are numerous in Paris, Berlin, and New York, and secure a rich palette which will compete with the finest tones of oil painting. For the grand feu, each ceramist must mix his own colors or have them experimented on by a chemist who makes a specialty of such work. These chemists are rare and the additional expense of such collaboration is possible only in large manufactories. The researches are costly and are naturally kept secret by the establishments to which they are a source of profit.

The isolated artist, not having any help of this kind, must be his own chemist. If he is fond of research he will certainly succeed, and the whole of his work will gain therefrom harmony and homogeneity.

His work will be simplified by the publications of such men as Brongniart, Ebelman and Salvétat, who in France are authorities.* He will find in these books information which will constitute his starting point and a number of acquired results which he may modify to suit his fancy. He will also be helped by catalogues of chemical products which large firms everywhere offer to the public, wherein the metals, acids and salts constitute a rich mine for varied experiments. These products are offered in a state of the greatest possible purity by reliable industrial firms.

In these articles I have carefully avoided the science of abstract formulae, but on the contrary have adopted the science of immediate and empirical application, which the

*In the United States "Seger's Collected Writings," recently translated into English, will be found a most valuable help.

humblest ceramist will be able to understand. The given data will be certain, the mixtures simple and producing *on the same material* constant effects, according to the firing for which they have been created, but these effects will vary with the body used.

Of course I will leave out every thing which relates to low muffle firings. These are known everywhere, and nothing will be found in them which could be of any use for grand feu ceramics. They are consequently of no interest here, which does not mean that I wish to bring into disrepute an art which has shone with great brilliancy and has given birth to many beautiful works which fill the museums and belong to the history of ceramics. I only mean that these muffle firings having been a step in the evolution toward grand feu ceramics have no *raison d'être* now that the latter have been created, but are repetitions and contrary to the law of progress, which is characterised by a march forward. This forward march opens in ceramics unsuspected horizons, more in harmony with the strenuous fight of mind against matter, and more fascinating in their results. I do not want a better proof of this than the splendid blossoming of grand feu works which has taken place in the last fifteen years, and the favor with which both public and collectors have met this production with its new and surprising effects. Whatever the number of discoveries made during that time, almost every thing still remains to be conquered, and the field cannot be harvested so that newcomers will not find much to glean.

COLORED SLIPS

I have told in a former article how the grand feu palette was developed at Sèvres, and I will now say what this palette is and what a rich field it covers. Under the direction of M. Lauth and of the present Director of Technical Works, M. Vogt, it has already appeared either in scientific publications or the bulletins of "*L'Union Ceramique et Chaufourniere de France.*"

The number of grand feu colors and glazes is limited, because few coloring substances can resist the high temperature for firing hard porcelain and grès. Metals only can supply them. However, as there are 49 known metals with the whole

series of their binary and tertiary compounds, the field of exploration remains fruitful. The first combinations were made by adding the coloring oxides to a porcelain paste mixed with water. The first attempt was made with chrome, the second with cobalt.

Cobalt and its compounds give blue colors. This metal is employed, either as a chemically pure oxide, or in the form of arseniate, carbonate and even phosphate. Variations of tones can be obtained by adding to it colorless oxides, like zinc and aluminum, or by increasing its penetrating power by the addition of nickel.



Grès dish by Taxile Doat. Applied porcelain cameo; center, iron brown with kaolinite pearls; rim, polychrome mat glaze.

Chrome is the basis of greens, from light green or celadon to the dark malachite green. It can be modified by the addition of cobalt and aluminum. Combined with other materials it gives a wide series of tones. Thus pink is a combination of

chrome, tin and aluminum. Combined with lead, it gives yellow; with iron, brown.

Nickel which has a great affinity for cobalt, is almost always found close to it in nature. The brown palette comes from this metal which possesses the greatest power for penetrating vitrified matter.

Copper, a marvelous metal, runs during firing through the whole gamut of the most opposite tones. According to the atmosphere in which it is developed, it gives black, green, turquoise blue and crimson red. It becomes metal, flows, is translucent or opaque, according to the materials with which it is mixed. And if it is the most difficult metal to control, it is also the good fairy of ceramists because of the charm of its unexpected effects.

Iron, so common in nature, is used in all its forms, colcothar, scales, bol d' Armenie, Terre de Sienne, yellow or red ochre, ferruginous silicate of Thiviers, etc. It is the basis for browns, reds and violets. It is both a source of trouble and a providence to ceramists, troublesome because it gets incrustated in the white, and providential because of the variety of tones which it gives to other metals.

Uranium is, like copper, among the erratic metals. It gives both yellows and blacks, going from citron yellow to yellow brown, and from grey to deep black.

Manganese, either common or ferruginous, and pure metallic manganese may enter into coloring combinations. They produce brownish black, violet, reddish brown and yellow. In most cases this coloring gives metallic reflections.

Iridium gives greyish blacks of a great delicacy and of great charm.

Platinum gives to the flux of the body and the vitreous glaze only a lead grey color half-way between the color of silver and that of tin, but it is the only metal which gives fixed tones which vary neither in oxidising nor reducing fires.

The two precious metals, gold (1030° C) and silver (770° C), which melt at comparatively low temperatures, disappear in porcelain firing.

The metals which I have just mentioned are those which have already been used by ceramists as coloring agents, but their combinations are far from being exhausted. And other

metals are just beginning to be experimented on. Molybdenum, ruthenium, titanium, vanadium which have a great future, will tempt experimenters.



Vases—Taxile Doat.

Small porcelain vase, bright apple green glaze flowing over a blueish grey green glaze.

Grès vase, white glaze on top, lower part in biscuit with reddish brown mat crystallizations.

Metallic oxides and their compounds act differently according to the nature of the atmosphere in the kiln. They must be studied for the kind of firing in which they will be used. So uranium gives black in reducing, yellow in oxidising. Copper, green in oxidising, is red in reducing. From this fact it will be seen that the scientific regulation of the kiln atmospheres has doubled the coloring resources. But certain metals,

zinc for instance, are volatilized and completely disappear in a reducing atmosphere.

Ceramists who use only one or two metals have not any mistakes to fear, but those who want a varied palette must carefully label their colors, in order to avoid disappointments such as I had one day when I accidentally used a celadon of copper glaze instead of a celadon of iron. The vase, when passing through a reducing atmosphere, became of a blackish red which concealed all the decoration. This was due to the fact that oxidised or deoxidised gases, according to the atmosphere, favor by affinity the development of one of the metals which enter into the composition.

Coloring oxides may be combined either with the paste or with the glaze. They give different effects with these different combinations.

When the color is mixed with the paste, it forms with it an opaque mass which remains fixed, is not displaced, and allows the superimposition of other pastes. This constitutes what is called *colored slips*.

If the same coloring matter is added to the glaze, the latter becomes more fusible and acquires a tendency to flow, thus making it impossible to superimpose a decoration. This combination gives the *colored glazes*.

These two processes complete each other, as the colored glaze may safely flow over a slip decoration which remains fixed. Colored slips are not of a complex preparation. It is sufficient to add to the white slip a few grammes of coloring oxide and to mix with water.

The greens which I use in the shape of slip are prepared as follows by simple grinding:

<i>Light celadon.</i>		<i>Dark celadon.</i>	
Chrome oxide	2	Chrome oxide	5
PN white slip	98	PN white slip	95
	<hr/>		<hr/>
	100		100

One may go up to 10% chrome. Although these two colors stand both firings, the light celadon is finer in oxidising, and the dark celadon in reducing.

