MEDIÆVAL CRAFTSMANSHIP AND THE MODERN AMATEUR

Frontispiece

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MORE PARTICULARLY WITH REFERENCE TO METAL AND ENAMEL

BY

NEWTON WETHERED

WITH ILLUSTRATIONS

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TO

CAPTAIN VICTOR WARD

IN GRATEFUL RECOLLECTION
OF INTERESTS SHARED AND
COUNSELS UNFORGOTTEN

PREFATORY NOTE

THIS volume is a development of some notes which I put together during a few months of enforced idleness. A difficulty arose as to the form it should take; and I fully realised that in attempting to steer a middle course I might be courting disaster. What I hoped to arrive at was to be neither too general nor too didactic. That at any rate seemed to be a treatment of the subject most applicable to the class of genuine amateurs who would like to avoid the rigidity of the textbook and are yet interested enough to desire an insight beneath the merely superficial aspects of a technical art.

One naturally incurs the hazard of falling between two stools. But it must not be thought that in avoiding a precise formality there is any thought of dealing disrespectfully with an art for which nothing but reverence is felt. It is, in point of fact, a statement of an experience in craftsmanship that is put down as faithfully as possible; the conviction being that the effort to overcome a few of the inherent difficulties and complexities should not exasperate but rather create an interest in the problems which are involved. The advantage gained is very much the same as in the more familiar instance of the spectator who has tried his hand at a game being able to detect finer shades of meaning in the play than the inactive critic.

With regard to the illustrations, for which *Country Life* has been kind enough to undertake the photography, it should be pointed out that they only profess to explain certain suggestions of method. The danger of giving

examples of the most expert work is that the amateur finds himself at once afflicted with a justifiable despair at the bare prospect of attempting what he can scarcely hope to accomplish. This is a situation where a different standard may prove either provocative or stimulating—in either case well within an ordinary capacity. The examples themselves are taken from the work of two amateurs, to one of whom I am indebted more than I can hope to express for his technical enthusiasm and most practical assistance.

This is my chief and, by necessity, anonymous indebtedness. But I would also wish to express my thanks to Mr. W. Graham Robertson for a fuller knowledge of the more modern phases gained from his personal reminiscence; and, in the matter of arrangement and other questions of detail, Mr. T. G. Hill has kindly offered many valuable criticisms which have helped to add a degree of uniformity to what is unavoidably a scattered view of an extremely wide subject.

NEWTON WETHERED.

CONTENTS

ILLUSTRATIONS

CHAPTER I

MEDIÆVALISM AND THE AMATEUR

I

At an interval of roughly a thousand years there have been two agitations affecting the progress of craftsmanship which stand out as landmarks worthy of some notice. The first of them was a revival pure and simple, a determined effort to get together as much of the scattered knowledge of the arts as was available at the time with the avowed object of saving them from the imminent danger of extinction. The other, lying well within our recollection, was a more complicated affair and may be said to have centred round the romantic, yet essentially practical, figure of William Morris.

It would be a mistake to attempt to lay any particular stress on the resemblances existing between the two movements. The greater interest rather attaches to their differences. The earlier of the two was in the nature of a definite advance; the forces at its disposal were marshalled and equipped, as best they might be, for a progress towards a fuller development; and this movement may be said to have culminated a few centuries later in the school of Benvenuto Cellini and the climax of the Renaissance period. The other was more in the nature of a retrograde movement, an attempt at retreat in the face of conditions which were distasteful, a retirement upon a more congenial phase of life and the desire for a return to a simpler expression of art.

With regard to the first, the revival of craftsmanship in the eleventh century is marked by one of the earliest technical books ever written—and very nearly unique in the comprehensiveness of its contents. In his *De Diversis Artibus*

Theophilus summed up all that was known or could be discovered at that time for the benefit and instruction of his brother monks. The information contained in his work was obviously collected from a variety of sources; the result probably as much of hearsay and accepted tradition as the experience of actual experiment. And a portion of his Preface is so apt to our subject, so quaint in itself, and has so inviting an appeal to a common necessity of existence, that a few lines in translation are worthy of quotation :—

'I, Theophilus, an humble priest, servant of the servants of God, unworthy of the name and profession of monk, to all wishing to overcome or avoid sloth of the mind or wandering of the soul, by useful manual occupation and the delightful contemplation of novelties, send a recompense of heavenly price.'

The 'recompense,' as he describes it, which was to cure all maladies of idleness, was bestowed on his disciples with a liberality which showed how greatly he had at heart his responsibility for their spiritual welfare as well as for their manual proficiency. The book covers the widest possible field of subjects with a wealth of detail that indicates the studious care with which it had been compiled. And the choice of occupation which it offers ranges from all manner of church work—the making of 'the utensils of the House of the Lord,' painting of various kinds (not omitting a disquisition on the vexed problem of varnishes)—to metal and glass work of every description, an account of gems and pearls, and the construction of organs.

Without going at all deeply into historical matter it is as well to point out that in the early Christian centuries the monks comprised amongst their numbers the master craftsmen of the time. They controlled in their hands all the artistic work lavished on the churches during the remarkable outburst of energy which is associated with the Byzantine period. In the same degree as their fortunes varied—and they varied with considerable frequency—so did the knowledge of their techniques fluctuate. It was the old story of discoveries made and secrets forgotten, lost arts regained and lost again, only to be renewed by fresh experi-

ment or by the fortunate assistance of pure accident. An age of persistent persecution succeeded in dissipating the Byzantine glory by the unlucky coincidence that in martyring a monk they may have unwittingly destroyed an artist —and with him a valuable stock of technical knowledge. Any chance survivors were received into European monasteries, and these communities carried on what remained of the artistic traditions as best they could.

The importance of the researches of Theophilus lies in the fact that they indicate an exact statement of the proficiency in craftsmanship enjoyed by the men of his day.

Considering that the monk craftsmen were amongst the few people able to read and appreciate his manuscripts, his information was necessarily confined for the moment to the use of the religious orders. In after years, however, his influence was destined to spread over a wider area, and to include a less privileged set of conditions.

II

It may fairly be asked why the occasion arises to ' drag in ' mediævalism ? Where exactly does the attraction or the appropriateness lie, that we should be invited to hark back to times which we are accustomed to associate with an almost chaotic condition of life ? Surely it might be claimed that we have passed beyond the early stages of experience into a knowledge of a far higher practical value.

An answer to these questions depends upon two things ; what, in matter of fact, mediævalism has to offer us, and the consideration whether the circumstances of modern life have created any peculiar interest in the seeking of inspiration from more primitive sources. Periodically, there seems to manifest itself a passion for restoring the spirit of old traditions, working upon pre-existing material and regaining some freshness of a more intimate feeling which, in the light of later development, can be built up into something bearing all the charm of novelty. It may suspiciously resemble the patching of old garments with

new cloth ; but, on the other hand, the old models which remain are so robust in their structure and have survived so much wear-and-tear, defeating so many possibilities of extinction, that they stand the test of restoration with a large degree of success.

The attraction of a reversion to the past is sufficiently common in literature. The outlook upon the present does not invariably appear in a gracious or inspiring light. Very likely Chaucer—to take a chance example—regarded his age and environment as too prosaic and monotonous to satisfy his genius, and for that reason may have dipped back into Boccaccio and the old story-tellers without the sign, so far as the result was concerned, of any sacrifice of originality. Perhaps the sense of perspective may in some way go wrong in such matters. At any rate, it is no uncommon situation to find an artist or a company of artists run into a *cul de sac*, or discover an obstacle in the road which is felt by them to be either insuperable or obnoxious. They are arrested in their progress. Momentarily they may not know which way to turn, but finally the inevitable happens. They change their front and face in the opposite direction. It is as if their disgust and their disquiet were too great for their peace of mind. Neither their energy nor inclination incite them to jump the barrier. Their thought is only to retreat into an older and more comfortable atmosphere—a refuge from present irritations—where their imagination can thrive and blossom with the most profound cheerfulness.

Such a situation arose to initiate an important artistic movement of the XIXth century. It may not have lasted for long in its first intensity ; but that circumstance may be attributed to the fact that it owed its existence very largely to the genius of one man and waned when his influence departed. The mediævalism of Rossetti was a personal gift which he impressed upon his immediate followers—with such convincing force that, do what they would, it seemed they could scarcely fail under his inspiration to produce fine work. When his magnetism had departed, the vitality of the movement flagged, and the

conviction with which he invested it tended to fade into an affectation.

The true significance of what we here recognise as the Æsthetic Movement was the almost childish instinct to get back to primitive ideas, to throw off the ugly complications which pressed upon the spirit, to revive the feeling of abandon characteristic of the old histories and early romances. There is no evidence that they ever worried particularly about the records of old craftsmanship, but their larger instinct covered that field as well as others. What Rossetti, Burne-Jones, and William Morris were especially concerned with was the task of reconstructing an atmosphere which may or may not have actually resembled mediævalism. The important point is that they imagined it did, and were happy in their own particular version of a romantic impulse, quite apart from historical values. They wished to escape to another world, like schoolboys off for a holiday. Their zest was unbounded in the playing of a game very much to their liking. Nothing would have delighted them more than the daily sight of men in complete suits of armour or ladies in XIVth century kirtles. It would not have struck them as humorous but rather as a splendid reality. They displayed a marked preference for heavily constructed furniture of an ancient pattern, and loved to paint old legends upon its panels. Very likely the beds they slept on suggested the days of Charlemagne—and the dreams they would have wished to dream would be the weirdest stories of a superstitious age. Their whole trend was to go back to the ancient models. As Mr. Chesterton has said, 'If William Morris had been a shoemaker, we should have found, with no little consternation, our shoes gradually approximating to the antique sandal. As a hairdresser, he would have invented some massing of the hair worthy to be the crown of Venus; as an ironmonger, his nails would have had some noble pattern, fit to be the nails of the Cross.'

It is impossible not to catch the irresponsible flavour which ran through the very beautiful work of these artists. They were serious in their enthusiasms, it is true; but the seriousness was of that nature which might have been fully

appreciated in the nursery, a renewal of fables and a retelling of stories in pictures which may not always have explained themselves but were none the less delightful on that account. Burne-Jones would paint, as exquisite decorations, pictures of Sidonia and Clara von Bork—and few would have even heard of the ladies, much less have suspected the origin of the story. Rossetti painted a number of portraits of exotic women who might have hailed from the court of the Borgias, but his genius also invested with a rare charm such a pictorial theme as ' The Tune of Seven Towers '—a title chosen as much for the melody of the words themselves as for the romantic idea they represented —to which Morris wrote :—

> ' By my love go there now,
> To fetch me my coif away,
> My coif and my kirtle, with pearls arow,
> Oliver, go to-day !
> " *Therefore*," *said fair Yoland of the flowers*,
> *This is the tune of Seven Towers.*" '

And in ' The Blue Closet ' we get the same association of dainty words inspiring the motif for a decoration, and the picture in turn dictating the poem :—

> But they give us leave,
> Once every year on Christmas-eve,
> To sing in the Closet Blue one song ;
> And we should be so long, so long,
> If we dared, in singing ; for dream on dream,
> They float on in a happy stream ;
> Float from the gold strings, float from the keys,
> Float from the open'd lips of Louise ;
> But alas ! the sea-salt oozes through
> The chinks of the tiles of the Closet Blue ;
> *And ever the great bell overhead*,
> *Booms in the wind a knell for the dead*,
> *The wind plays on it a knell for the dead.*

Altogether the Æsthetic Movement was not the dull, melancholy thing which it is often supposed to have been. That is an impression for which caricature and plagiarists

are responsible. In its first appearance it was light-hearted and bright coloured, indulging the fancy with visions of dark forests and eccentric adventures, woodlands and blue mountains, mediæval castles, cities ' full of churches, their towers full of bells '—and all the vague mysticism which invested a bygone age with an atmosphere of imaginative beauty.

III

Within recent years two books have been written under titles which suggest that both Christianity and Civilisation have arrived ' at the crossroads,' indicating that a serious point has been reached in the world's history at which vital decisions must be taken. If William Morris had written a third entitled ' Modern Craftsmanship at the Crossroads ' he would have had no hesitation in saying which path he himself would have wished to pursue. To right or left the prospect would hardly have pleased him ; and to force his way over the hilly ground in front was not an alternative which appealed to his adventurous spirit.

It has already been suggested that the reason for any phase of reversion in art to a previous stage of artistic development is either a lack of sympathy with the conditions of the times or a hatred of the barriers of progress. Both these elements were present in Victorian days to induce the members of the Æsthetic Movement to take a step backwards as their personal protest against the trend of modern industrialism ; and also, by way of a revulsion of feeling, to check the ugliness which had arisen in the absence of a definite style. From elastic-sided boots to frock coats and horse-hair upholstery the taste was execrable enough to call for a counterbalancing influence. The same perverse feeling had crept into the construction of everyday necessities ; and Morris spoke in the strongest terms of trying to educate the public to prefer ' artistic finish ' to what he stigmatised as ' trade finish.'

What exactly was the meaning of this phrase ' trade finish,' which, to his way of thinking, was a regrettable

feature of the time? It was, briefly, a substitution of the machine for the humanity of the artist. The cry had probably often been heard in the past and needed a modification, but the newer conditions were fast becoming alarming. By means of what had been called 'the nefarious intervention of steam'—and, it might have been added, of photography—the possibilities of reproduction had increased so enormously as to threaten the original artist with the most disagreeable possibilities if he did not come into line with the trend of modern developments. The camera, for good or ill, had taken printing a step further in the race for mechanical reproduction; and, later still, reproduction in colour had gone far to confuse the original with the facsimile, to such an extent that the direct work of the artist was in danger of losing its significance. Even the sculptor now finds his province invaded by a photographic arrangement which offers a sitter a portrait in wood or marble by purely mechanical means. Little wonder that the sensitive artist seeks to depart from a blameless and mechanical accuracy and to cultivate once more a deliberate contortion of form such as commended itself to a less civilised age.