If only a small quantity of slip is needed, the mixture can be made on a rough glass with a muller; and with water.

For a quantity of more than one pound, a hand mill should be used. Chrome slips have a remarkable distinction and delicacy, but have not a great power of infiltration through other pastes. In order to give more delicacy to their combinations, one may add to them from 3 to 5 grammes zinc oxide.

The blue slips which I use are made as follows:

<i>Light blue—</i>	Cobalt oxide	2,50	
	PN white slip	97,50	
			—— 100
<i>Medium blue—</i>	Cobalt oxide	4,00	
	PN white slip	96,00	
			—— 100
<i>Very dark blue—</i>	Cobalt oxide	10,00	
	PN white slip	90,00	
			—— 100

Cobalt has a very great coloring power, but must be ridden of the nickel which it contains and for which it has a great affinity. If on a cobaltiferous slip another colored slip, or simply a white slip, is laid, the latter will be penetrated by the cobalt oxide. This infiltration through a white slip laid over a cobaltiferous slip, has given birth to the process of decoration called *pate sur pate* or applied slips.

Colored slips must have the following qualities: such a degree of plasticity that they can securely be applied to the piece and make a whole with it; coefficient of expansion identical to that of the porcelain itself, so that creasing, blisters and cracks will be avoided. Besides they must be mixed as thoroughly as possible either by grinding or fritting, so that they will give uniform tones without spots or shading.

The mixture by grinding is very simple. It is done with a muller and a palette knife.

The mixture by fritting is more complex and requires practice. A *frit* is the product of the calcination or fusion of many substances, so that they will be intimately mixed and incorporated with each other. It is made in a fire clay crucible. This crucible, containing the substances to be fritted, is placed in the hottest part of the kiln, where it passes through the different temperatures of the firing and undergoes a partial or complete fusion. If there has been only calcination, the crucible, when taken out of the kiln, is simply emptied, and the

calcined product mixed in the mill. But if the materials have fused, they are stuck to the crucible, which must be broken, to allow the gathering of all the vitrified substance which then will be crushed and ground, and will be used in the shape of impalpable flour. It is in the upper part of my kiln that I place the crucibles. If the mixture is liable to overflow, an old bat should be placed under the crucible to protect the placing material. My crucibles are made of placing material (Provins clay and grog) and have the shape of Fig. A, with a spout. I

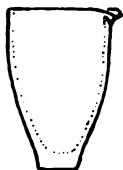


Fig. A.

buy them from Mr. Pollard, rue du Poteau No. 59, Paris. The most useful are about 8 inches high and 4 inches in diameter.*

Dark Blue Slip

Is obtained by thoroughly mixing in the crucible and fusing moderately the following materials:

	Fontainebleau sand	54
<i>Frit</i>	Pure and very white clayey kaolin	45
	Cobalt oxide free from nickel	11

This frit crushed and ground is mixed with the slip in the following proportion:

Clayey kaolin	45	
PN white slip	71	both for oxidising and re-
Frit	57	ducing atmospheres.

A moderate fusion can be obtained by placing the crucible at the bottom of the kiln, a strong fusion by placing it on top, of course in a down draft kiln; inversely in an up draft kiln.

For some very weak frittings, I have made a hole in the bottom of the kiln. Protected by a depth of a foot the crucibles receive a very mild heat. As much as possible I avoid fritting, but it must be admitted that it is the surest way to obtain a

*The plumbago crucibles of the Dixon Graphite Co., Jersey City, N. J., are excellent. (Pub.)

thorough incorporation of the coloring matter with the paste and their intimate mixture. Slips which have not been fritted have a rough appearance and are sprinkled with spots, which are not shown on fritted slips. The latter harmonize better with the precious porcelain material. For this reason fritting is to be recommended, but it is slow and expensive.

Blueish Green Slip

Strong fritting	{ Fontainebleau sand	30
	{ Pure clayey kaolin	22
	{ Chromate of cobalt	7

To be mixed by grinding in a hand mill, if no motive power is to be had.

Mixture	{ Clayey kaolin	43	for oxidising firing.
	{ PN white slip	90	
	{ Frit	55	

Green Slip

Very strong fritting	{ Fontainebleau sand	30
	{ Clayey kaolin	25
	{ Feldspar in flour	75
	{ Chrome oxide	20

Intimate mixture	{ Clayey kaolin	20	for oxidising and reducing firings.
	{ PN white slip	85	
	{ Frit	30	

Mauve Slip

Simple mixture	{ Chrome aluminate	30	strictly oxidising firing.
	{ Feldspar in flour	20	
	{ PN white slip	100	

Chrome aluminate or artificial ruby, composed by Salvetat is obtained by the strong fritting of the following mixture:

Dry alumina	1000
Bichromate of potash	75

Black Slip

Strong fritting	{ Clayey kaolin	50
	{ Chromate of iron	15
	{ Cobalt oxide	6

Mixture	{ PN white slip	75	for oxidising firing.
	{ Frit	30	

Grey of Platinum Slip

	Light grey.		Dark grey.	
Simple mixture	Platinum oxide	2	Platinum oxide	6
	PN white slip	98	PN white slip	94

for oxidising and reducing firings, very fine tone in oxidising.

**Vases—Taxile Doat**

White porcelain, apples in pink slip; leaves, celadon; cover in pale green biscuit. Stand in natural grès, mat brown glaze.

The Three Cupids—Pâte sur pâte cameos on mauve ground, wreaths in celadon slip; grès stand, mat iron wood color.

In all these formulae, the PN body may of course be replaced by any other porcelain paste which will be adopted. But one must carefully avoid putting a color made with a certain slip over a slip of a different composition. It is

better to use for these color mixtures, not the fresh porcelain paste, but the scraps of paste which are gathered on the wheel after throwing. They have the advantage of having been worked and being more plastic.



The Apples of the Hesperides.

Juno's Jewels.

Small pieces in hard porcelain, pates sur pates, by Taxile Doat.

The slips which I have mentioned do not suit grès, as its coefficient of expansion is different, besides they give on grès only neutral, grey tones. *They are exclusive to porcelain.*

Colored slips are applied either on raw or baked pieces, quite thick, *in successive layers*, each layer being dried. They are applied either with the decorating brush or with a fine sponge when large surfaces must be covered. To lay the slip in one coat would be to surely produce crackles and blisters.

It must be laid very carefully in the shape of very thin slip for the first coat, gradually thickened for the following coats. It is mixed in water without the addition of gum.

PATES SUR PATES

Over these slips, which are not displaced in the firing, can be made, by a superimposition of white slip, the fine bas reliefs, which are called *pâtes sur pâtes*, and are known everywhere.

When the design has been traced over the colored slip, either with a pencil or a pouncer, it is covered with slips of white paste laid in successive coats and of different thicknesses according to the effects to be obtained. The water is absorbed by the raw body and the paste is gradually deposited. When the desired thickness is acquired, the paste, thoroughly dry, is modelled with an iron dented chisel such as is used for medal engraving. During the firing the coloring oxide of the under paste penetrates the white applied paste according to its coloring power and gives it in the thin parts a transparency which reminds one of the precious effects of cameo. Blue and green slips possess the greatest penetrating power. For this reason bas reliefs executed over these slips must be made thicker.

Colored pastes being opaque are naturally mat after firing. To give them the necessary brilliancy and glassy finish they must be covered with a glaze, which will preserve them from the injuries of time, and distinguish them from the bas reliefs made in Wedgwood style.

X—Grand Feu Colors.

COLORED GLAZES—FLAMME GLAZES—FLOWING GLAZES.

COLORED slips used on small surfaces give to the decoration a firmness and a character of solidity which are very attractive; but used on large surfaces they impart to a vase a heavy, marble-like appearance. This defect led to researches for the incorporation of color with the glaze and gave birth to colored glazes. Colored glazes are real translucent colored glasses, and the color dissolved in them is, as for slips, derived from metallic oxides. The basis for these glazes is the colorless glaze, called white, with which the porcelain is covered, and into which are introduced by careful grinding and mixing a few hundredth parts of coloring oxides.

If one wishes to obtain the exact value of tone which the formulae in these articles are capable of giving, it is necessary to use oxides free from all impurities. This purification is the duty of technical chemists. The analyses which are necessary in order to obtain the best products are minute and delicate and, consequently, slow and expensive. A ceramic artist cannot undertake them, as he must give his time to the absorbing experiments of his art. He must be, as I am, satisfied with materials as he finds them, avoiding for some tones a certain harshness which is caused by too pure materials, but in other cases submitting to the unavoidable result of impurities.

Cobalt free from nickel gives a fine blue tone both in daylight and artificial light. When it contains nickel, it is duller in the daylight and black in the artificial light. Notwithstanding their purity, the Sèvres blues are black in artificial light, while the old Chinese blue porcelains remain blue in all kinds of light. How did these empirics of genius manage to do it?

At Sèvres, all materials, before being used, are analysed in the laboratory and tried in the fire. This is the secret of the fixity and richness of colors used on the various ceramics which are made at Sèvres. For my own work I have to be satisfied with frittings and grindings made with the greatest care, and

with the greatest possible precision in the conduct of the firing. And it is a great deal to succeed in doing that with modest resources.

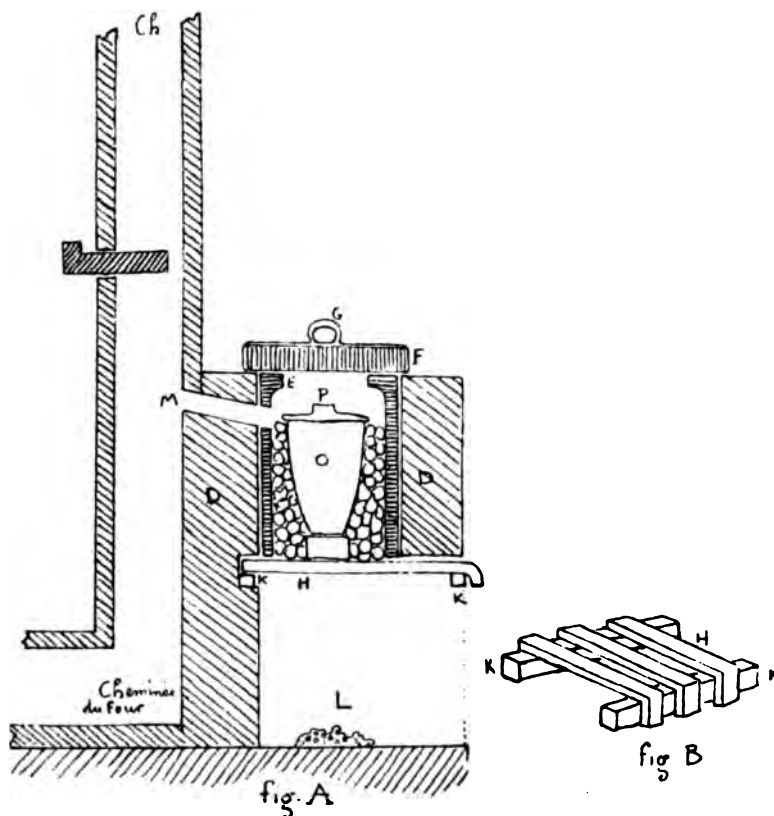
I wish to call the attention of artists to cases in which they will be obliged to modify the formulae given below, which have been worked out for two bodies, PN and Lacroix-Ruaud. As the addition of a coloring oxide to a glaze changes its fusibility and its coefficient of expansion, the mixture must be so arranged that it will fire at the same time as the body, without crazing, and this can be done only by careful experimenting. But whether these formulae are used as I give them, or modified, it is important to maintain the degree of plasticity which makes the glaze adhere to the body. For this, only a small part of the elements should be fritted, and the rest should be added by simple mixture. The intensity of the color is based, not only on the quantity of coloring matter, but also on the proportion of chalk which it contains, the latter varying more or less according to the fusibility given to the glaze by the oxide.

The fritting of colored glazes cannot be done in the kiln, as was the case with colored pastes, because it must be watched, and the fusion stopped or continued, according to circumstances. Frits are made in a special kiln.

This kiln is a blast kiln (Fig. A), communicating with the chimney of the regular kiln, so as to get the advantage of its intense draft. The kiln is vertical and cylindrical, entirely constructed with fire bricks D and contains a fire clay cylinder E open at both ends. The upper part is closed with a fire clay plaque F with iron bands and a handle to allow of easy lifting. The lower part rests on square iron bars, about $1\frac{1}{4}$ inch apart, to give free passage to ashes and air. These bars rest themselves on two cross bars K fixed in the wall. The bars of the grate can easily be removed to clean the kiln. (Fig. B). The ash pit L, formed by the space below the bars, is wide open in front. The fuel is coke which is placed around the fire clay crucible O. The top of the kiln communicates with the chimney through an oblique opening M made through the thickness of the wall. It is easy to watch the fusion of glazes by lifting up the cover P of the crucible with flat pincers.

The number and size of crucibles determine the size of the kiln. The one which I use is 18 inches high by 10 inches

inside diameter. I use crucibles No. 20 which are 14 inches high and $6\frac{1}{2}$ wide and make it possible to melt 20 pounds of material. The crucible is placed on a fire clay plaque which holds it in the center of the fire mouth. This kiln is very economical.*



*In this country, where oil is a cheap fuel, the little test furnace made by H. J. Caulkins & Co., of Detroit, Mich., will be found very useful and economical for crucible work. It can either be used for fritting, or by the insertion of a small muffle, can be transformed into a small kiln for tests and experiments on porcelain. The gas furnaces of the Buffalo Dental Mfg. Co are also suitable for fritting.

Hard porcelain fuselé vase by Taxile Doat. Top bright white glaze, lower part mat reddish brown, with kaolinite pearls. Grès stand, mat ironwood color, with kaolinite pearls. Stopper in fruit shape porcelain, mat reddish brown.