But our particular concern is with the reproduction of work in metal. And in this case the distinction between the original and the replica, to all intents and purposes, ceases to exist. Any divergence from the object which was fashioned by the worker's hands may be said to have evaporated into thin air for every practical consideration. Supposing that there existed an original shilling made by the craftsman himself who designed it, would it be in any way possible to pick it out from a handful? When, again, it is remembered that casting in gold can be carried to such a refined point of detail that a sprig of parsley can be reproduced in the pure metal, or a golden bee made so unmistakably like that the minutest feather on its back is visible, and its legs are accurately constructed in threads of gold, it may be realised that the exactness in certain forms of casting can scarcely go to further lengths. The finely chased feet of a casket could be taken apart, duplicates could be cast with

absolute fidelity, and reassembled so as to defy the closest scrutiny.

Reproductions by stamping are equally convincing. Let an artist make a silver fruit dish, and a steel die can be made from it which may be costly to manufacture but will yet permit of as many other similar fruit dishes being struck from it as it is considered, from the trade point of view, possible to dispose of. It would be possible to continue the minting of fruit dishes as if they were sixpences.

How then does this facility of reproduction affect the public and the artist? An indulgent public has discovered an agreeable benefit in cheapness and in the power to supply itself with an ever-increasing number of commodities that have apparently become necessary to its present standard of living. This craving for prodigality might even be regarded in the light of an alarming symptom, calling, as it does, for a greater and still greater ingenuity in scientific methods. It is even reasonable to suppose that as the speed of supply increases the more insatiable will become the appetite for useless and inartistic possessions.

And the position in which the artist finds himself placed is sufficiently obvious. Except in cases where unique works of art are imperative he finds it profitable to work frankly for reproduction. Quite apart from the artistic enterprise in posters and general illustration, the silversmith's window supplies an example of design and workmanship undertaken, for the most part, in view of an indirect process. The interest in the originals recedes into the background; the actual imprint on the metal from the tool of the artist is regarded as nothing; the satisfaction obtained from handling the object on which imagination and intense concentration of purpose have played their part, is lost. Neither is there any guarantee that the original of a gold or silver dish had in the first place been executed by the artist in a similar material.

One necessary consequence of the interference of machinery upon a handicraft is that the work becomes more and more immaculately perfect in precision and finish. Measurements are intensely accurate, circles, domes, and lines are literally

machine-made, and artistic licence is firmly discouraged. No more convincing example of the tendency can be cited than the type of convoluted design which may indeed be suited to florid commercial decoration but is now freely exploited on trinket boxes and other objects appropriate to the toilet table. It is nothing more than a scientific inscription, and possesses a minimum of artistic value. Possibly it may be admired for a meretricious prettiness when covered by an unbroken sheet of very transparent enamel, but these soulless records of elaborate lathe work excite an interest—if the question is closely analysed—only by a puzzled curiosity in a terrifying form of immaculate regularity. This instinct is directly opposed to the artistic sense which recognises that an unexpectedness, an occasion of delighted surprise invariably accompanies fine design. The acid test of great art is that its effect is to produce an emotion of the heart, a catching of the breath, a warmth of feeling that glows in the veins. What emotion, it may be asked, except the most superficial can be aroused by a coldly intricate but meaningless filling of spaces.

And the perfection of finish—as it is erroneously understood—belonging to these modern tools and appliances, as well as the specialised skill in the use of them, is apt to exercise an injurious influence on the popular taste. In fact, the whole tendency is to develop a professional type of worker whose attention is drawn insensibly towards mechanical perfection, and who must be influenced, even unconsciously and against his will, by the marvellous adaptability of his accessories almost to do his work for him.

Upon this level of accomplishment the amateur cannot compete. Any circumstances which gave him the advantages enjoyed in a professional workshop would be so unusual that they can be disregarded altogether. He will, in all probability, have a small stock of tools with which to obtain his results ; and, more often than not, will be compelled to improvise makeshifts in order to extricate himself from the difficulties of technique which are constantly arising. His methods are for the most part rough-and-ready. Con-

stantly he will have to say, 'I must use so-and-so. I haven't got the right thing to make a perfect job of it.' So the more elementary tool is used and the results may serve the purpose but are beyond a doubt, to modern eyes, imperfect. The amateur is from this point of view precisely upon the footing of the mediæval craftsmen who had to do the best in their power with plain but honest means. The atmosphere in which they worked was primitive. They were gratified if they achieved by their labours an effect which spoke more for their perseverance and ingenuity than the excellence of their materials. In their struggles against difficulties which would at the present day be negligible, they lost something, but gained immeasurably more. Nothing can deprive their work of that quality of humanity which makes an appeal directly to the emotions. Flaws of execution may be quite obvious, a slight gap will appear in this place, an ill-directed blow in that, a circle is imperfectly round, and a setting for a jewel frankly clumsy, but everything stands for a sound, honest endeavour, and the work is solid and strong, capable of resisting the rough usages of centuries.

The older craftsmen not only attract us by the humanity of their work but inspire us by the catholicity of their practice and interests. The specialist in craftsmanship had not yet come into his own. Modern industrialism has dictated a narrow range of proficiency, a system of small individual tasks which, one would imagine, must be not only monotonous in the extreme but actually harmful to the worker. In this way it is almost unfortunate that it has become a matter of pride to the manufacturer of a motor car that its passage to completion is attended by a small army of mechanics, each one of whom is concerned with only one simple action executed with the utmost speed. Let alone the makers of motor cars, how many shoemakers can make a complete shoe ?

We find, on the other hand, in the early centuries a wide range of proficiency. The same artist would practise a variety of crafts. He would be expected to model, chase, engrave, emboss, and work in enamel and niello. An ex-

cellent programme for a modern enthusiast! But who could hope to fulfil it, except in the rare cases of a few experts, unless he had leisure at his disposal and an inclination towards investigation and experiment! It is here that the amateur, if he chooses, may seize his opportunity. He would have been happy in the company of the monkish craftsmen who felt their way tentatively with indirect processes to the accomplishment of their tasks. His interest in any particular craft is not to secure a livelihood, but is actuated purely by a love of making things, of attempting experiments, of pursuing a course of discovery—or even rediscovery—which excites his inventiveness or satisfies his craving for a fresh amusement. He can find a pleasure in reverting to earlier types of methods and studying the most primitive authorities. Duplication, as an end in itself, has no attractions for him. All he desires is to produce a box or two of a particular type, an enamel of an unusual design, or some other undertaking which will remind him of hours of intense and most pleasant application. Such work alone of itself might lead him to the verge of starvation; but should circumstances place it within his power to indulge his fancy without a fear of incurring a menace to his convenience or comfort, there could scarcely be imagined a more delightful voyage of discovery or a final result—supposing success had crowned his efforts—which would be more reminiscent of plans carefully laid and brought to a concrete and flattering conclusion. He is the one man who can afford to do things for pleasure which cannot be done for profit. The amateur, if that is his inclination, may be the mediæval craftsman of to-day.

IV

But to speak of the amateur as a serious artist may cause a shock of surprise to those who are accustomed to regard him with some degree of suspicion as a mere dilettante, a jack-of-all-trades who flits from one occupation to another in a desultory fashion without ever getting to the root of the matter. We inevitably recall that butterfly of the arts

Mr. Skimpole, 'a musical man, an artist too'; the 'Amateur, but might have been a Professional.' He could admire without envy, he could sympathise with the objects. 'I don't know,' Mr. Skimpole admitted with his engaging candour, 'that it 's of any direct use my doing so, but it 's all I can do and I do it thoroughly.'

The modern amateur, however, is made of sterner stuff than all the Harold Skimpoles that ever existed. What is true is, not so much that he is fickle and lacks earnestness, as that his tendency is to be versatile; and he may, in the opinion of many, suffer for that quality.

It cannot be denied that versatility, after all, has its attractions. The public admires the all-round sportsman—and with some show of justice; because it indicates, for the most part, a courage and instinct for adventure—as well as a facility of execution—which is wholly admirable. The professional moves in a narrower circle; and when the two are opposed to each other there is often found to exist a sympathy with the side which labours apparently under the disadvantages of fewer opportunities and a less specialised training. The historic instance would be the stripling David using his nimbler wits and more slender methods to outmanœuvre the expert fighter: and this motif has been repeated in a thousand forms to delight the hearts of children in every age and entertain a story-loving world with a theme of undying interest.

But such dramatic situations do not arise in the quieter regions which concern the practice of an art. It is altogether a more individual adventure 'when we pass our own private gate, and open our own secret door.' Considerations of any matters of outside opinion find no entrance within the seclusion of this remote life. They need never vex the true amateur because, if he lives up to the real meaning of his title, he is only occupied with what for the moment engages his interest for the fun he gets out of it. It is a game he is playing for his own amusement without any ulterior object of profit or fame. If others happen to be interested or amused, so much the gain; but, in all that he does, he follows his own impulse, the free choice of his heart and

soul. If anything comes of it, the accident—for accident it is—does not turn him from his enterprise. Even success in the effort is not a necessity ; the pleasure of the attempt is always a sufficient satisfaction. It is the experiment, the breaking of fresh ground, the knowledge opening up further horizons which fire his spirit and intrigue him with fresh opportunities.

Of such a type, so Mr. Chesterton tells us, was Robert Browning, whose vivacity ran irrepressibly in its varied channels. Nothing would hinder him from attacking ' a hundred things at which he could never have even for a moment expected to succeed. . . . Personally he may not have known enough about painting to be more than a fifth-rate painter, or enough about the organ to be more than a sixth-rate organist. But there are, when all is said and done, some things which a fifth-rate painter knows which a first-rate art critic does not know ; there are some things which a sixth-rate organist knows which a first-rate judge of music does not know.' Even the writing of a second-rate book may provide an experience which is not devoid of its instructive value.

In a word, the amateur has everything to gain and nothing to lose. Browning may supply an instance of versatility which did not, as a matter of fact, reach a high level of achievement in other things than his poetry ; but of that he would care nothing. He plunged into a new venture with a desire to discover fresh beauties in other forms of art—and this too with a zest for the work itself which any schoolboy might have envied. Of a similar type—and, beyond all question, a fine craftsman in the true sense of the word—was William Morris, an amateur in spirit if ever there was one. It may safely be said that he would have allowed nothing to hinder the course of that versatile genius which consumed his energies. Life was to him ' a progressive series of efforts ' ; the mastery over one technique was only the stepping-stone to an attempt upon another. He felt that there were so many interesting things in life, so many problems to solve, so much romance to be poured out in verse and picturesque prose that time was not to be wasted

by dwelling too long on any one accomplishment. He must know something of them all for the reason that they were too attractive to ignore—and he loved to pass from one to another as the mood dictated. He was, in addition, so excellent and apt a player that he modestly flattered himself in the end that 'he knew a few things tolerably well.'

'What a lot of fun we could get out of a pot of white-wash!' was an extreme statement of this irrepressible enjoyment. Any new toy served its turn, and was received with a breezy cordiality which he was lucky enough never to outgrow. The keenness of this instinct never deserted him; and it might be truly said that within the practice of his art—and the amateur might take it as his motto—he did what he liked and liked what he did.

CHAPTER II

A NOTE OF MANY COLOURS

I

A MOOD or an emotion, it is often claimed, matches itself involuntarily in a colour—or a scheme of colour—which serves to express its exact pitch of feeling; vitality tending to vividness and the most exciting phases of the chromatic scale; lassitude or sensibility responding to a less stimulating vagueness of effect. Applied to literature there is the same unmistakable significance, difficult at times to define, but in many cases inevitable. Carlyle speaks of the unhealthy taint that coloured the writings of Rousseau—the making of 'pictures of a certain gorgeous attractiveness; but they are not genuinely poetical. Not white sunlight; something operatic; a kind of rose pink, artificial bedizenment. That same *rose pink* is not the right hue. Look at a Shakspeare, at a Goethe, even at a Walter Scott! He who has seen into this, has seen the difference of the True from the Sham-True, and will discriminate them ever afterwards.'

Symbolically also colour penetrates with a definite significance to the meanest intelligence. Black and violet have their sombre associations, green is felicitous; while, on any election day, the popular imagination distinguishes inevitably between the aristocratic blood which is blue and the socialistic which is red. For that reason the emblems of nations have a precise and precious meaning. The 'red, white and blue' means something very different to us from a group of colours such as green, orange and purple.

These two contrasting associations of colour are not taken merely at random; although, curiously enough, they happen to be very nearly exclusive of each other. It is almost as if

Plate 1

[*to face p.* 16

the chromatic circle were divided into two halves: and a symbolical association attaches to them also—for the one is typical of the Christian civilisation, while the other represents a scheme essentially oriental in character. The East and the West would seem to express themselves with particular emphasis in the language of colour.

In the early history of the Jews, the sacerdotal instinct marked out a set of colours which spoke for the aspirations of a virile race. 'And they did beat the gold into thin plates, and cut it into wires, to work it in the blue and in the purple and in the scarlet and in the fine linen, the work of the cunning workman.' This mighty and compelling colour has flamed in the windows of Christian churches and enriched the canvases of Titian and Tintoretto. Crimson and blue, in their fierce opposition, have supplied the strongest of all possible contrasts, the virile and the womanly, the sound of the trumpet and the everlasting hills, the kingly colour ruling the land and the divine excellence of sea and sky—the mystical colours of Corpus Christi.

This exciting expression of religious energy which has characterised the Western world may be compared with the cooler and more meditative harmonies appealing to the Oriental mind—the contrast of the clear-cut note of the bugle with the muffled tones of the gong.

It would open up an elaborate subject to inquire at all closely into the phases of colour which, following a natural evolution, fit in with any particular form of decorative symbolism; but it is a matter of common observation that each continent appears to preserve its own peculiarity of expression in the matter of colour as clearly as it shows a divergence of character in its calligraphy. If a race decides for some occult reason to express its ideas in words written from every manner of angle, left to right, as we have it, or right to left, downwards or upwards, it may readily be expected that the choice of colour arrangements—which, after all, may be said to be a kindred symbolic expression—will equally indicate certain inherent characteristics.

In their verses on their beloved porcelain the Chinese poets have interpreted an instinctive delight in a few definite

qualities. The most beautiful colours, they tell us, resemble in their eyes the tones that are 'found in late autumn when all things are mystic with a garment of haze.' Their whole instinct is for an atmosphere very closely allied to this spirit of autumn through which it seems to them preferable to view the more outspoken vividness of the colours at their disposal. The feeling for the more broken and mysterious quality is insistent, the impalpable suggestion of moonlight, the crystalline quality of cracking ice, the colour of dead leaf, the autumnal chrysanthemum that survives the fading summer—all point to a preference for the more reticent modulation of tones, reaching under their hands the extreme limit of perfection. Even the blue they love the best is that which approximates to 'the gleams on high hills' at the hour of dawn.