All the following preparations for colored glazes should be thoroughly mixed.:

Blue:

Quartz sand of Nemours	30,5	} strictly oxidising.
Dry clayey kaolin	20	
Ordinary washed chalk	24	
Grand feu blue frit, as below	30	
Frit: Dry and pure cobalt oxide	20	
Feldspar in flour	80	

Brown:

Sand	30,5	} oxidising
Dry clayey kaolin	20	
Chalk	19	
Scale brown grand feu frit, as below	33	
Frit: Manganese oxide	15	
Calcined umber	20	
Feldspar in flour	65	

Black:

Sand	30,5	} oxidising
Dry clayey kaolin	20	
Chalk	24	
Grand feu blue frit	6,5	
Frit as below	25,5	
Frit: Feldspar in flour	30	
Chromate of iron	6	
Chromate of cobalt	3	
Cobalt oxide	3	

Yellow:

Sand	30,5	} oxidising
Dry clayey kaolin	20	
Chalk	22	
Frit as below	20	
Frit: Feldspar in flour	30	
Nitrate of uranium	8	

Pink:

Sand	30,5	} oxidising
PN slip	47	
Chalk	24	
Tin pink as below	7	
Tin pink: Tin oxide	100	
Chalk	34	
Bichromate of potash	3 to 5	

The preparation of this tin pink presents difficulties. It should be mixed by pouring the dissolved bichromate over the tin oxide and chalk, then the mixture should be strongly calcined, and washed until the water is colorless. The quantity of bichromate varies according to the more or less hydrated condition of the chalk. In my preparation of this glaze 3 parts bichromate are enough because I dry the chalk in a baking fire and keep it protected from moisture.

Blue celadon:

Sand	30,5	} very oxidising on account of copper.
Dry clayey kaolin	20	
Chalk	24	
Frit as below	29,5	
Frit: Feldspar in flour	30	
Copper oxide	1,5	
Tin oxide	2,7	
Iron oxide	0,3	

Grey celadon:

Sand	30,5	} very oxidising on account of copper.
Dry clayey kaolin	20,5	
Chalk	24	
Frit as below	38	
Frit: Feldspar in flour	30	
Copper oxide	4,9	
Tin oxide	8,2	
Iron oxide	0,9	

All the above glazes have been created for oxidising fire and burn between the fall of cone 9 and bending of cone 10. Having been prepared for porcelain, *they do not give good results on gres.*

The following series of colored glazes will suit grès, having been created at Sèvres for the coloration of the large grès frieze which adorns the facade of the Grand Palais, on Avenue d'Antin. The body exerting a great influence over the glaze, a special palette had to be created for the execution of this frieze.



The Springs, hard porcelain dish, Taxile Doat. Cameo on green background. Center, clouded red of copper. Rim, yellow brown with flowing white streaks.

The substances which enter into the composition of these glazes do not require the slow and troublesome work of fritting, as they are simply mixed. All the following formulae belong to the manufactory of Sèvres, and are of easy execution:

Colorless glaze for grès:

Is made by mixing and grinding together in water, the following substances which can be bought from Mess. Poulenc

Freres, Paris, and which must be as thoroughly pulverised as possible:

Feldspar from the Pyrenees	42,1
Quartzy sand of Nemours	27,2
Dry clayey kaolin of Limoges	13,0
Chalk from Bougival	17,7

The Nemours sand is nearly pure silica, and the kaolin which enters into this composition is an hydrated silicate of alumina.

Like the other glazes, these grès glazes are applied either on raw or baked ware, after having been diluted in water thickened with a little gum tragacanth.

Cobalt blue for gres:

Cobalt oxide	3,0	} oxidising
Bougival chalk	14,1	
Feldspar from the Pyrenees	42,1	
Quartzy sand of Nemours	27,2	
Dry clayey kaolin of Limoges	13,0	

Manganese violet brown for gres:

Manganese brown oxide	5,0	} oxidising
Chalk	13,0	
Feldspar	45,0	
Quartzy sand	28,5	
Dry clayey kaolin	11,0	

Nickel reddish brown for gres:

Carbonate of nickel	3,0	} oxidising
Chalk	15,3	
Feldspar	42,1	
Quartzy sand	27,2	
Dry clayey kaolin	13,0	

Uranium yellow for gres:

Uranium oxide from the calcination of uranate of ammonia (a very im- portant point)	5,0	} oxidising
Chalk	17,7	
Feldspar	42,1	
Quartzy sand	29,3	
Dry clayey kaolin	8,5	

Iron yellow brown for gres:

Pure red oxide of iron	5,0	} oxidising
Chalk	13,0	
Feldspar	45,0	
Quartzzy sand	28,5	
Dry clayey kaolin	11,0	

Chrome green for gres:

Green chrome oxide	1,0	} oxidising
Chalk	17,7	
Feldspar	42,1	
Quartzzy sand	28,0	
Dry clayey kaolin	11,3	

Copper green for gres:

Copper oxide	4,0	} oxidising
Chalk	12,7	
Feldspar	42,1	
Quartzzy sand	27,2	
Dry clayey kaolin	13,0	

By simple mixture of these fundamental colors, it is easy to obtain an unlimited range of tones, and to dilute them with colorless glaze to bring them to the desired shade. For instance a *flesh tone* will be obtained by the mixture of

Manganese glaze	50
Colorless glaze	50

a violet grey by the mixture of

Nickel glaze	10
Cobalt glaze	3
Colorless glaze	87

a blueish green by the mixture of

Chrome glaze	30
Cobalt glaze	3
Colorless glaze	67

a golden brown by the mixture of

Manganese glaze	50
Iron glaze	50

These few examples show what an artist fond of experimenting may do with these glazes made each from one oxide, but which can be combined ad infinitum.

The grès colored glazes must be fired in an oxidising atmosphere to keep the quality of their tones.



Flammé copper vase, Taxile Doat. Shading from black to white and having at base a band of rich crystals.

FLAMMES OR FLAMBES

This name is given to glazes which derive their coloring power from copper and iron, and which during firing, are submitted to the constantly changing influence of the flames which circulate in the kiln. After firing they present variable effects, according to the more or less oxidising or reducing action of the flames, also to the pyrochemical combinations which the various elements of these glazes produce together. It is easy to understand that at the high temperature at which these combinations are formed, it requires the greatest care to avoid the oxidising of a metal as sensitive as copper, which is turned green by an oxidising action lasting a few hours. Hence the unlimited variety of flammés.

I have explained in the article on firing how to obtain a reducing atmosphere at will.

The red cuprous glaze is prepared in a special way because it contains substances which are soluble in water. The matters which compose it must be combined in the crucible.

The following should be thoroughly mixed and fused:

Pegmatite (feldspar)	108,0	} strictly reducing
Quartz sand of Fontainebleau	126,0	
Zinc oxide	15,5	
Carbonate of barium	36,0	
Fused borax	45,0	
Dry carbonate of sodium	16,5	

After fusion, the glass thus obtained is pulverised and colored as follows:

Ground glass	10,000
Oxalate of copper	0,200
Calcined tin oxide	0,100

This new mixture is carefully ground so as to form a homogeneous mass, and the glaze is applied, quite thick, on the raw ware, with the brush and gum tragacanth.

Whatever the care given to the preparation of this erratic glaze and to its firing, it is difficult and very rare to obtain pieces identical in tone, even when they closely resemble each other. However Chaplet has shown me two flammés which were absolutely identical on their four faces, although each of these faces was of a different tone. I must add, however, that these two pieces were only 2½ inches high and had been fired side by side in the same sagger.

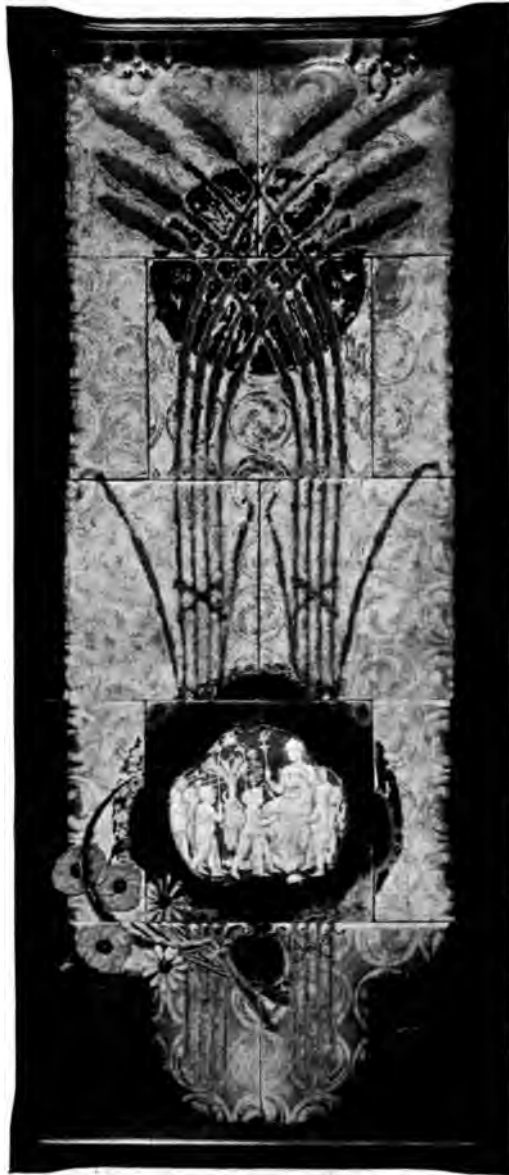
But if flammés can give a succession of deceptions, they also give a succession of unexpected and fascinating results.

Reds of copper will develop on both bodies, grès and porcelain. I have obtained them on both, but flammé red porcelains possess a brilliancy and freshness which is given them by the underlying material and makes them superior to flammé red grès.

Among flammés are the celadons of iron. These are produced by the introduction into the glaze of 1 to 3% iron oxide. Just as for the reds of copper, a strictly reducing atmosphere is necessary and saggars must have spaces free from



Panel in kaolinic grès by Taxile Doat, purchased by the French Government for the Musée du Luxembourg. Subject: Venus. Figure and small flowers in white pâte sur pâte on green ground. Decoration of small squares in mat and bright yellow. Cartouche and columbines in mat pale blue speckled with rust.



Panel in kaolinic grès, by Taxile Doat, purchased by the French Government for the Musée du Luxembourg. Subject, Ceres; white pâte sur pâte on lapis-lazuli blue ground. Lambrequin, mat light green with scattered wheat heads in yellow bright glaze. Cartouche, mat crystalline dark brown with red poppies, white daisies and the sickle in golden yellow. The wheat stems, which cross each other on a disc of bright glaze, are yellow with snowy white on edges.

lute (Fig. 91) to allow the flame free access into them. The greatest part of the old Chinese and Korean celadons were thus obtained with iron. These celadons are finer on grès than porcelain, especially when the glaze is calcareous.

Here is the formula of flammé celadon of iron, which resembles the Korean celadon and may be seen on some of my grès vases:

Sand	33,35	} to be strongly fritted.
Chalk	19,70	
Feldspar in flour	26,30	
Clayey kaolin	8,60	
Red ochre of Burgundy	12,00	

FLOWING GLAZES.

The use of borax in flammés has led the Sèvres chemists to study the combinations of this substance with other oxides and its influence upon their development. By superimposing a boracic glaze over a colored glaze, one obtains this curious series of marbled effects, the shade of which varies with the glazes used, while the greater fusibility of the boracic glaze provokes the flowing and sliding of both, so that they mix their colors in the most unexpected and harmonious way.

The use of this process of decoration requires much practice in the disposition in spots or clouds of the boracic glaze over the ordinary glaze, also in the thickness which must be given to obtain artistic and pleasing effects.

The fire does not act here as in the case of flammés. It only determines the flowing of boracic glazes and the results will be to a great extent unexpected, according to the time of firing and the variable thickness of the color.

First, one or many colored glazes should be applied on the raw ware, as evenly as possible. When the piece is thoroughly dry, a coat of boracic glaze is applied over the colored glaze, its thickness depending on the kind of effect which is looked for.

Interesting results may also be had by applying a thin coat of boracic glaze between two strong coats of colored glazes of a different nature. These glazes do not give as good results on grès as on porcelain.

For boracic glazes, as for flammé reds, it is necessary to place the vases on high columns, and to wash these thoroughly

with the infusible wash (50% calcined alumina, 50% washed kaolin). As for reds also the vase must be thick, so as to avoid cracks, which, during firing, might be provoked by the thickness of glaze, the latter forming a kind of cuirass on the vase.

The preparation of boracic glazes is made by means of a flux to which, in a second fusion, are added the coloring oxides. Here is the formula of this flux.:

Feldspar in flour	40
Sand	40
Borate of sodium, fused and pulverised	12
Chalk	18

This flux being the key to these very simple combinations, it is unnecessary to give them in detail. Each person will mix with it, to suit his fancy, coloring oxides in the proportion of 2 to 4%, and then will frit the mixture mildly.

Coloring oxides which give the richest effect are copper, manganese and cobalt. The most successful superimpositions are boracic glazes with copper or manganese over the black or the brown glaze; or boracic glaze with cobalt over the yellow or the pink glaze. The boracic glazes which I use on my pieces contain 4% of coloring matter. These flowing glazes develop in an oxidising atmosphere.

XI--Grand Feu Colors

MAT GLAZES

IN addition to the rich palette which develops on grès only in an oxidising fire, it was natural to determine a mat palette which would do well in a reducing fire, as grès naturally likes a reducing atmosphere and receives from it its superior qualities of a fine blueish grey tone and a great density. Besides, grès being combined with other materials in architectural construction, a mat tone harmonizes better with the character of stone and brick. The following glazes are prepared by simple mixture and grinding:

Mat colorless glaze, slightly opaque:

Feldspar in flour,	30,0
Dry pure clayey kaolin,	40,0
Nemours sand,	28,5
Chalk,	20,0

Mat ivory yellow:

Feldspar,	35,7
Dry pure clayey kaolin,	13,7
Nemours quartz sand,	43,6
Chalk,	15,9
Ground natural rutile*,	9,6

Mat yellow:

Feldspar,	53,0
Clayey kaolin,	14,0
Quartz sand,	14,1
Chalk,	25,5
Rutile,	9,6
Red oxide of iron,	2,4

Mat reddish yellow:

Feldspar,	53,0
Clayey kaolin,	14,0
Quartz sand,	14,1
Chalk,	25,5
Rutile,	9,6
Red oxide of iron,	4,8

* Rutile is one of the three forms of titanium dioxide. (Pub.)

Mat violet speckled with yellow:

Feldspar,	33,60
Pure clayey kaolin,	12,89
Quartzzy sand,	47,00
Chalk,	15,00
Rutile,	6,00
Red oxide of iron,	6,00

Mat crystalline yellow brown:

Feldspar,	33,60
Pure clayey kaolin,	12,89
Quartzzy sand,	47,00
Chalk,	15,00
Rutile,	9,60
Red oxide of iron,	9,60

Mat crystalline dark green:

Feldspar,	30,85
Clayey kaolin,	25,35
Quartzzy sand,	36,00
Chalk,	28,00
Rutile,	18,00
Cobalt oxide,	12,00

Mat blueish grey green:

Feldspar,	53,0
Clayey kaolin,	14,1
Quartzzy sand,	14,0
Chalk,	25,5
Rutile,	12,0
Cobalt oxide,	1,2

It is with these mat glazes that the great architectural fragment exhibited by Sèvres at the Exposition in 1900 was executed. It is also with these mat glazes that I decorate most of my ceramics. They make a pleasing contrast with the bright glazes used on part of a vase, and resemble more closely the mat effects of nature.