If this is true of the remoter East, it may equally be said of the Moorish type that the prevalent colour scheme suggests the stains burnt by the fierceness of an overwhelming heat. There is something slightly volcanic in their appearance. The blues of carpets and nondescript garments appear dulled and faintly purpled, if not blackened, by the rays of the African sun. Earth colour and tawny browns, cinnamon and purple intermingle to form a scheme which harmonises with and balances an environment almost oppressive with the weight of extreme languor.

While, further north, a contrast is to be found under a far different climatic condition; the colour sharpens in tone; there is felt to be, in comparison with the warmer scale, almost an acid flavour in the beautifully cold tones of the more characteristic examples of Russian art—steel grey and white, pale purple and jade green, medium blue, green and buff yellow—a fitting expression for a people familiar with snow and turquoise skies and the fresh tints of spring.

II

It would be rash to press these involved symbolisms too far, because this question of racial colour is bound up with technical considerations. Although there may be justifiable

Plate 2

[*to face p.* 18

reasons for drawing such distinctions, it must not be forgotten that they vary very largely according to the different arts of dyed stuffs and ceramics. While the magnificence of the fierce colours belonging to the use of dyes was easily obtainable, the typical colorations possible in the decoration of clay were more severely limited. The Persians had at their disposal only a simple choice of colour for their tiles and pottery—dark blue and sapphire, olive green and dull purple—by which they produced what are rightly regarded as amongst the most beautiful of all artistic achievements—a scheme of subtle variations, capable of infinite repetition—cool and splendid but never monotonous. And the same range of colour is noticeable right down from the Ming period in Chinese porcelain through the black, green, and the rose families.

To take a narrower view of colours regarded by themselves, may be a safer line of investigation. Colour arrangements are so much a matter of sentiment and personal liking that it may not be altogether a fruitless inquiry to assign to individual tones the degree of favouritism which they may be said generally to enjoy. On the whole, the pride of place may be given to a colour we know as *violet rouge*, the colour of red wine and amethysts. Not a little fortunate has been the coincidence that certain mineral oxides, of fairly common occurrence, should have the property of staining glass with superb colourings. Of these manganese, according to its quality and firing, gives a range of warm violet—from mulberry browns to the richest purple. And the particular enamel which is indicated is the highest in the scale. It is a colour to be found in some of the more magnificent pansies—and in purple iris petals when the setting sun is shining through them.

Then what of turquoise ? Both in transparent and opaque enamel this colour comprises a distinguished range of tones. It may often be seen in Chinese porcelain flowing in transparent glazes over a vase, blending in an exquisite harmony with purple. Then the two tones, *turquoise vert* and *turquoise bleu*—both transparent—are a delightful pair of variations, each lending a vibration of colour against the

other when placed in juxtaposition. The opaque varieties also are perhaps the most beautiful of all opaque enamels; they vary from the bluer quality of 'sparrow-egg' to the pale and cooler green shades. A further advantage is that they fire successfully—and, being often semi-transparent, can be introduced, without violence, into schemes of transparent colour.

Possibly the most magnificent of all blues belongs to the familiar small figures to be found in the Egyptian tombs. They are, in fact, practically solid pieces of enamel. The clay figures were dipped into the powdered glass and fired with the most dazzling results. Lapis lazuli, on the other hand, is more reticent though rich in tone—approximating to a *violet bleu*. It was a colour closely imitated by the Chinese in their cloisonné work—as an opaque, but not entirely opaque, enamel. But green, the colour of their precious jade, is the most typical colour of China. Quiet and refreshing to the eye, of a semi-lucent consistency and mysterious in its wonderful quality, a material beautiful to handle and fascinating in its modulations of tone, jade inspired an imitation in porcelain which, as celadon ware, has been recognised as one of the greatest achievements in the ceramic art.

But the brilliant greens in our transparent enamels may be seen, on silver, at the height of their vividness. In their purer shades they match very closely the emerald, tourmaline, peridot, and the tone of malachite. In no other material can green be expressed with such a delicious freshness. As an opposition of colour there is little to equal the sharp and lively brilliance of an emerald enamel with a pale but warm shade of yellow—the soft, pale gold of a white wine.

On the other side of the scale are the fiercer tones, jasper, heraldic red, rose and carnation, down to full browns, orange and plain yellow. Technically we are here on more treacherous ground, both as regards the greater difficulty of their management in the firing and their harmonious combination with other colours. The earliest achievements in pottery and porcelain did very well in avoiding them alto-

gether—an advantage rendered necessary and forced upon them probably by technical considerations. But the Rhodian ware represents the most successful example of incorporating these hotter tones with the older and simpler harmony of blue, green and puce. In the Chinese cloisonné, however, a very fine red is found, accompanied by occasional dashes of yellow, which produced perhaps the most brilliant colour effect of all—and the smallness of the scale enhanced its beauty—in the 'grape design' work, with the strong oppositions of intense turquoise, violet, purple, and dark blue.

In transparent enamel, the reds are the most vivid when fired on gold. They practically never succeed on silver; but on copper they can be very full and rich in quality. *Rouge feu* and *rouge cerise* are amongst the best that can be used on the more common metal. The former is rather tricky in the fire, but at its best is a lovely pale red, well worthy of a trial.

The yellows had better be first experimented with, to see how far they may be trusted. They should be left as late as possible in any work, because they are apt to become opaque and unpleasant in quality when fired further than is absolutely necessary. These yellows vary very considerably; but, on occasions, use may be made of their eccentricities. On silver they may become broken, not unpleasantly, after a second firing, and over copper we have known a transparent yellow turn into a semi-opaque ivory which was quite admirable.

The list would not be complete without the mention of the colour *aubergine* which plays such an important part in Chinese porcelain. Although extremely variable in tone, it exercises a wonderful harmonising influence upon the cooler tones with which it is placed. Through all its transitions from puce grey to purple and purple brown it possesses the faculty of tempering a cool arrangement of colour; supplying the necessary warmth and at the same time producing an effect of serene and calm sobriety. Still further, with its contrast of yellow, it neutralises the coldness of blue and green; and so successfully does it accomplish its

duty of keeping the surrounding tones in their proper relation that the presence of a more emphatic pink or red can be regarded as a positive detriment.

The value of grey, the colour of the pearl—as constituting a scheme in itself—has also exercised noticeable influence upon artistic work. We apply the name of 'celadon' to a remarkable set of quiet colourings, ranging from a pearly turquoise to subtle blue and lilac greys, perhaps forgetting that the name was applied to this class of ware as late as the XVIIth century. The shepherd Celadon, wooing his beloved Astrée, wore on the stage a costume the colour of which created such a furore that it started a prolonged fashion in ladies' dress. In fact this blue grey tone was worn almost exclusively for a long period, and lent its name to the monochrome porcelain which was then being introduced into Europe.

Curiously enough, this same cool and refreshing taste in colour is reflected in the charm of a later French landscape painter. The colour schemes peculiar to Corot closely followed this range of reduced celadon tones. If a typical canvas of Corot, depicting the quiet, even atmosphere so characteristic of his style, is examined, it will be discovered that there is scarcely a square inch which could not be matched from a representative collection of celadon china. The subtle differences of tone and the slight transitions from pearly grey to a certain drab tint of peculiar beauty, which we recognise as *feuille morte*, would, at first sight, appear too insignificant to supply sufficiently marked contrasts; but with skilful handling, they successfully provide the basis for a poetic treatment of nature. Much the same clear and sober harmonies of cool blue and dusty yellow, lavender and grey green were used by Harpignies in his water-colours to render the sun-steeped landscapes of France.

III

While dwelling chiefly on enamel colour, we have not as yet considered the question as to whether a lustrous colour

Plate 3 [*to face p. 22*

is, after all, a beautiful type of colour. A prejudice on this matter has at any rate to be reckoned with amongst those who deny the beauty of gems for their sparkle and regard with disfavour even gold because it glitters. Such an adverse opinion has the support of Ruskin, who, discussing incidentally a problem of colour, expressed no half-hearted judgment on the matter. He speaks of an argument with a friend who tried to persuade him that 'lustre was an ignobleness in anything,' and admits that 'it was only the fear of treason to ladies' eyes and to mountain streams and to morning dews which kept me from yielding the point to him. One is apt always to generalise too quickly in such matters; but there can be no question that lustre is destructive of loveliness in colour, as it is of intelligibility in form. Whatever may be the pride of a young beauty in the knowledge that her eyes shine (though perhaps even eyes are most beautiful in dimness) she would be sorry if her cheeks did; and which of us would wish to polish a rose?'

Which of us indeed? But this, after all is said and done, is only an objection to brightness in itself as a quality. It is true that neither does a rose need a polish to enhance its beauty nor a lily any disfigurement with gold leaf. But what shall we say in criticism of another flower which may be regarded as an arch-offender?

> The rich buttercup
> Its tiny polished urn holds up
> Filled with ripe summer to the brim.

And, in a lesser degree, of the gentle Celandine—

> Spreading out thy glossy breast
> Like a careless prodigal,
> Telling tales about the sun
> When we 've little warmth or none.

The appeal to Nature is scarcely convincing. She is too versatile an artist to confine her technique to any one precise order of superficial beauty. And, further than that, if too sweeping a generalisation were insisted upon, it would rule out of the field the greater part of enamel, the kindred art of

ceramics (which also presents a surface of glass), stained windows—and even, in a qualified degree, the glory of sunsets, as vulgar and pretentious.

To take the first of these. The beauty of ' dead colour ' in many of its forms, is undeniable ; but it does not necessarily follow that the dread word ' shininess ' has only to be used to constitute a reproof. Practically all glass, except ' frosted ' glass, is shiny. It shines on the surfaces of porcelain and pottery as well as in windows—and though the remark may be made, ' I don't like enamels,' perhaps for this very reason, it is permissible to appeal to a more catholic taste which discovers beauty in the type of colour that has a surface-lustre as well as in the delicate opacity of more restrained fresco paintings.

The question may be viewed also from another standpoint—that it involves a distinction as to the medium which is to be employed in dealing with some particular pigment, some tinted powder or other. Because the pigment, it may be forgotten, is often identically the same in a number of processes. A tendency exists to over-classify the forms in which a colouring material may be used, to assign to separate compartments such methods as water colour, oil, and distemper colour, or vitreous colour. They are distinct in themselves only in degree—cobalt is cobalt whether a child dabs it on a copy-book with a sloppy brush full of water, or whether a Chinaman has painted a hawthorn pattern on a ginger jar and exposed it, without any danger of its fading, to the intense heat of a furnace. The umbers which may look rich or muddy, as the case may be, on canvas and paper are not distantly related to the fine purples and violet browns that go to make the *aubergine* of Chinese porcelain or appear sumptuously in the windows of our churches. Iron, copper, chromium, manganese, and other metals supply a number of coloured oxides which can be mixed with a variety of compounds to play very different parts. Their derivatives are not so numerous but that they can, according to the way in which they are employed, be made to display qualities of the densest opacity, the clearest transparency, or, perhaps—the most beautiful of all—a union of both

qualities, a veiled transparency that defies a strict definition and possesses a mystery of its own.

It must not, however, be inferred that, though the coloured substances are very much a common property, a vast importance does not attach to the question of the medium employed. The faded bloom, to be remarked in the oldest fresco painting, is amongst the most beautiful effects of all pictorial art; and many transitions may be found passing between the tempera of the older painters and the full use of oil and varnish, which became in later years the more fashionable medium. With glass employed as a vehicle there has been less scope for ambitious pictorial work; the difficulties are intensified by the necessity of passing it through a firing process—changing the original appearance and making all preliminary preparations liable to the chances of guesswork.

In defence of enamel it can also be said that no medium has a property equal to that of glass for preserving in so pure a form the pigment which it carries. And this is no mean consideration to those who experience a difficulty in the handling of colour.

What is usually described as a ' gift for colour ' is a priceless possession to those who are happily endowed with it. To those who are less favoured it is an exasperating circumstance that, do what they will, they will never be able to exercise with any facility the delightful knack of resolving harmonies under their fingers with instinctive ease. Colour behaves in the most wilful fashion under the influence of different temperaments. With some, the jarring note never occurs, the beauty comes of itself—while a kind of paralysis afflicts those who suffer almost a physical inability to place tones together as they know at the bottom of their souls they ought to be placed. With them the dreams of colour never come true: even the most intense feeling for its innate beauty avails them little.

In enamel the colour is so simple and direct, so precious in itself, that for the most part it requires a wilful tampering to produce results which are entirely disagreeable. There are colours naturally to be avoided, but any persistent

offenders in this respect should be quickly convicted and expelled beyond hope of recall. Clear them from the field of experiment, and the remainder—a select company of approved friends—should get on very well together.

The prepared pigments, on the other hand, which are used in oil or water colour painting, are much more promiscuous in their behaviour. They mix so fluently that, in inexpert hands, they can soon resolve themselves into an unattractive mess from which it becomes a dreary task to extricate them. It is true that they are mostly employed upon a problem of extreme difficulty; a representation of nature involving the additional handicap, that an inclination may exist to match tones with an impossible accuracy even though direct imitation is not being consciously attempted.

If the instinct for colour—and beautiful colour alone—is uppermost, it can scarcely be more easily and surely gratified than in the use of coloured glass—for the reason that the material is of so independent a nature that it admits of less interference, in the matter of its intrinsic merits, than any other which we know of. The besetting evil—as experienced by the ordinary run of amateur—is the tendency to be fettered by an insistency on local colour. He has the utmost difficulty in breaking away from its influence. Frequently he does not even make the attempt—with the consequence that a certain common lack of originality in amateur painting is due to the fact of his reluctance to depart from the conventional colourings which are associated with various features of nature. The scheme in his hands is apt to err on the side of the harsh, cold, and unflattering aspects of the subject, and lacks the vivacity and brilliance which are only to be obtained by indirect methods.