CRYSTALLINE GLAZES

After these, I must mention the crystalline glazes which have been received with such favor by collectors and the public at large. As a result of the researches made at Sèvres, these glazes can be obtained easily, even on large pieces, on grès as

well as porcelain. As in the case of reds, the substances which form their composition must first be fused.



Sèvres. Small pieces in hard porcelain with crystalline glazes of a most charming effect.

In order to vary the relative proportions of zinc oxide and potash, which are the fundamental components of crystalline glazes, and to establish the proportions most suitable to the formation of fine crystals, the two following mixtures are prepared:

	Frit No. 1	Frit No. 2
Dry carbonate of potash,	138	69
Zinc oxide,	162	202,5
Quartz sand (silica),	360	350

These are fused in an oxidising fire, then various mixtures of No. 1 and No. 2 can be tried.

The mixture which gives me the best results is:

Frit No. 1	85
Frit No. 2	15

It is necessary, especially for porcelain, to apply this glaze

on biscuit fired pieces, to avoid warping and cracks which would occur, if the glaze was applied on raw or baked ware. The coat of glaze must be quite thick, so that an excess of glaze will flow during firing, and the piece should be placed on a high column made of lute or scraps of porcelain paste.

The presence of zinc oxide in this glaze makes it necessary to have a strictly oxidising atmosphere, and the temperature at which it will develop, is that of new porcelain, 1310° C., or Seger cone 9. A slow cooling favors the development of crystals.

I also use a yellow crystalline glaze which gives me very fine results. It is made by a fritting of the same elements with the addition of rutile:

	Frit No. 3
Dry carbonate of potash,	138
Zinc oxide,	162
Quartz sand,	300
Rutile	82

In this case I mix the glaze as follows:

Frit No. 2	15
Frit No. 3	85

If in Frit No. 3, rutile is replaced by pure titanium oxide, one obtains a colorless crystalline glaze, somewhat different from the first as to the appearance of crystals, and which is of great beauty.

These crystalline glazes, besides the artistic use which can be made of them for the decoration of small cabinet pieces, may be advantageously used in the decoration of tiles for architectural purposes, and give the latter a richness which has never been equalled by any other construction material.

I am satisfied that ceramists who will carefully prepare all these fine glazes, will find the different processes which I have mentioned, a very useful guide. But one must not forget that all these preparations require some practice, strict weighings on accurate scales, pure materials, very finely ground so that their mixture will be thorough, also frittings made with the most minute attention. All these operations constitute an expenditure of time and labor, and it is to be regretted that chemists do not undertake the production of all the compositions which enter into the decoration of ceramics. I am sure

that they would find it profitable, and it would free artists from this complex work, which restricts their art production.



Hercules, hard porcelain plaque by Taxile Doat. Cameo on blue turquoise ground. Lion mane in mat yellow brown; center, rutile crystalline glaze. Rim, mat blueish grey green.

Although the formulae contained in these articles have been studied for the PN porcelain body and the Sèvres grès, and strictly suit them both, artists, especially if other bodies are used, will need to experiment constantly with colored pastes and glazes. For such trials they will find it convenient to use a kiln in which firing will be rapid. I have adopted for this work the small Perrot laboratory furnace, the fuel for which is gas. It will hold six small sample tiles or a small vase 4 inches high and 2 inches wide. The temperature reaches uniformly 1300° C., and the atmosphere is reducing or oxidising at will. Porcelain is fired in it in two hours. This

furnace is made by the firm of Mr. Wiesnegg, 64 rue Gay Lussac, Paris, in five different sizes. I use No. 3, which is more exact in its results, and costs 215 francs (about \$40). In this furnace frittings can also be made.



Grès vases—Taxile Doat
Crystalline and truité mat white glaze. Mat white glaze with moss like crystals.

I have now reached the end of my story which, it is earnestly hoped, will contribute to the advancement of the potter's art. This art is a part of human attainments which ennoble man, are necessary to him, and which permanently perpetuate the history of humanity. It is from fragments of the potter's works, found in the ruins of ancient civilizations, that human evolution is reconstructed. And it is to be regretted that these fragments, which have been preserved only in the burning sands of dry climates, have not been made of less destructible material than faience. We would then have numerous documents to tell us the obscure history of the Middle East, of the great Asiatic uplands, the cradle of man.

Better favored by the richness of its soil and the precious quality of its clays, the Extreme East, China, affords us ceramics which, although 4000 years old, have not lost any of their

freshness, their brilliancy or sonority. The sinister crazing, forerunner of ruin, an open door to the disintegrating humidity, has not touched them.

It is the duty of our century, illuminated with science, to use this science for the technical development of wares which will survive, notwithstanding our damp and destructive climate.



Hard porcelain dish by Taxile Doat. Comic mask. Cameo on nickel green ground. Center, white crystalline and truité glaze. Rim, yellow crystalline glaze.

This goal is reached by the adoption of the finest of clays: kaolin. Its advance has been slow, its study bristling with difficulties, but it is beginning to take its place. Alone with its worthy partner, grès, porcelain possesses, besides its great beauty, this inalterability which will defy the wear of centuries.

These indestructible materials had to be enriched with glazes which would also resist the attacks of time. Modern

chemistry is doing this fascinating work. Empiric and scientist, everybody, is bringing his formulae to this edifice of beauty, which progressive publications are anxious to unravel, by advocating the logic and charm of the grand feu. And the day is not far off, when Occidental ceramics, besides their fundamental quality of inalterability, will be "brilliant as a mirror, thin as paper and sonorous as a musical instrument," according to the Chinese poet. They will have also the splendor of Persian faïences, the sumptuousness of Hispano-Moresque wares, the richness of Italian potteries and the variety of the muffle fire palette.

I will conclude by saying that ceramists who will take their inspiration from this work, and follow the instructions very carefully, are sure to obtain a first result, perhaps shapeless, because they will lack the practical teaching, the use of clay paste and the right handling of their kiln, but there is no doubt that after a few firings they will begin to see through the complex details which form the technique of grand feu ceramics. At first they may use the PN paste for casting, made by Mr. Frugier, and fire a few simple shapes in the Perrot gas furnace. Thus their first experiments will be made at a very small cost. When they are sure of these first results they can build a coal kiln and pursue their experiments on bodies and colors. After a few coal firings, they will be able to transform the fire mouths into fire mouths for wood, and having mastered the handling of their clay and kiln, they will be able to give a personal touch to their work.

It will be a pleasure for me and the best of rewards, if I succeed in making converts and in reducing their first expenses to a minimum.

1

American Clays

FOR

GRAND FEU WARES

BY

Prof. Charles H. Binns

Of the School of Ceramics, Alfred, N. Y.

American Clays for Grand Feu Wares

THE chapters by M. Taxile Doat are of the highest importance to every one interested in the progress of the ceramic art. Coming, as they do, from the pen of one who has himself performed those things whereof he writes, they constitute the most important pronouncement upon the production of hard porcelain which has appeared in the English language. Any one who has seen and handled M. Doat's dainty creations cannot but feel a glow of gratitude towards him for having with the utmost generosity laid bare his art to the brotherhood.

It is with the view of making the work of the famous Frenchman more useful to his American readers that these lines are penned, for it is very evident that clays and pastes cannot profitably be imported by those who desire to take advantage of the information given in the treatise. Nor is there need of this for our own land contains clays as fine as any in the world and in the school over which the writer presides beautiful porcelains have been made from purely native materials.

AMERICAN CLAYS FOR PORCELAIN AND KILN USE.

Porcelain clays containing no ball clay are very short and must be aged and well worked to develop plasticity. Fortunately however, we in America are placed under a considerable advantage in the possession of our Florida clay. This clay, while in reality a ball clay, having been washed away from the site where it was formed, is virtually a kaolin with a high plasticity. It may be obtained by the barrel from the Golding Sons Co., Trenton, New Jersey, or East Liverpool, Ohio, it is called simply Florida clay.

The following kaolins are suitable for use in porcelain bodies:

Harris Kaolin, the Harris Clay Co., Dillsboro, N. C.

Georgia China Clay, I. Mandle, Clay Merchant, St. Louis, Mo., or John Sand, East Liverpool, O.

Delaware Kaolin, the Golding Sons Co., Trenton, N. J., and East Liverpool, Ohio.

Ground flint and feldspar may be obtained from the: Illinois Mineral Milling Co., East St. Louis, Illinois.

The Golding Sons Co.

The Eureka Flint and Spar Co., Trenton, N. J.

The Brandywine Summit Kaolin and Feldspar Co., Brandywine Summit, Pa.

The chief difficulty which will be met with in these last



Group of Porcelains by Mrs. A. Alsop-Robineau.* Crystalline glazes.

named materials is that they are rarely found, in commerce, ground fine enough for use in porcelain. Hence it is important that the maker of porcelain should instal some kind of grinding machinery.

Porcelain is an exotic in this country and the pastes cannot be bought ready prepared as they can in France, moreover, the making of porcelain is an art of extreme difficulty and half the battle is in starting right. One who is unable to undertake a reasonable outlay at the beginning has but small

Mrs. Robineau's porcelains are the result of experiments made during the publication in *Keramic Studio* of M. Doat's treatise. The body is hard porcelain made of American clays; the fuel is oil; the ware is fired at cone 9 in a Revelation kiln made by H. J. Caulkins & Co., Detroit, Mich.

prospect of success and it is best therefore to carefully count the cost.

Porcelain can be made at temperatures ranging from cone 9 upwards, cone 13 being as high as one has ever need to reach. The limit is not in the body composition but in the glaze. Translucent white wares can be made as low as cone 4 but the true porcelain glaze is one without lead or boracic acid and this cannot be produced, in the present condition of the art, below the temperature named. The mixture for a porcelain body to mature at cone 13 will be somewhat as follows:

Harris Kaolin	25
Georgia Kaolin	20
Florida Clay	15
Flint	25
Feldspar	15

and for lower fires the feldspar must be increased and the kaolin lowered.

The two kaolins are not absolutely necessary, but better results are to be obtained by using both than by either one alone.

A porcelain glaze for cone 13 will be the following:

Feldspar	25
Whiting	11
Kaolin	19
Flint	45

For lower fires the kaolin and flint should be reduced.

Success in porcelain making depends, as will be gathered from M. Doat's chapters, upon the proper proportion and use of saggers and other placing material such as rings, bats and props. No cheap clay will do for these, for the stress of the fire falls upon them and if they fail the whole of the labor will be lost. Many highly refractory sagger clays exist in the country, some of these are in use as glass pot clays and, while too expensive for factory use, may well find a place in the studio. Some of these clays are mined in a hard rocky form and must be purchased in ground condition or they will be useless. The following list of merchants and their products comprises all that will be necessary:

The Warrenite Co., St. Louis, Mo., ground Warrenite.



PORCELAIN BOWL AND VASE—Mrs. A. ALSOP ROBINEAU

Bowl, outside and edge mat brown; design incised in white; center, green crystals on pink ground.

Vase, 9 $\frac{1}{4}$ inches high—Flying fish catching drops of rain; upper part mat brown; lower part dark mat green; fish and drops of rain, mat blue.

The Christy Fire Clay Co., St. Louis, Mo., ground glass
pot clay.

W. H. Cutter, Woodbridge, N. J., sagger clay.

I. Mandle, St. Louis, Mo., Tennessee ball clay No. 1.

The Golding Sons Co., Trenton, N. J., Florida clay.

The Christy clay and Warrenite are not suitable for use alone, but are most valuable in mixtures; some plastic clay is necessary to combine with them. Tennessee ball clay is the most plastic in the list but not refractory enough for use alone. Florida clay is both plastic and refractory but expensive.

An important factor in the blending of sagger clays is "grog." This is the name given to any burned clay which is crushed and added to the mixture. The object of this is two-fold, it helps to diminish shrinkage and thus to keep the forms true and it adds to the porosity of the pieces and permits the passage of kiln gases, thus making the fire more effectual. The preparation of grog is important. At first it must be made of pure calcined clay. After one or two burns the supply of broken bats and saggars is more than sufficient to supply grog.

In making grog for a beginning, the fragments of clay should be reduced to the proper size before burning as the dust can be used in mixing and there is no waste. Two sizes will be needed; for saggars the grog should range from the size of ground coffee to that of split peas, for bats and supports from the size of ground coffee to that of mustard seeds. A coffee mill is, by the way, an excellent tool for grinding the smaller sizes and an adjustable mill can sometimes be set wide enough for even the split pea size. Three sieves are necessary, having respectively eight, fourteen and twenty meshes to the linear inch. These can be made to lock together, the coarse one at the top, so that the whole sifting is but one operation. The crushed clay is placed on the coarse sieve, that which will not pass is re-crushed, that which lies upon the second is used for saggars, and that upon the third for bats and props. The dust passing through the third sieve is returned to the clay box for use as clay. The two sizes of clay grains are now collected, placed in jars and burned at as high a temperature as may be available. The jars must of course be made of a good refractory clay. Such jars or crucibles are always useful and if, when practising at the wheel, a dozen or two of these be

made as trials, they will prove a great satisfaction, they can be used many times.



Porcelain Vase and Stand by Mrs. A. Alsop-Robineau.
Vase in brown crystalline glaze with green crystals on neck.
Stand in mat black glaze, crabs in mat reddish brown.

In using sagger fragments for grog the same process is gone through except that the burned clay is harder to crush. In this case the dust is useful for various purposes. It can be mixed with the clay for lutes or can be worked up with a little plastic clay to use as stopping for cracks in the kiln. Of course the sagger clay itself can be used for wads but wad clay is needed at every burn while sagger clay, when once the supply of saggars is made up, may not be required for some time. For saggars the following mixture will be found good:

Ground Warrenite	2	parts by measure
Coarse grog	2	" "
Tennessee ball clay	1	" "
	or	
Ground Christy clay	1	" "
Tennessee ball clay	1	" "
Coarse grog	2	" "

For bats the same mixtures will answer but fine grog should be used. And for lutes or wads the grog is replaced by sagger dust. These mixtures cannot well be made as slips in the manner recommended for bodies because the grog would settle out. The best way is to mix thoroughly in the dry state and then to form the clay batch into a ring like the banks of a pool. Fill the pool with water and allow it gradually to soak into the sides. The clay can thus be worked up into a plastic mass without loss and with the minimum of "muss."