Any one who has experienced something of a feeling of disappointment, possibly of chagrin, that is apt to accompany his pictorial efforts, might be more happily employed upon a technique which is frankly decorative. He has, in enamel, a palette of certain fixed colours, and is compelled to use them directly with decision and deliberation. Comparatively little temptation assails him to modify the character of this tone or impair the perfection of that. He has no

Plate 4

[*to face p.* 26

option but to set them down in their essential purity—and can scarcely avoid getting fine colour if only he observes an ordinary care in their arrangement. Should he pin himself down, for example, to a cloisonné treatment of a subject in landscape, he has to accept the most arbitrary conditions imaginable. Rigid outlines of wire are his means of drawing, and the spaces must be filled with definite flat tones. If he is wise, he will fill them almost irrespectively of any imitative considerations, and the result, when the fire has consolidated his work, should be, at least—to say no more—interesting.

As an example of such fearless uses, the greatest eccentricity in colour that can very well be conceived is to be found in the ancient glass windows at home and abroad. The reason for its general appeal to all classes alike is indeed not altogether easy to discover; so much of the drawing is scarcely intelligible—and yet, in spite of its strangeness, the impression is one which defies criticism. There is inevitably a sensation of awe-inspiring dignity conveyed by the figures of saints sitting apparently in mid air on incomprehensible thrones—whose robes are shapeless patches of colour, gold and purple browns, crimson, emerald, and other haphazard tones. Faces, hands, and feet may be gigantesque, roughly hewn, and nondescript in tint, but their unearthly splendour provides a startling impression. A neighbouring window may display much accurate drawing and an arrangement sufficiently realistic to be readily understood; yet, notwithstanding the greater lucidity of its meaning, it attracts little more than a passing attention—and the eye returns with a relief of wonder and contentment to the queer but arresting figures wrought by the earlier masters. It is true that one accepts in glass what would barely be admissible on canvas. In contemporary painting, however, there is evidence that a distortion, which came naturally to a less scientific age than the present, has its very definite artistic value, and may be deliberately cultivated for its indirect appeal to the imagination.

However that may be, it is the arrangement of colour within strongly marked areas that is the commanding

feature of old glass. The effect might almost suggest the shaking of many fragments of jewelled colour from a magic casket, and their positions fixed at random as they fell. That there is a magic in the patterns of silver and umber, the splashes and cloudy spaces of bright green, warm lilac, chestnut, blue, and scarlet cannot be denied—and not the least lovely is the discoloured silvery tone which at intervals supports a splendour too overpowering if it were not relieved by an opposing coolness. In some windows the yellows, pink oranges and reds stand out like tinted candles in a dim room of rich and splendidly obscure blues, purples, and sombre greens. While within the same building may be seen a contrasting scheme of long, narrow windows, vaguely stained with a tone of dull bitumen and relieved from monotony by a few broken reds and dim notes of sapphire neutralised by age.

IV

But when Nature chooses to put out her full strength in a display of colour, we step on to a different plane of magnificence altogether. It is no remote parallel to speak of the vitreous quality—what has been colloquially called the ' shiny wetness '—of a sunset sky. Enamel under some of its phases seems the only material to get really close to this appearance, so suggestive of a fused mass of colour. It is as if the sun in an expiring effort had glazed the firmament with that liquid definition which only the fire of a furnace seems able to impart.

An illustration of this quality of material occurs in a description by Jack London of a sunset in the Pacific :—

' Half the sky, from the zenith to the western sea-line, was an astonishing sheet of pure, pale, even gold. And through this sheen on the horizon burned the sun, a disk of richer gold. The gold of the sky grew more golden, then tarnished before our eyes and began to glow faintly with red. As the red deepened a mist spread over the whole sheet of gold and the burning yellow sun. Then as the gold mist continued to clear away, the colours became garish,

bold. The turquoises went into greens and the roses to the red of blood. And the purple and the indigo of the long swells of the sea were bronzed with the colour riot in the sky, while across the water, like gigantic serpents, crawled red and green sky reflections. And then all the gorgeousness quickly dulled and the warm tropic darkness drew around us.'

The effect is as of a glass mirror charged with swiftly moving colour—the essence of the beauty of dawn or sunset. The transitions are too rapid to be arrested at any one stage with the least hope of conveying a full impression. In that fact lies the reason that these terrific colour displays, so amazing to witness, can be sadly disappointing in pictorial art. One momentary phase can scarcely explain itself: it is no more than a microscopic section cut at haphazard. The succession of the scheme is everything. No particular tone is the same for two moments together. The movement is a transition of perpetual variation; and there is only one pigmented material in which we can imagine the colours and quality of surface which stand out in the descriptions as, beyond all question, true.

In the quotation which follows are mentioned appearances of sea and sky which are never opaque in the same sense as are scenes associated with landscape; and the variations of the same prevailing tone are such as are frequently seen when either silver or gold or even bright copper are shining through the same enamel. A pale, cool olive over silver may assume an indescribable golden tone over the richer metal, and the range of colour in this way is capable of being increased beyond all the possibilities which lie within the province of a less transparent and brilliant medium:—

'Then came the colour riot, the dominant tone of which was green. It was green, green, green, the blue green of the springing year, and sere and yellow green and tawny brown green of autumn. There were orange green, gold green, and a copper green. And all these greens were rich greens beyond description: and yet the richness and the greenness passed even as we gazed upon it, going out of the grey clouds and into the sea, which assumed the exquisite

pink of polished copper, while the hollows of the smooth and silken ripples were touched by a most ethereal pea green.

'The grey clouds became a long low swathe of ruby red or garnet red—such as one sees in a glass of heavy burgundy when held to the light. There was such depth to this red. And, below it, separated from the main colour-mass by a line of grey-white fog, or line of sea, was another and smaller streak of ruddy-coloured wine.

'. . . And as the colours dulled in the slow twilight the moon, still misty, wept tears of brilliant heavy silver into the dim lilac sea.'

CHAPTER III

THE JOINING OF METALS

I

THERE would be little scope, much less amusement, to attempt anything like a comprehensive survey of craftsmanship in all its branches. The field is so wide that the effect would be encyclopædic; a casual amateur would be landed in a state of bewilderment at such an alarming prospect. What he needs is to be saved the necessity of selection as far as possible. It is improbable that he would elect to specialise in printing, bookbinding, or any of the more outlying crafts. Something more generally applicable to ordinary needs—and yet not so ordinary as to be either commonplace or monotonous—would supply the entertainment he is in search of. There is also no knowing into what specialised craft his fancy might wander if once he were fairly started on the road; and literature dealing with every by-path is sufficiently abundant to reward his researches. Above all, there is the compelling consideration that he demands first and foremost that his information is as original as circumstances permit; that at any rate he is not asked to accept results of a second-hand nature. The principle expressed by Eraclius—one of the earliest technical writers—'nil tibi scribo quidem quod non prius ipse probassem'—could not be improved upon as a guarantee of personal experience.

It may be remembered also that a large number of the various arts and crafts belong very much to the same family. There is the branch which embraces such employments as embroidery, leather work, and the like; but a distinct affinity can be traced between these and such seemingly

remote processes as cloisonné and repoussé work in metal. Any one who has worked in repoussé in metal could apply identically the same procedure upon stout leather, well damped—especially if he makes use of a penknife to cut back the leather in those parts of the design where the effect needs to be sharpened. In the same way an identical design can be employed in the treatment of many materials—upon the simple principle of setting out spaces deliberately and definitely and filling their interiors decoratively, either on the flat or in relief. As one example amongst many it may be noticed in Hungarian work that the designs used for enamels and appliqué work are precisely the same, even to the application of twisted silk as an outline in the identical manner of the twisted wire used for setting out a cloisonné design for enamel.

It is indeed a fact that very frequently a knowledge of the technique in one material can be applied with remarkable similarity to another ; the principles are the same ; the tools used for one can in many cases be used for another ; and the exercise of a moderate ingenuity can supply most of the necessary modifications. Too great a tendency exists to regard crafts as confined in so many water-tight compartments ; whereas the truth is, that a cunning craftsman can follow his fancy in covering an amazing variety of ground simply by keeping his decorative object steadily in view, and incidentally finding an additional fascination in the different turn which the nature of the material imposes upon his technique. By these means he succeeds in gaining a pleasing variation in the final expression of his idea.

It is indeed not so inappropriate as it might seem to speak of the arts and crafts as constituting a large family the members of which are united by mutual bonds and interests. Their common endeavour is to live in the pursuit of as great an association of beauty with utility as is humanly attainable. Coarseness, vulgarity, and affectation are frowned upon and the best traditions are insisted on as the essence of their existence. It need not be regarded as out of the question to enjoy a nodding acquaintance with them all ; and an intimate friend of the family finds it polite, as well as enter-

Plate 5

[*to face p.* 32

taining, to show an interest even in the case of those connections with whom he may not be closely acquainted.

Our choice of metalwork and the further opportunity of colouring its surface with enamels, has much to commend it. But before the more exciting phase which culminates in this added glory can be contemplated, it is necessary to understand the elementary principles of cutting out metal and fastening it together. The problem is very much that of the tailor who not only accurately adjusts the shapes of his pieces of cloth but merges them into a complicated whole by sewing them together; and also by means of buttons and similar fastenings completing the process of holding everything compactly in its proper place.

In metalwork, soldering and riveting roughly correspond with these well-known devices. Of the two, that of riveting is perhaps the more generally understood. Any one who has clipped together a number of sheets of paper with the piece of brass, made up of two thin strips united to a round head—commonly associated with examination papers—has, to all intents and purposes, performed an act of riveting. A boiler riveter only carries the operation to a more strenuous length. He runs a stout metal bolt, having a head at one end, through the two iron sheets which must be bound together, and beats down the other end of it, softened by heat, so that the metal spreads under the force of the hammering to form a head corresponding to that which already exists on the other side. The plates are thus held together by being squeezed tightly in a vice-like grip between the two heads of the rivet, and the cooling of the bolt further causes a contraction, binding the join still more firmly.

II

Soldering is a less simple method of uniting metal; a definite cohesion being obtained by introducing another metal more fusible than itself and compelling it in a molten state to combine at the points of contact with the parts which require to be united. It is a fact also that the solder,

in combining with the metal which it is uniting, itself actually hardens. The part it plays is easily understood by imagining that a metal postage-stamp may need to be affixed to a metal envelope. A metallic alloy would take the place of the more familiar gum ; and the application of heat instead of water would ensure the necessary cohesion.

It might be thought that the invention of this process would have occurred at a fairly late stage in the history of craftsmanship ; but, as a matter of fact, it is amongst the earliest. To find a prosaic affair such as we generally associate with the profession of the modern plumber mentioned in the Old Testament, comes almost as a shock. But a still more astonishing curiosity of history is to be found in a process of gold soldering which, for minuteness and delicacy of manipulation, defies even modern workmanship. The ancient Egyptians produced a form of granulated gold jewellery which antedated the more familiar Etruscan work of the same character by nearly three thousand years. In another place we shall discuss the process of this amazing workmanship ; the curious form of decoration in which the design is laid down in fine wire upon the gold ground and the spaces filled in with microscopic granules—the regularity and completeness of the work being almost beyond belief. A parallel might even be drawn between this perfection of very ancient workmanship in gold and the unsurpassed quality of the earliest printing which, it is claimed, reached its zenith almost as soon as it was born.

It will assist the practical consideration of soldering if we realise that the problem is that of running a metal in a molten state along a join separating the two points or surfaces of metal which it is required, at the moment, to unite. Under proper conditions this alloy, or ' solder,' on becoming cold forms a solid whole by means of which the two pieces of metal are held together—not unlike the way in which two pieces of sealing wax, held in a flame against each other until the wax becomes sufficiently fluid, would remain united when the mass had cooled.

In order to induce the molten metal to run into its allotted position certain conditions are necessary. Firstly, the sur-

faces to be united must be absolutely clean—just as a cut in the finger will decline to heal properly if it remains dirty. A difficulty exists in this matter with metal ; because, under the influence of heat, it tends to become foul. If a piece of copper is brought to a red heat and then allowed to cool, its surface will be found to have blackened, and chips of the oxide which has been formed will fly off. The presence of this dark oxide—which for the process of soldering may be regarded as so much ' dirt '—would form an absolute barrier to any solder ' running '—in other words, its adhering freely to the required surface. It is necessary, therefore, to use a substance which will absorb the oxide as quickly as it is formed. The surface of the metal would, by such means, be kept perpetually clean ; and the solder, beginning to melt, would rush at once to the point of clean contact. Let that surface at that particular moment be in any way obscured and the solder will at once appear to sulk, roll itself into a ball apart, and entirely refuse to behave in a correct manner. Frequently the solder will find one of the two surfaces clean and rush in that direction, but utterly refuse the other which has become dirty. The gap then remains open, and no join has taken place. The same thing happens if the surfaces are unequally heated. The solder will fly on these occasions to the hotter of the two and neglect the cooler—with the same unsatisfactory result.

Upon the proper use of a substance to absorb these undesirable oxides, as they are continuously thrown off by the heated metal, largely depends the success of the experiment ; and the greater the heat employed, the more forcible must be the action of the ' flux ' employed.

The second necessary condition is that the portions of metal which require to be soldered must be held in position so firmly that the interval between them remains constant. The object is, as it were, to form a bed or mould into which a melted alloy can run freely, settle into its new quarters, cool comfortably in this position, and become a solid entity with its neighbours. To do this effectually is not as easy as it would seem. Metals expand under heat to such an extent that a gap is likely to widen at the most inconvenient

moment. Solder will not form a bridge across a distinct interval; a close contact is in all cases imperative. So far as such objects as we are likely to deal with are concerned, the thin iron binding wire, sold for the purpose, will help to keep everything in its place. It adds little to the bulk of the metal which has to be heated—and economy in this respect is important in facilitating the process. With the work trussed up, as it were, in a light wire bandage so that the points of contact lie just right with each other, the solder with its appropriate flux can be laid along the prescribed channel, and all is then in readiness for the skilful use of the blowpipe to complete the operation. As the solder might be inclined to run on to any iron wire in its immediate vicinity, it is often an excellent plan to hold off the wire with small iron tapes from touching the points of contact. If the wire happens to be at all rusty, the fact will constitute a positive advantage, as the rust would help to reject the solder and confine it to its proper channel.

The third essential concerns the application of the necessary heat, and the temperature must necessarily vary according to the solder which is being used. A good deal of misapprehension may exist as to the nature of 'hard' and 'soft' soldering; and this might be avoided by the rough-and-ready description of 'hard' as a silver and 'soft' as a tin solder. Both are, in point of fact, alloyed metals; but the distinction is sufficiently accurate. Tin requires comparatively little heat to melt it, silver—even when mixed with a proportion of copper, which renders it the more fusible—considerably more. For the softer solder—in those cases where the object is of a moderate size—a Bunsen burner or the heat given out by the hot copper head of a soldering tool is sufficient to cause it to run; but the more intense flame of a blowpipe is necessary in the majority of cases to melt the harder silver solder. The principle remains the same; but the use of different fluxes becomes necessary under the action of different temperatures, with the essential object of preserving the cleanliness of the metal surfaces.

Having stated the problem in general terms we may proceed to a practical example. Suppose we wish to make

something in the nature of a silver napkin ring. We should begin by cutting a strip of sheet silver of the required width and of a length to go comfortably round the napkin when folded. The intention is to unite the two edges by running between them a metal so closely allied to the silver itself that the join will be scarcely visible, and of an equal hardness with the rest. The first thing will be to wind binding wire round the circlet so that the edges slightly overlap. Then twist the end of the wire and take the rest of it round a few times with just that degree of firmness that will enable the edges—which must be bright and clean—when drawn from their overlap, to lie closely and neatly together. Small chips of solder must now be cut from the thin sheet of hard solder. If any number of these chips is necessary, cut a few parallel lines with the scissors, like the teeth of a comb ; and then, holding a finger against their extremities, cut across and the chips will fall in even squares. However, in our immediate experiment, only a few will be needed. Brighten the sheet solder with emery paper before cutting it.

We shall use ordinary borax powder as the flux. Cover the join with a thick solution and heat with a blowpipe sufficiently slowly to evaporate the moisture. After a certain amount of bubbling, the borax will settle into a crusted mass resembling dirty snow. Continue the process a little further and it will be seen to be on the point of forming a glass. Chips of solder, also dipped in the borax solution, are now laid along the joint. The heat will be applied, first to warm the whole object at points some little distance from the juncture, until it is apparent that the snow is resolving itself into a lake of molten glass. Then the point of the flame may be directed in its full intensity upon the scene of action. If all goes well, the solder may be seen to spring suddenly to life and plunge headlong into the molten sea, spreading itself under the surface in a glittering streak of silver along its appointed channel. Unwind the wire, and the ring should be as strong at its joint as at any other part of its circumference. File away any solder where there is an excess, and in those places where there is not enough, add more chips and repeat the process.

A weak solution of sulphuric acid, one part of acid to ten of water, will remove the borax ; or a gentle tapping on a small anvil with a hammer will cause the borax glass to flake off. If these flakes are closely examined, it will be found that this glass—for it is actually a soft glass—has absorbed the silver oxides as they were formed under the influence of the heat, and has become yellowish in colour. The ' silver stain ' in glass windows—the bright, ' brassy ' yellow which is apt to assume an unpleasantly harsh tone—is an example of the same phenomenon on a different scale ; the silver oxide in the case of the window being utilised as a colouring medium, while in any soldering the borax is employed merely as a vehicle for removing the same oxide and carrying it away as a waste material.

In the hands of the expert who is constantly engaged upon this class of work, the proceeding we have described is little more than mere child's play. But it is well to warn the amateur that, in the course of events, he may find his patience sorely tried, that many things may go wrong, that one small detail, playing false, is quite sufficient to ruin the business. Everything then will need to be begun over again ; and quite possibly the process may need to be repeated several times before success rewards his efforts. Silver is easier to manage than copper, as it oxidises—especially pure or ' fine ' silver—the less freely of the two and is altogether cleaner. But copper can be painfully obstinate. It is naturally so dirty in its oxidisation that a stray chip of solder will frequently defy the most emphatic efforts to induce it to take the final irresponsible plunge ; it will decline with the utmost perversity to move, and the work must be broken up, to be begun afresh. Brass will be found easier to manage than copper ; but iron, being fouler still, is the most difficult of all.

By relieving the borax of its moisture before beginning any work, the inconvenience of the bubbling can be avoided ; and the advantage of this lies, not only in shortening the process, but in preventing any chips of solder being shifted from their place by the violent upheaval which takes place. The borax can be bought in the form of ' glass of borax '—

or converted to it by ordinary heating—and if this glass is ground in a mortar with paraffin oil, it can be painted on the join and the solder laid in its place without any further preliminaries. In delicate work also it may be an advantage to file from a stick of hard solder a small pile of filings. Using these as a coarse powder, a paste can be made with the borax ground up with paraffin. Placed directly on the spot this mixture will simplify proceedings very considerably. For soldering such small articles as the links of chains, each link of which has to be separately secured, a dab of such a mixture is all that is necessary ; the paraffin is ignited by the flame and the solder runs with only a slight application of heat.

It is interesting to compare with this description the account given by Theophilus. He describes the making of the solder, which we buy without any additional trouble of manufacture. ' Take a little of the silver, and mix with it a third part of copper, and melting them together you will file it finely.' As a flux he recommends the use of ' wine-stone,' made by burning the lees of wine. The ash, when refined, answers to what we know as ' cream of tartar,' a compound of potash. ' The wine-stone being burnt and salt added you will mix it with water ; thinly anointing with which, spread the filings over the fracture. This dry, again anoint the mixture, more thickly, and coals being applied above and below, you will blow gently, until you see the solder flow. Seeing which, immediately sprinkle it with water (to prevent the possibility of the work fusing as well), and if it be hard, well ; if not, however, do the like again until it has become firm.'

This is very much the way we should set about it ; except that our borax flux would be the more satisfactory to use. All soldering was done with a charcoal fire, whereas we should use a blowpipe flame. Charcoal, however, is often most useful to support any work, and also is of assistance in concentrating the heat.

III

Before dealing with 'soft' solder, it should be pointed out that it enjoys the worst possible reputation in any connection with silversmith's work—and rightly so. In its nature it is too widely removed from the finer and harder metals, and its cohesion is much slighter in view of the lower temperature at which it fuses. Both these conditions count for loss of stability and discount the possibilities for further work in the way of hammering or any future applications of heat. It is, in fact, as unsatisfactory as mending a broken strap with common string instead of incorporating a fresh piece of leather at the point of fracture. A fine workman would reject without the slightest hesitation the use of unsound methods; and for the amateur, only in those extreme cases where the difficulties may try him too highly, should any licence in the matter be granted. The final stages of a piece of work might on that account only justify the easier method.

Soft solder can be employed in very much the same manner as the harder variety—with the following differences of method. The flux used need not have the same high qualities of absorption, as there is less oxidisation to combat at the lower temperatures. Excellent liquid fluxes can be obtained which only need to be painted on the parts to be soldered.

If it is wished to prepare a liquid flux to suit every purpose, it is only necessary to dissolve zinc in hydrochloric acid until no more of the metal can be dissolved. The action entails a good deal of violent bubbling and throwing off of hydrogen gas, so that the preparation had better take place in the open air. In its operation during soldering this flux appears to have the property of cleansing the surface of the metal and at the same time of depositing a film of zinc, the two actions assisting in the final cohesion of the solder.

Soldering pastes are also sold, which are of a greasy nature and contain a large proportion of resin. The value of resin can be noted if fragments are sprinkled on a sheet of copper which has been heated until it becomes dark

with oxidisation. Spots of clean copper will appear in the places where the resin has fallen. If the heating is continued, the resinous substance will be dissipated and the oxidisation will continue. This experiment will serve to demonstrate how temporary the absorption may be—sufficiently long, however, for the soldering to be completed. Sal ammoniac acts in very much the same way.

A stick of the soft, or 'plumber's,' solder can be hammered at one end on an anvil—this will demonstrate its softness—until it is as thick as a shilling, and chips can be cut crossways in the manner already described. Dipped in flux the chips are placed in position after everything has been secured with binding wire. With the application of heat over a Bunsen burner or from a blowpipe—a gradual warming of the whole being the first proceeding—the interstices should be soon filled with the melted alloy. The heat is then withdrawn and everything left to cool. Washing in a hot solution of common soda will remove all dirt and grease.

Coarse filings also afford an easy method of manipulation, of course associated with the flux. The mixture of the two is pressed into position with a knife or brush and fused. Any excess of solder can be removed by cutting it away with a small gouge or scorper, by filing or scraping with a knife. The less that is visible, the better; and a final smoothness can be obtained by a little emery powder and oil rubbed over the surface with a piece of wood.

For smaller and more intricate work the above methods may be recommended as the most practicable, but a 'soldering tool'—especially when the knack is acquired—has considerable advantages. In the skilled hands of a tinsmith the facility with which the work is done is admirable. Instead of the solder being melted directly in position, it is melted on to the hot lump of copper which forms the head of a soldering iron. It is carried, as it were, on this temporary platform and transferred to the spot required. The copper head is kept hot enough to bring the portions of metal to be soldered up to the temperature necessary for a satisfactory welding of the molten solder in the joint where it is

lying. It is not unlike the use of a palette knife in oil-painting, the taking up of a dab of paint and applying it to the canvas : the only difference being that the palette knife in the case of the solder must be of a large size in order to retain its heat and keep the solder fluid.

In using the soldering iron, it is necessary, first, to prepare the copper ' bit ' to receive the solder. It is filed bright—the best way to make it clean. Any dirt would cause the solder to refuse. The bit is then heated to a temperature which conveys a pleasant glow when held close to the cheek. No greater heat is necessary, and the larger the copper, the longer it will retain this equable temperature. It has now to be ' tinned ' or ' silvered '—these expressions are, strictly speaking, inexact, the only meaning being that it must receive a thin coat of solder. The lid of a tin box will serve the purpose. Pour some liquid flux into the lid, and at the same time as the hot bit is moved about in the liquid, press the stick of solder against it, so that one or two drops of solder are melted. The rubbing will cause the solder to cover the face of the bit, which will then be ' silvered.' Wipe the surface quickly with a handful of coarse rag to clean off the flux, which has become dirty, and the tool is ready to convey more melted solder to the point where it is required.

The situation is now equivalent to that of the dab of oil paint lying ready on a palette knife. Moisten the parts to be soldered with flux, apply the bit to the place, rubbing it to and fro in order to warm the surface to a temperature approximating to that of the bit itself. This ' sweating in ' —to adopt another technical phrase—is most important. The hot solder will scarcely be comfortable in cold surroundings, and the use of the bit as a warming agent will perfect the cohesion.

In this case also, the solder will not bridge over a hole or any distinct gap. The most it will do will be to form a small ball upon the edge which is of no practical use. In the event of covering a hole, a patch of metal must be cut, and its surface covered with solder by means of the bit. With the edge of the hole cleaned and moistened with flux,

the patch is laid in position and the heat of the bit which is being rubbed upon the back of it will be sufficient to melt the interlying solder. Better still, a similar patch on the other side, applied in the same way, will close the opening effectively.

Theophilus describes soft soldering—but not under that name—in the making of ' vials,' vessels with a spout after the manner of our decanters or coffee-pots. He speaks of the beating out of two tin cups which are to be joined ' so that the rim of one may pass into the other, and that which contains the other being placed upon hot ashes, beat very thinly a piece of the same tin mixed with a third part of lead, and, cutting it up very small, lay it around the join : and a few ignited coals being applied, as soon as it has glowed, anoint it round with resin of the fir-tree, and you will instantly see these particles (of solder chips) melt and flow about. The coals being directly removed, when cold, it will be firm.' Evidently he did not regard this tin soldering in the light of a difficult process, as he refrains on this occasion from considering the probability of having to ' do the like again.'

IV

The use of rivets is the most stable method of construction that can be employed when shaped pieces of sheet metal are to be united. It offers the best resistance to any degree of strain or hard usage. It also has its artistic merits, in those cases where the heads of the rivets present an even and regular pattern. In addition, it is of the greatest service as a preliminary process in fortifying the basic parts of any object of importance, leading up to the employment of soldering in the minor details.

The method is purely mechanical—the boring of holes in their correct positions, threading a piece of metal through them, and beating down the ends so that the interlying sheets are clamped together as in a vice. For small work the holes can be made with a jeweller's drill—which produces the neatest result—or with a simple pointed tool,

the hole being trimmed up with a file. But for anything larger a mechanical drill, such as is ordinarily found on the bench in a garage, is almost indispensable. Especially when an extra pair of hands is available to hold the object in position, the stoutest metal yields pleasantly to the edge of the drill, and as it is cut, curls away in graceful coils. It is often necessary to mark the position for an opposing hole; and a wire or piece of stick dipped in a little black oil paint is useful to insert through the hole already made, leaving an impression on the exact spot of the underlying metal for the fresh drilling.

For the rivet itself, a copper or brass wire of the right thickness can be used. The making of a head at its extremity may cause some difficulty. It may be done by cutting off a short length, placing it in the vice, and spreading the metal—very little is actually necessary—with a hammer; but the wire is liable to buckle up in a disconcerting manner. Still the method is practicable; and the remaining process of passing it through the holes prepared for it, cutting it fairly close and hammering over the other end, is comparatively simple. Certain small brass nails used by shoemakers are often a convenient form of rivet; the head at one end is already made, and it is only necessary to snip off as much of the nail as is required. To hammer a head over, the blows should be directed at first round the circumference of the rivet, with a final smart hit in its centre. This will correct a tendency of the metal to crack, and also produce a better appearance. It has, in addition, the advantage of helping to close up the rivet holes—as it must be remembered that a rivet holds chiefly by the pressure of the metal against the sides of the holes which have been prepared for its reception. The final hit in the centre of the head helps to drive in this inner portion of the rivet. The tightness of the fitting has at least as much to do with fastening together the parts as the closing down of the heads upon the upper and under surfaces.

An excellent device for making rivets of convenient sizes is not difficult to construct. Two pieces of block brass, about $2\frac{1}{2} \times \frac{1}{2}$ inches, are clamped together in such a way

that a hole can be drilled upon the point of the line where the two edges meet. With the type of mechanical drill we have referred to, holes can be drilled about three-eighths of an inch deep across this line with each different size of drill in such a way that each of the pieces of brass when separated bears on its surface exactly the one half of each drilled hole, a series of half-sections. It is better also to countersink them. To keep the pieces of brass in an exact position for the half-sections to correspond with each other, holes can be drilled crossways at the two extremities, through which small butterfly bolts can be passed. When these are tightened, any number of rivets can be made of the sizes indicated.