Sagger making is not easy. It demands considerable strength and skill but of course it is not impracticable even in the studio. M. Doat says the sagers may be thrown upon the wheel. The objection to this is the coarse grog which would cut the hands badly. In practice they are made by rolling a sheet of clay around a wooden drum of the right size. Care must be taken, however, to see that they are straight and true. For this they should be set on the wheel and turned with a steel tool. Bats may be either beaten out and cut or pressed into plaster molds. These are of course burned before use. Not so the porcelain bats upon which delicate pieces are set. The essence of these is that they shall contract with and at the same rate as the porcelain itself, hence they are made of the same clay and used before burning. Soiled scraps of porcelain clay should be set aside for this purpose. The stains and spots of impurities will not affect the shrinkage and good clay will be saved.

AMERICAN GRÈS

The composition of the paste for grès differs from that used for porcelain mainly in the fact that the former is nearly, if not quite, a natural clay while the latter is a mixture more or less elaborate. The chemical analysis, however, of a grès paste would not greatly differ from that of a porcelain. The main point of divergence would be the amount of iron contained. The porcelain paste contains less than one per cent.; the grès often as much as two per cent. or even more. A fragment of pure kaolin will bear an intense heat without losing its porosity. It is of such a refractory nature that the porcelain fire would not suffice to produce translucency. It is therefore necessary to make an addition of some fusible

mineral to the paste in order that the desired vitrification may be secured. The mineral almost exclusively used for this purpose is feldspar of which a porcelain paste contains from 15 to 30 per cent., according to the heat which it is to undergo. A natural porcelain paste, white and containing the requisite amount of fluxing material, does not exist—except for the alleged natural porcelain in Japan—and it must therefore be artificially produced. This is done by mixing the proper proportions of kaolin, feldspar and quartz, having due regard to the fire it is proposed to use and to the nature of the result required.



Group of porcelains by Mrs. A. Alsop-Robineau.

Mat glazes.—The large vase in center is a thrown piece 12½ inches high in mat brown glazes of various shades with fine mat crystallisations on upper part. Stand in mat brown.

The clays used for grès contain exactly the ingredients which kaolin lacks but they are unsuitable for porcelain because they do not become white in the kiln. The manufacture of grès belongs then to the category of coarse or natural wares and it is the more to the credit of the successful artist who takes this crude material and fashions it as he will.

The characteristics of a clay suitable for grès are not hard to ascertain but it will be necessary to consult a chemist if reliable information is sought. The first point to consider is the fluxing content. There are several of the constituents of a clay which contribute to its power of vitrification. Iron, lime, magnesia, potash and soda all occur in clay and each is, under certain conditions, a flux. Kaolin, feldspar and quartz as used in porcelain contain only potash and soda as fluxing ingredients, sometimes only one of these but more often both, therefore an endeavor should be made to find, in a clay to be used as grès, the amount of fluxing material which shall be equivalent to that found in porcelain. This of course presupposes that the same fire is to be used in each case but as a matter of fact the fire undergone by porcelain is usually much more severe than that to which grès is subjected. The reason for this is in the endurance of the clay.

The shortest and most accurate way to compare the composition of porcelains and grès is by means of the analysis. In a work on Ceramic Technology published in London by the writer, certain analysis of typical porcelains are given, among which are the following:

	Meissen	Limoges	Chinese
Silica	58.50	70.20	69.00
Alumina	35.10	24.00	23.60
Lime	.30	.70	.30
Magnesia	trace	.10	.02
Iron	.80	.70	1.20
Alkalies	5.00	4.30	6.20

Now, the question is, "Can any single clay be found in America which shall closely approach any one of these compositions?" Here are some native fire clays:

	New Jersey	New Jersey	Pennsylvania
Silica	65.85	65.70	63.43
Alumina	29.48	28.97	30.23
Lime
Magnesia
Iron	.85	1.55	1.38
Alkalies	3.47	3.75	4.91

The chemical resemblance between the porcelain pastes and the natural clays is quite remarkable but this does not of

necessity mean similar behavior. One of the most important factors in a clay, as governing its points of fusion, is the size of the grain. A clay containing coarse sand will, other things being equal, be much less fusible than one in which the sand is fine. There is also the question of color. It may, in fact, be said that the main difference between a porcelain paste and a grès clay is the color. Nor is this color wholly dependent upon iron as some have supposed. For example, the Chinese paste contains more iron than the first clay given and yet it is very



Group of porcelains by Mrs. A. Alsop-Robineau.
Crystalline glazes.—The lamp and shade in center are thrown pieces decorated with green crystals on brown ground.

much whiter. There is no chemical reason, so far as present knowledge goes, to account for the subtle changes of color in clays, especially in clays which are nearly white. Nothing but experiment will determine the point.

There is, therefore, no difficulty in procuring native clays which are suitable for the manufacture of grès. In fact any of the clays which are used in the production of sewer pipes,

stoneware or low grade fire brick will prove suitable. The requirements are a slightly sandy grain, a good plasticity and a point of vitrification about cone 8. This is rather low for the best grès which are fired nearly to porcelain heat. In fact a brilliant glaze of the true porcelain type cannot be fused much below cone 12.



Porcelain plate by Mrs. A. Alsop-Robineau.

Thrown plate with green crystals on salmon ground in center, outline of crystals dark pink. Rim, mat brown; pond lilies, mat cream white with touches of brown in center. Back of plate, mat brown with dragon flies in crystalline glaze on edge.

Grès clays can be well worked on the wheel, in fact most stoneware clays are shaped in this manner to some extent. In the preparation of the clay for careful work some pains must be taken, for a badly prepared clay will cause serious losses. All these clays are liable to contain small nodules of either iron carbonate, iron sulphide or lime carbonate. These

may be as small as the head of a pin but if they lie in the ware unnoticed they will become "poppers" after firing or cause blisters during the fire. The effect of the "poppers" is to blow off small fragments of the pottery and, of course, after a piece is decorated it may be entirely ruined by such action. The remedy is always to make the clay into slip and to strain it through as fine a sieve as it will pass. Through 100 mesh is best, but some of the sandy clays will not pass this, in that case a sieve of 80 meshes to the inch must suffice. If the slip be made thin it will pass the more freely. It can then be allowed to stand until thick and dried to plasticity in plaster moulds. The glaze for these clays is about the composition of Seger cone 4 of which the formula is:

K ₂ O	.3		Al ₂ O ₃	LiO 2
CaO	.7		.5	4.0

and the mixture is:

Feldspar	42
Whiting	18
Kaolin	13
Flint	27

—
100

This glaze may be applied upon the unburned clay. If it does not agree in shrinkage with the particular clay chosen the kaolin may be decreased or a little ball clay may be substituted for some of the kaolin. Ball clay shrinks more than kaolin.

If the ware be first burned the clay will be a disadvantage as tending to cause the glaze to crack. In that case the kaolin should be first calcined and then ground and a little mucilage should be added to the glaze. The glaze is designed to stand a reducing fire for it is this fire which imparts the pleasing tones to the grès.

The clays mentioned above may be procured in quantities, not less than a barrel, from W. H. Cutter, Woodbridge, N. J., and H. C. Perrine & Sons, South Amboy, N. J. They go by the name of stoneware clays. Those residing in the West can find abundance of similar clays in Ohio and Colorado, and should write to John Sand, East Liverpool, Ohio.

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