It is only necessary to insert wires of any appropriate metals—including aluminium and French nails—which make a good fit, snip the end off to protrude an eighth of an inch above the surface, and with a small round-faced hammer spread the metal till it lies flush with the brass. The rivet has now, with its head, been completed, and can be shaken out or extricated by unclamping the two sections.

As an illustration of the use of riveting we will take the making of a skeleton casket to receive side panels of metalwork or enamel. The metal is rather thick brass—an old firescreen has before now been cut up for the purpose. Two ribbons, half an inch in width, are cut perfectly truly, of sufficient length to form the top and bottom rails of the sides—each of them bent at the corner points to form the four sides. For the upright corner-pieces similar strips of double the width are bent over lengthways at right angles. It will require sixteen rivets to bind this framework together, two at each of the eight points of junction. The bottom of the casket is an oblong or square piece of brass cut to overlap slightly this completed framework; and at its four corners are riveted brass balls or claw feet, which can be bought at a brassfounder's. On its reverse side the framework must be fastened by four small ⊤ pieces of brass, riveted in turn against the inner side of the lower rail and the base. The lower portion of the casket is now rigid.

The lid is cut to the same dimensions as the base. A

pair of strong brass hinges, the ordinary machine-made variety, can be shaped to have quite an excellent appearance. The square corners are rounded off with a file, and all the square edges. With the assistance of emery paper they can be smoothed down until no sharp edges remain. These reshaped hinges are riveted into their places. A twisted wire soldered round the base will add a necessary finish ; and upon the lid is soldered an enclosure, made of a narrow brass strip, into which a decoration may subsequently be fixed.

The need for a suggestion of this character is often felt in order to utilise decorations which have been made purely for their own sakes. It is a difficulty which is constantly arising, to discover a satisfactory method of ' setting ' such ornamentation without the effort appearing too obvious. A series of panels in enamel would be delightful to carry through as an independent task ; and then the question often arises—what can we do with them ? That is the reason that a varied knowledge of allied processes is so valuable. They all work together to produce something which may be regarded as, on the whole, worth doing.

But at the same time it must be recognised that it is an artistic heresy to regard the decoration itself as the initial proceeding. The main structure, properly speaking, comes first ; its decoration should be a secondary matter. To suggest that a use may need to be found for a decorative piece of enamel is excusable only on one score—that the problem of enamelling is so engrossing in itself, that for the time being, little thought may be given to the place it will finally occupy. There is so great a chance of its not proving a success that the thought arises—might it not be a too ' previous ' calculation to construct the cart before the horse has been found to stand between the shafts. The enamel, one feels, is the main difficulty ; if this is successfully surmounted, time may be allowed for considering any subsequent considerations. When a full measure of confidence and experience has been acquired, then the idea of a main construction should come first and the enhancement of its decoration should in a correct sequence follow.

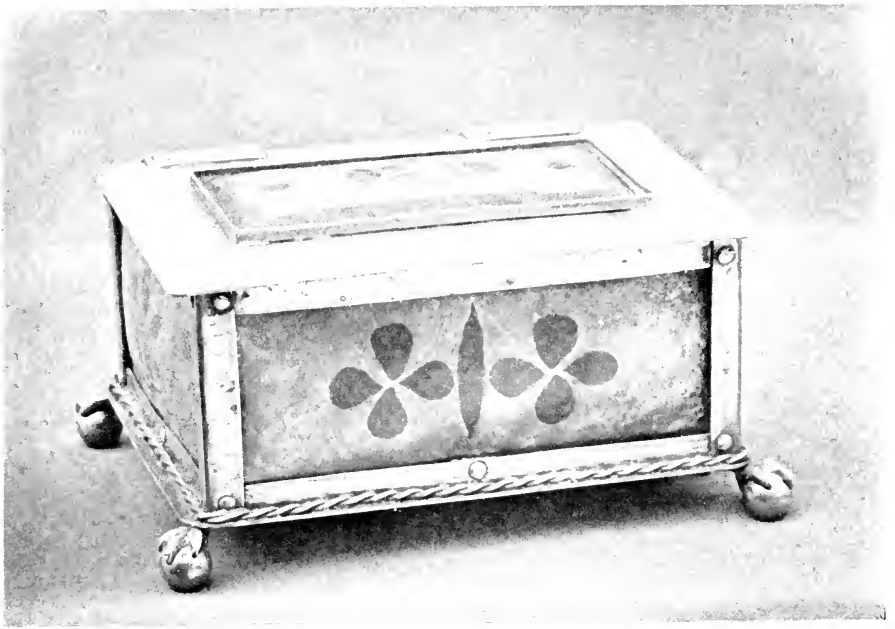

Plate 6

[*to face p.* 46

CHAPTER IV

ON ENAMELLING

MANY of us associate enamels with three things—the iridescence of such living creatures as beetles, butterflies, and the snake with 'her enamelled skin'; the colouring and the decorative design of flowers; and lastly, the precious stones.

With regard to the first association, the conflict of colour which we recognise as iridescence is perhaps too amazing and complicated to fulfil the highest demands of the artistic instinct. A splash of oil on a wet road gives a succession of tones, golden browns, magenta, greens, and the like passing swiftly into each other, but the scheme is too promiscuous to be pleasant. In quality of colour, however, there is much in common between iridescence and enamel, though a sparing hand is necessary in dealing with so wide a profusion. The flash of colour from the wings of birds and butterflies possesses the same qualities, but is redeemed by a more exclusive selection, and on that account may suggest many agreeable arrangements worthy of imitation.

With flowers we are on safer ground. The scheme is simple, although every detail is broken with the subtlest variations; and the appeal, being more natural and sympathetic, is the more human and affectionate. A finer guide for the best employment of enamel than this frail type of beauty is scarcely possible. The very names of the flowers recall the exact shades which comprise the enameller's palette—the palest tones of tinted white, the deepest shades of gentian and madder, all fitting into their places without discordance upon a pattern of mingled greens. Their scale is small and dainty, exquisite in a

brilliant delicacy—and this all serves to establish the eternal association of flowers and jewellery.

The same idea runs through the assembly of flowers summoned to honour Lycidas :—

> And call the vales and bid them hither cast
> Their bells and flowerets of a thousand hues.
> Throw hither all your quaint enamell'd eyes,
> That on the green turf suck the honey'd showers.
> Bring the rathe primrose that forsaken dies,
> The tufted crow-toe, and pale jessamine,
> The white pink, and the pansy freak'd with jet,
> The glowing violet.
> The musk-rose and the well-attired woodbine
> With cowslips wan that hang the pensive head,
> And every flower that sad embroidery wears.

The association with precious stones is perhaps the most obvious of all; there is the same brilliance and glitter of surface to rival—in a more humble degree—those jewels beloved for their power to dazzle by sheer magnificence; while the more opaque loveliness of turquoise and jade are closely followed by their vitreous imitations. In the early days enamel was rightly regarded in the light of an artistic rival, and upon these lines the best traditions of the art have been built up. In fact, the value of coloured glass as a decoration was not considered too insignificant to be associated with jewels, if it was felt that their splendour was enhanced by these means. After all, the relationship is not so very distant: it is to some extent a question of degree only. In the cases of glass and precious stones, transparent or semi-transparent bodies are stained with metallic oxides, the chemical difference being that enamel is a glass fused at a comparatively low temperature, while jewels are composed of such hard substances as carbon, alumina, silica, and magnesia, which can only be resolved under conditions of excessive heat. Such metallic substances as cobalt and chromium are frequently the colouring materials present in both cases—and the preciousness of the jewel is due to its rarity, while at the same time a

superior brilliance is obtained by virtue of its hardness and greater power of resistance.

After these more remote associations another aspect may be considered which comes very close to the point. If any resemblance between an enamel and a stained-glass window has ever struck a chance observer, a vital relationship has been detected: for an enamel is nothing but a stained-glass picture. We might even go so far as to hazard the possibility—certainly a remote one—that the window itself might be converted into the picture. The idea, at any rate, would illustrate the elementary principles of applying glass to metal. The word 'enamel' conveys, in its derivation, the sense of melting—with the special significance of making use of the known fact that glass can be melted to adhere to certain metals under appropriate conditions. When it is also recognised that glass is capable of remarkable colourings, while at the same time it may still retain its transparency, the possibilities which are opened up by melting it on to gold or silver surfaces—so that these metals shine through in their full glory—are sufficiently magnificent to fire the imagination.

The stained window, which it is proposed, theoretically, to sacrifice, had best be of the oldest and best variety, where 'pot-metal'—that is, a special coloration of glass prepared in a crucible and blown into a sheet—is displayed at its full value without a particular regard for design. Many of the most impressive windows are little more than an exalted patchwork of colour outlined with the black of the lead divisions which hold everything together. For the sake of the illustration it will be imagined that these lead outlines are reproduced in thick silver bands and laid in their corresponding positions upon a sheet of silver and firmly soldered down. There is now a skeleton plate ready to receive a coloured inlay of glass, somewhat in the manner of a transparent mosaic. Each separate fragment of glass will need to be removed from its lead casement, broken into powder and laid evenly in the corresponding compartment prepared for it. The metal plate, having been entirely filled in, will be subjected to the heat

of a furnace—irrespective of a considerable danger that the silver may itself fuse before this particular type of glass has fully melted. Barring, however, this possibility it is conceivable that when the glass has melted and cooled, a curious but not unpleasing enamel upon a large scale would remain as a relic of what at one time transmitted light but is now a riot of coloured tracery.

How, it may be asked, will the colourings have been affected? The pure white of the silver ground will produce a clear impression as it shines through the paler colours. Most noticeable will be the brilliance of the blues and the intensity of the greens. Violets and purples will be beautiful and lucid, the yellows inclined to be harsh; while the behaviour of the reds will probably be erratic, liable to vary between chocolate and black—with just a chance, although an unlikely one, that their original tone may be preserved.

Suppose gold had been employed instead of silver. The gold would offer, amongst other advantages, a greater resistance to the furnace heat: it would not melt. And the scheme would be vastly enriched and deepened by the gleam of the 'spangled ore' through the transparency. Reds and crimsons would be magnificent, clear, and opulent; the yellows a warm amber; the greens would rival the richest of emeralds; while the purple violets would, very possibly, assume the most sumptuous tones of all. Least significant would be the patches of blue, too qualified by the opposition of their golden background to assert their fullest intensity.

I. PREPARING THE ENAMEL

It is not proposed to indulge in any such iconoclastic crimes as breaking up precious windows to obtain our raw material for enamelling. The glass, as it is prepared in the form of enamel, is easier to melt, and is obtainable in lumps and odd fragments like so much candy or toffee.

A pestle and mortar are necessary to grind the enamel into a coarse powder. Agate is undoubtedly the best

Plate 7 [*to face p.* 50

and most pleasant material with which to do this grinding. Made in glass, the mortar and pestle have the advantage, that, although they tend to wear away with use, it is only glass that is wearing away, and the presence of a foreign body in the ground enamel is thereby avoided. In the case of the stoneware, or so-called ' porcelain ' varieties, chips of white, as the wear continues, are bound to occur, and these—unless they are removed previous to firing—will show up quite distinctly as white specks and possibly interfere with the effect. However, too great stress need not be laid on this possibility. The stoneware is good for the larger quantities ; the glass mortar must be used with some degree of gentle consideration ; while the agate need not be large and will be worth the additional cost.

The pieces of enamel to be ground should not be larger than the size of peas before they are placed in the mortar. If they are larger, wrap them in some wastepaper and hammer them on an anvil until small enough. The enamel is laid in the mortar and sufficient water poured in to cover it by an inch or so. Gentle tapping with a mallet or a horn-headed hammer on the end of the pestle will help to break down the larger fragments ; and then, by revolving the pestle in the fingers, it will be possible to obtain a grip on the enamel and reduce it to a fine regular powder of about the consistency of table salt. By this time the water will have become milky and may be poured off into a small basin, reserved for the purpose. The fine sediment which sinks to the bottom is worth preserving, and will be found of use later on. It is important to remember that in the case of transparent enamels this throwing away of what is termed ' mud ' must be continued until the enamel in the mortar is washed perfectly clean. If this is imperfectly carried out, the enamel is liable to fire slightly opaque ; and the more transparent the result is intended to be, the greater must be the care taken in ensuring a thorough ' washing.'

The mud collected in its own basin is allowed to dry after the clear water has been poured off, and will do so the quicker if the basin is tilted on one side. Kept dry in a special tin, this waste may be used for a variety of pur-

poses—as a polishing agent and also for the coating of the backs of plaques.

The ground enamel in its wet state can be laid between a cloth folded several times, and will be found practically dry the next day. In this state it can be kept in a corked bottle for an indefinite period, but would soon begin to lose its qualities in a wet condition. However, it may be required, wet as it is, for immediate use.

II. CLOISONNÉ

That a beginner in the art of enamelling should be invited to make his first essay in the style of cloisonné may create some surprise. The method appears to be over-elaborate, the initial necessity of arranging wires and fixing them is apt to be alarming—altogether cloisonné would seem to belong to an advanced form of enamelling. But there is no need to be overwhelmed by the apparent difficulties. Provided that the problems are attacked one by one in a methodical fashion, it will be found that, step by step, the processes lead up to a sure conclusion.

There is also the undoubted consideration that cloisonné is an eminently satisfactory form of the art, because it is closely allied to the style of stained glass, in that the cloisons correspond to the effective lead outlines—and allied also to the best traditions of jewellery in that each point of colour has its rigidly fixed setting. Uncompromising outlines were largely insisted upon in early work—and to this rule enamel was no exception. An alternative method to the use of wire was the chiselling out of definite shapes in the solid metal into which the enamel was introduced as into a pocket. If some old examples are examined which have lost, here and there, a portion of the enamel, it may be seen that the pocket was actually lined with gold. A richer effect was obtained by such a precaution. Champlevé, as the method is named, is particularly appropriate to heraldic work and may seem a little out of the common track. But the principle of marking out definite partitions is the same as in cloisonné, the only difference being that

Plate 8 [*to face p.* 52

the use of wire permits of a freer style and is more readily adapted to a graceful type of design.

One further deterrent may exist in the recommendation that the attempt should be made in silver. But the cost is in reality quite moderate and compares favourably with the expense of paints and canvas. The work is small and the silver thin. Quite a respectable length of silver cloisonné wire can be bought for a few shillings and will cover a good deal of work. And a consolation exists in the fact that, in the event of failure, the work can be broken up and the silver used again. It is an error to regard enamel work as remarkably permanent, except so far as its colour is concerned. A few taps with a hammer and the glass will chip off, leaving the silver little the worse, and free for renewed experiment.

It will be assumed that a design has been decided upon, covering not more than a square of two and a half inches—and if it includes a number of circles and half-circles, all the better for an initial attempt. The silver must be ' fine '—that is, unalloyed with copper, as is the case with ' standard ' silver—of about the thickness of a postcard. The cloisonné wire is bought ready drawn in a true oblong so that it will stand upright.

The pattern has been drawn upon white cardboard to the scale desired. First anneal the wire by taking a foot or more of it; and winding it into a small strand introduce it cautiously over a gas or spirit flame until each part has become just red hot. Such thin wire is easily fused, and the coiling of it together in a bunch diminishes the danger of its being melted. The wire is now ductile enough to be formed into any shape that is desired. A peculiarly charming form of draughtsmanship belongs to the manipulation of thin wire in any experienced hands. The curves fall evenly ; and the continuity of its line has a graceful certainty which defies criticism even when it may not be perfectly adjusted. At any rate it shows no evidence of indecision ; the outline is fixed.

Circles, half-circles, and other sections are delightfully easy to make ; and if they are not true as a die, there is

little excuse for the error. Take a round wooden paint-brush handle—and if it tapers gently, all the better, as it is possible to wind the wire round that portion which corresponds with the diameter required. Wind the wire round for as many turns as circles are needed, slip it off carefully without disturbing its spiral, and with a pair of fine shears cut right through the length of the loop at one point. A number of ringlets will fall, the ends of which can, with the aid of small pliers or the fingers, be made to meet on a flat surface such as a piece of glass—so as to form a complete and perfect circle. For half-circles or other segments these are easily subdivided—and it is not difficult to see how an extended pattern of scales could be made by a number of half-sections placed in an alternate fashion.

If, in the same manner as circular or semicircular forms, a leaf or other conventional pattern is repeated in the design, a piece of wood can be cut with the fretsaw to the particular shape and the wire wound round it, to be snipped through in an identical fashion. This will supply a regularity of forms to be employed in a decorative effect—and their repetition may be found to be actually helpful. Many an impromptu design could be built up, provided the shapes are cut in good typical forms and set out with a due consideration for a balanced arrangement. This, however, is only a mechanical suggestion for those who are disinclined to trust to the manipulation of their fingers and the judgment of their eyes for distance and dimension.

The wires have now been bent into the shapes marked on the card and cut into fairly short lengths. A pair of light tweezers, with the points turned off at an angle, are convenient for picking up the sections, comparing them with the pattern and laying them in their places. Pressure with the finger, or a little tap on a flat stake, will be sufficient to induce any recalcitrant fragment to straighten itself and lie flat. On a piece of cardboard spread a thin surface of fish glue, diluted with a little water, and taking each shaped piece of wire in turn with the tweezers, lay it for a moment on the adhesive, and then place it in position upon the silver sheet which has been cut to the size of the design.

The diluted glue will not affect the soldering, which can be carried out with very small chips of solder laid at intervals—and gold solder is actually the best for the purpose, as it leaves little trace—or with solder filings mixed with a liquid hard-soldering flux painted economically into the joins. The glass of borax ground up with paraffin will be found to work excellently. Then heat with a Bunsen flame from underneath until all the solder is seen to flow.

Put the work in a pickle of a ten-to-one solution of sulphuric acid until the borax has gone. Clean with a glass scratch brush and water; this will show whether any wires are loose. If it is necessary, resolder these. Finally, burnish with an agate point, using a steel polished point, such as a broken bodkin, to get into places where the burnisher refuses to go.

Everything is ready for filling the cloisons with the wet powdered enamel which has been prepared in its various colours and lies ready at hand in small separate glass or china dishes. A dozen common teaspoons are excellent for this purpose, easy to move and handle. This filling in of spaces, with what may be regarded as so much clean coloured sand, may be said to be one of the most pleasurable of the successive processes. The enamel can be taken up on the point of the spatula or conveyed on the tip of a fine brush. Placed in its appropriate bed, it is gently insinuated into the corners and levelled with a due regard to tidiness. There is no need to lay more than a moderate covering, as it will be necessary later to repeat the process after the first firing—and heavy layers of enamel at any one time are to be avoided.

As a first venture those colours should be used which may be confidently relied upon to stand the fire successfully. Let them also be transparent; because it would clearly be a waste of good silver to lose its value as a brilliant white mirror shining up through the translucent glass. Blues, varying from violet into the greener shades, the richer violets and the paler greens, these may all be depended on to run little risk of failure, and incidentally achieve a pleasant harmony.

If the work is small enough, not larger than a half-crown, the enamel may be fused by means of a blowpipe or Bunsen burner—and very frequently a combination of the two is most serviceable upon those occasions when a high temperature is necessary, such as, for example, in the case of soldering larger pieces of metal. With a double junction on a gas pipe, it is possible to employ a Bunsen burner under a piece of work at the same time that one can bring a gas blowpipe jet—actuated by a rubber hand-bulb—to play upon the upper surface. But this method is recommended with caution in enamelling, as the flame of a blowpipe is liable at any moment to blacken or lustre the surface of the enamel. This lustre, however, will disappear in a subsequent firing inside the muffle of a gas furnace, where the oxidising conditions are more perfect.

On this point it should be stated that, for successful enamelling, a gas furnace is indispensable. There is no way of avoiding this necessity, except perhaps in the smallest work—and this, by itself, would soon lose its interest. After all, a small furnace is scarcely a more serious proposition than an ordinary gas fire—and might even in cold weather serve the two purposes. This question of firing, however, will be dealt with more fully in a later section.

It is presumed that the first coat of enamel has been fired and that, on cooling, the intensity of the colours has been studied. If it is desired to deepen any particular shade, a second layer of the same tone—or possibly a variant—is imposed. If the colour is sufficiently strong, there is no need, for the moment, to reinforce it. The second firing will probably establish the desired scheme. The surface may appear uneven, and a wish may be felt to continue the enamel up to the top of the wires—although the prominence of the wiring, left as it is, need not be regarded as entirely unattractive. A transparent flux—by which is meant a clear uncoloured enamel—must be used for any filling up to an even surface ; and to preserve its transparency in the highest degree, be it remembered, a very careful washing is necessary, no trace of cloudy sediment being allowed to remain in the water. This flux may be laid as

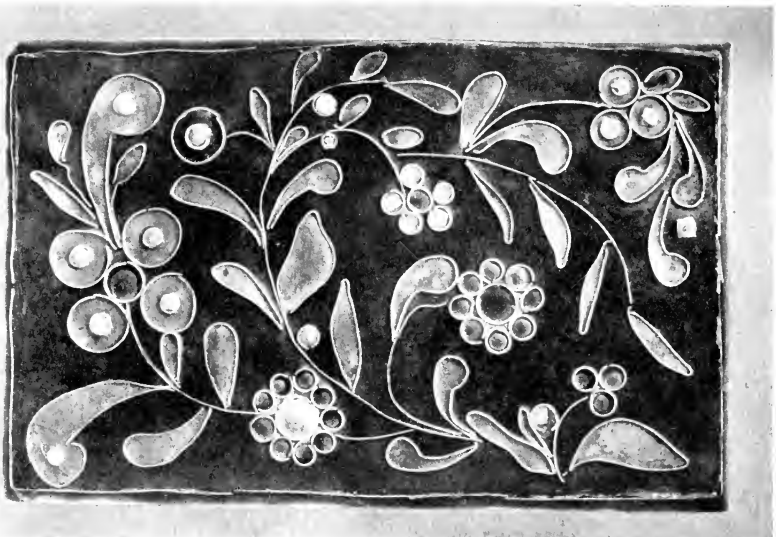

Plate 9

[*to face p.* 56

a final coat, and should bring the work to a brilliant and even finish.

A word is necessary concerning the flux used for silver. Different varieties can be bought, including a clear crystal, and another of a very pale bluish tone. Silver has the effect, as has already been stated, of imparting a yellow tinge to glass, and the bluish variety of flux appears to neutralise this tendency. As with many other enamels, it is always as well to make a preliminary trial to avoid any spoiling of an otherwise satisfactory piece of work by the use of an untrustworthy colour. A professedly 'crystal' flux may fire opaque even when the greatest amount of care is taken; and nothing can be more annoying than to find what is intended for a final translucent glaze result in a cloudy effect, entirely disastrous to the underlying work.

The last question to be decided is whether the work shall be carried further by grinding down its surface and polishing it by hand. The process is long and troublesome. A less laborious method is to reduce any inequalities with corundum and water, or even with a fine cutting file—only in this latter case the object should always be held in the hand while the filing is being done. To file a surface of enamel while it rests upon a hard resisting block or table is to court disaster. The enamel, after being rubbed down, should be washed with hydrofluoric acid, which cleans by eating away the surface. As this acid is very injurious to the skin, care should be taken in using it: the enamel can be laid well damped on a piece of sheet-lead turned up at the sides, and a feather dipped in the acid will serve to paint upon the surface of the glass. Then wash it—but be careful of the fingers. The 'fire polish' obtained by a refiring in the muffle will restore the lost transparency.

Almost all the cloisonné work made in the East has been laboriously ground down and submitted to the action of various stones in order to reduce everything to a dead level. This is more or less essential with vases and other ornaments, as a rough texture of slightly uneven enamel and a marked evidence of wires, or thin fillets of metal, would be unpleasing to the eye and touch. The amateur, however, is not,

as a rule, anxious to waste precious time over his results. He is also generally working on plaques, more or less flat; and the simple unstudied effect of well-laid wires and pure enamel, untouched as far as possible, may be regarded as a fitting and satisfactory reward of his efforts.

Gold, being practically free from oxidisation, is excellent for this class of work. It can be quite thin; but must in any case be 'fine,' unalloyed with other metals. Gold cloisonné wire would naturally be used. An excellent compromise may be recommended, to use a gold wire on a silver ground. One disadvantage of silver wire is that it blackens with exposure to the air. If this is felt to injure the effect, a gold wire can take its place. Silver and copper, it should always be remembered, cannot be associated under strong heat; they are ready at the slightest provocation to fuse into an alloy. But gold wire on silver works excellently; and there is reason to believe that, as an additional advantage, it partially solders itself in the process.

Treat the gold wire in the same way as the silver, but use a solution of tragacanth gum instead of any glue solution for laying the cloisons on the silver ground. Tragacanth dissolves in water in the same way as gum arabic, though more slowly—and it is advisable, owing to a tendency to become mouldy, not to prepare more at a time than is needed. Its sovereign merit in enamel work is that, in the firing, it disappears entirely, leaving no trace of injury—whereas other kinds of adhesive may cause bubbling or some other of those imperfections against which the enameller is for ever striving.

When the gold wire has dried on to the silver, the wet enamel can with care be laid without disturbing the design. It must be as little wet as possible to avoid redissolving the gum, and the outer spaces should be first filled. If the inner cloisons are at once filled with the wet enamel, they are inclined to slip: but by first building up, as it were, the enamel in the surrounding intervals to hold them in their places, all the wires should keep their positions.

Finally, a few remarks on copper cloisonné. This metal in cloisonné can scarcely be recommended as likely to

repay time and trouble. For one thing, transparent colour on copper is apt to be disappointing from the point of view of brilliance—and the copper wire itself, under the influence of heat, is continually throwing off its metallic oxide over the enamel, with the result of spotting it badly and destroying its lustre. A somewhat rugged effect can be obtained by using a flattened wire and bending it into the broad form of design which is characteristic of fine old iron work. These wires should be hard soldered to their copper bed. With the whole plate well cleaned in dilute acid, opaque enamels may be employed with good effect—dull blues and greens, white or grey, and the opaque reds which may, or may not, fire to quite the richness of their original colour. Should the reds, however, happen to turn rather dark or brown they may retain a sombre quality of their own, which may not be ineffective in work of a bold character.

III. PREPARING A PLAQUE

The plainest—and ugliest—enamel plaques that ever entered a muffle, meet our eyes in the most public of places, with an effrontery which is deliberately calculated to attract the greatest possible notice. Not every one would recognise these works of advertisement as the present-day descendants of the oldest Byzantine enamels, perverted as the type may legitimately be regarded. But the material is very much the same, so far as opaque enamel is concerned, and the same principles govern its application.

These sheets of advertisement, hung on the sides of railway platforms, may be examined with some technical interest whenever the metal beneath the enamel has been exposed. The metal will be immediately recognised as iron, and it can be seen that a substantial layer of opaque enamel has been fired upon its surface. Examine the other side, and a similar coating—though of a less obtrusive colouring—will be detected.

Why should the back receive this attention and be covered like the front? The object is merely to keep the front intact. If the back were neglected, the important announcement for

which the advertisement was constructed would fall to the ground. Metal and glass both expand and contract under the influence of heat and cold in a different ratio—with the one exception of platinum and glass—and as the temperature of the air is constantly changing, they tend to be pulling against each other whenever they are closely associated. The consequence of this conflicting movement would inevitably mean that, unless the tendency were neutralised, the weaker of the two would have to give way to the pressure; and if the weaker happened to be brittle in its nature, it would immediately crack and become disintegrated. Fortunately there is a remedy to counter this misfortune. The metal can be encased equally on both sides with the same material; and the strains are in this way equalised. It is the technical application of the Balance of Power.

Even in the case of cloisonné—where the enamel obtains a purchase against the walls of its wire enclosures and is thus held in its place against the strains induced by varying temperatures—there still exists a danger that the force exerted by the metal may overpower the weaker member. It is wiser, therefore, even in this more protective form of enamelling, to fuse a layer of enamel on to the reverse side and so make matters safe. After all, it is the employment of the same principle as in the cases of non-curling photograph films and the pasting of paper on either side of book covers to prevent any buckling caused by an unequal tension.

A metal plaque is usually raised or embossed for enamelling purposes, not only to give it an additional strength, but to prevent the enamel, intended for the back as well as the front, from sticking, when in a molten state, to the support on which it rests. If an interval exists between the back and the support, the only place at which this sticking can take place is on the edges of its circumference, which does not greatly matter. It will detach itself with a little encouragement.

Take a sheet of copper and cut from it a piece of the size desired, making sure it is small enough to go easily into the muffle of the furnace. The copper should be thin

Plate 10

[*to face p.* 60

in proportion to its size: no unwieldy mass of metal is either necessary or advisable. After annealing, work it lightly into shape by hammering with a wooden round-faced mallet on a loose sandbag. In the case of a round plaque, the metal will assume, almost of itself, the domed shape which is required, and only a little adjustment with a hammer on a flat surface will cause the edges to lie perfectly truly. A square or oblong plaque is rather more difficult to manage, especially at the corners. Much assistance is gained by cutting with the scissors at the sides of each corner a narrow shaving of about half an inch in length, so that the squareness of the right angle at the corner is slightly reduced. Rubbing with the burnisher, or some light hammering, may be used to complete the inner shaping of the plate—with especial attention to the corners. Should it lift at two sides when placed on a flat table, rub gently with the handle of the burnisher, flattening it a little, and in time it will sit evenly. The doming of the plaque should finally assume the curved form of a watch-glass.

A perfectly flat plaque is not so easy to enamel on both sides. The copper must necessarily be thicker, and a few strips of thin copper require to be cut and bent into rings to form supports. Four or five of these will be sufficient; they can be pulled off afterwards. The embossed plaque will be found the most convenient form to adopt; and apart from the greater ease in working, it has the advantage of conveying a richer and more decorative effect.

It is now necessary to cover back and front with a layer of the crushed enamel, preparatory to fusing it on the metal in the furnace. The enamel mixed with water will hold during the firing on the top of a plaque, but without the addition of gum or some substance to hold it together, it will have a tendency to fall off the bottom at the slightest jar. A solution of gum tragacanth—of a consistency at which it pours easily—will best serve the purpose.

The question of appearances as regards the enamel on the back of a plaque must be decided by the individual; it is a matter entirely of personal taste. Some may be disinclined to delay over what they regard as a non-essential

detail, and will use up any odd stuff—such as the washings which have been reserved for such a purpose. Others, who prefer to see everything carried out as perfectly as it can be, will use one enamel only ; so that the back of the plaque will present an even and attractive appearance rather than a nondescript tone which will, almost certainly, fail to be beautiful. Either choice will be equally effective as a safeguard against cracking. One precaution, however, is necessary. The enamel must not be too soft, as it will in that case fire into beads or run off like so much treacle on to its supporting base, with the most distressing results. It is advisable to keep in readiness for this contingency any odd pieces of ordinary ' flint glass ' ground up finely—such as glass jugs or broken wine-glasses. If this is again ground up with the soft enamel in the proportion of about one to four, it will, by its superior hardness, hold everything together and avoid by its greater resistance to the fire any tendency of the enamel to run over the surface of the metal too freely.

A true covering of the whole of the back of a plaque is important. The enamel on its front is always liable to crack exactly opposite to the place where there may be beads or cracks or deficiencies on the under side. This fact may be observed in some of the Limoges enamels, where the opaque white has shown a disposition to crack. The irregularities on the back, if the back is visible, will almost certainly account for the trouble. The cracking is also the more likely to happen if the copper itself is too thick. Look at the beautiful enamelled surface of a watch or clock dial and see how thin the copper is.

Spread the prepared enamel on the back of the plaque with a palette knife as if it were so much stiff butter on a piece of bread, lay it fairly wet, and smooth it down with the knife—or, in the more difficult places, with a paint-brush. When smooth enough drain off the superfluous moisture with a folded cloth, laying it fearlessly upon the top of the enamel. After a minute it can be lifted, and practically none of the enamel will stick to the cloth. While the surface is still only damp, and not really wet, complete

the smoothing process with the knife or any kind of spoon-shaped tool, and this will finish the preparation of the under surface, leaving everything ready for dealing with the upper and more important side.

We will suppose that an ordinary transparent flux is to be laid on the upper side of the copper. The flux has been crushed and well washed. Take a portion on the spatula and place it on the centre of the plaque. With the edge of the curved end of the spatula work the enamel evenly towards the sides by a series of gentle chopping motions, the endeavour being to produce a thin even surface over the whole plate. Fresh enamel is added until all the copper is equally covered. Every worker will discover a favourite device for laying this slightly intractable material. The use of a brush only is apt to produce a ' blobby ' surface. Something more like the action of a garden rake upon a gravel path is preferable. A form of etching tool which consists of three or four needles fixed side by side—an equivalent could easily be improvised—is an excellent means of taking a blob of wet enamel off a brush, laying it in the right position, and smoothing it down evenly with the rest.

A folded piece of linen is laid over the finished surface in the same way as was advised with reference to the back and gently pressed. This all helps to improve the general evenness.

Another method of laying the enamel is known as ' peppering '—sifting the dry powder over the surface of the copper, which has previously been painted with a suitable adhesive. A solution of celluloid in acetate of amyl, rather thinner than treacle, is an excellent varnish—leaving no trace whatever, as the celluloid is quickly dissipated in the fire. Seeing that this varnish dries quickly, it is best to lose little time in tapping or shaking a small tea-strainer half filled with the dry enamel over the plate until the whole is covered and no copper is visible. Then give it just a little more to make sure that there is enough. If you sift too little, spots of copper will appear after the firing, and these will have to be cleaned with acid and scraping, repaired

with fresh enamel, and again fired. But in any case—after the sifting and before firing—lay a thin sheet of paper over the sifted enamel and very gently press over it with the tips of the fingers. On the whole, the wet method of laying the ground will be found the most satisfactory, and perhaps the simplest; but the use of sifted dry enamel over a celluloid or gum solution—and this is the method adopted with the big advertisement sheets—has its conveniences and will often be found a useful trick for obtaining an evenly distributed result.

To prepare the gas furnace, first close the air inlet and with a taper light the gas at about half-cock. It will burn with a yellow flame. Gradually open the air inlet until forks of blue flame become well in evidence, place the muffle inside and close up the opening. Turn the gas on rather more fully, although the full pressure will not, as a rule, be found necessary. In half an hour or more the muffle should be glowing with a cherry red colour, and will be hot enough to receive the plaque. This should already have been placed on a support, either the kind sold for the purpose or a piece of thin iron—the lid of a tin box would serve the purpose—which has been brushed over with a thin mixture of clay and water to avoid any sticking of the enamel when it melts. A wide-necked bottle partly filled with some form of prepared clay, and sufficient water to maintain it in suspension, can be kept ready at hand for this purpose.

Should the absorbent plaques, sold as supports, be used, they must be perfectly dry before they are placed in the muffle. Otherwise, a mild explosion may be expected which will upset the plaque, scatter the enamel, and spoil all the preliminary work.

Let the plaque stand on the top of the furnace to dry thoroughly. To carry the plaque on its support an implement will be needed in the form of a shovel—or miniature spade—which can easily be made out of an odd piece of iron joined to a long handle. A long pair of iron tongs is also useful to assist in gently pushing the plaque lying on its support off the shovel on to the floor of the muffle

without disturbing the enamel, which is now so dry that it might easily be dislodged.

After the plaque has been cooked, with the door of the furnace closed, for a minute or so, it will be as well to see what progress is being made. Not until the surface has melted to the appearance of a shining mirror should it be removed on the shovel. If it is seen that one end has been fired less completely than the other, turn the plaque round the other way, and thus reversed, give the plaque a little longer in the fire. This will ensure an even firing over the entire surface.

Let the plaque cool gradually—and this stage of the proceedings is ended. Should it at any time buckle up a little and fail to lie flat upon its edges, press it down on a flat surface, while still incandescent, with two palette knives, or pieces of clean sheet iron, at the points which require it. In some cases a common flat-iron is excellent for this flattening. It will not harm the enamel itself or the plaque, if used with discretion.

IV. DECORATING A PLAQUE

We have now reached the stage at which the copper is showing through a clear transparent flux as a pale yellowish pink ground. Possibly, through a slight vagary in the firing, or some impurity on the face of the copper, the effect is inclined to be of a cloudy red. Subsequent firings will probably clear this away, and no serious apprehensions need be entertained.

If the object is merely to obtain one simple colouring, it is only necessary to grind up the enamel which is selected, lay it evenly—and not too thickly—and then fire as before. Should the enamel on the back be imperfect, this also should, first of all, be patched up with fresh enamel. But when once a substantial covering has been assured on the back it will scarcely require retouching—although, theoretically, the quantity on either side should be approximately equal.

In the case of a design in colour, the value of the divisions

in wire will be missed. There will be nothing to prevent one enamel drifting slightly into another so that the edges are lost. If no objection, however, is felt to this mingling of tones, the colours can be laid side by side. An enamel which has been mixed with a little gum tragacanth can, if more definition is desired, be allowed to dry before any other is placed next it; and this will help to separate the tones more decisively. So long as the colours are transparent the effect may be satisfactory; but if opaque colours are used in this way, the ragged edges, where they mingle, will become so marked that the appearance will be positively disagreeable.

In decorative work of this kind there is an instinctive partiality for definite outlines and a distaste for looseness of effect, except under special conditions. A few suggestions therefore for introducing lines of demarcation will not be out of place. On the copper itself, well cleaned, the pattern can be drawn in a common black oxide—unless the more costly oxide of iridium, which decorates our watch dials, is preferred for its greater strength. Take some of the oxide and grind it on a glass muller with a medium such as a weak solution of gum arabic, vinegar, wine, or even, it is said, beer. Some fluid with just sufficient body to carry the gritty oxide in suspension is necessary. The drawing of the pattern can be carried out with a small brush quite directly; or a fine pen can be used, in which case a brush must convey the mixture to the pen and renew it frequently, as this fluid will be found to run very less freely than ordinary ink owing to its gritty consistency. When the drawing is completed a coating of flux can be laid over it, care being taken not to disturb the outline that has already been drawn on the metal.

When the plaque is fired, the drawing should be visible with a charming quality of its own under the glaze, and transparent enamels can be used as a colouring in much the same way as the tinting of a water-colour drawing. The reds should come out strongly, the other colours will be somewhat reduced in tone owing to the copper ground—but the general effect should be reticent and harmonious.

Plate 11

[*to face p.* 66

Small details, if it is wished, can be picked out in finely ground opaque colour.

A more complicated variation, but a variation capable of excellent results, is to etch the copper plate deeply—preferably with a solution of perchloride of iron—and to rub a black oxide mixed with gum or celluloid varnish into the lines. Fire a coat of flux over the whole, and an enamelled etching is produced which can be treated with transparent enamels. Any strongly decorative etching can look very dignified with deep rich violets, reds, and paler tones. Final touches can be given with vitrifiable colours; but for the most part the transparent enamels should be relied upon to obtain the full effect.

Another equally original treatment includes the use of cotton thread as a temporary form of cloison. The term 'temporary' is employed advisedly, as the cotton, being cellulose, will disappear entirely in the fire, leaving a slight detached ash on the enamel which does not injure it in the least. The *modus operandi* is as follows. A little gum arabic is placed in a saucer and the lengths of cotton, cut as they are required, are dipped in the gum with the brush or tweezers, and laid in position on the plaque, which should preferably have been fired with a transparent flux. A pattern can be constructed with surprising ease; it almost suggests the effect of lacework. If a number of pieces of cotton are required of the same length—for example, a number of decorative leaves or flower petals—wind the cotton round a stick or piece of cardboard of an appropriate size and cut through with the scissors in the same way as with the wire circlets. It will be found quite easy to lay down the designs and build them up. A nip here and there with the tweezers will assist in the sharper angles. Even before the cotton has completely dried, the enamels can be laid in their respective spaces, either opaque or transparent, and with only ordinary care the positions of the cotton enclosures will be very little affected. Some distinctly interesting results are quite on the cards when the enamel has been fired.

An excellent adaptation of this method is to prepare a

monochrome plate—for instance, *rouge feu* over a coat of flux, which should give a ground of soft red. Set out a slight pattern, such as the *fleur de lys* or conventional rose, with the thread and fill the spaces with a thin glaze of a darker tone in warm violet or red. The effect will be a ground colour of a beautiful quality upon which is traced a softly defined pattern.

By employing the very finest thread, it is not particularly difficult to set out even a pictorial design such as a formalised tree with fruit and blossoms after the Persian manner or the Herbals of the best period. The sky can be treated with blue and opaque turquoise to set off the transparent colours. Many other possibilities may suggest themselves, if the method commends itself.

So far, we have considered a ground of copper for the enamels, and there may have been a feeling of disappointment that the colourings have not been as gay and brilliant as was expected. Silver we know to be capable of a brighter effect; and an undue expenditure can be avoided by employing thin silver foil instead of the solid sheet. The foil must not be of the very thinnest type known as 'leaf.' That would immediately be consumed in the fire and disappear. The foil must be at least as thick as that sold for Limoges enamelling—the thickness of ordinary writing paper—and will be cut with the scissors to the required shape. Meanwhile a copper plaque has been covered with a sound coating of flux and fired. If at any time the silver should come in contact with the bare copper it will at once fuse; precautions should therefore be taken that the copper is adequately covered. A careful annealing of the foil will be necessary to remove its stiffness; and it should be gently worked on a sandbag to a shape as near the contour of the plaque as possible. With a needle prick holes here and there over its surface to enable any air to escape which may happen to have become enclosed while the silver was settling down on the enamel in the furnace. Otherwise a blister will be formed, which will need to be pricked in the same way as an ordinary blister on a finger, and afterwards burnished down flat. Place the foil over the plaque

Plate 12 [*to face p.* 68

with a little gum to keep it in position and bring the whole to a sufficient heat in the muffle to remelt the flux. The foil will subside gently on to its surface and adhere. Stroking with the blade of a palette knife will, if necessary, facilitate matters. When all has cooled, a very fair surface of silver should be found—not as good as sheet silver, but good enough—and any roughness caused by the needle pricks can be gently filed down. We have now to all intents and purposes a silver plaque ; and the silver has the great advantage over copper that in addition to its superior brilliance it is a purer metal as regards enamelling. The powdered glass, with few exceptions, can be laid directly on the metal, whereas with copper a foundation of flux is generally indispensable. Gold foil is well worth using in the same way for the fine richness of effect which can be obtained by its use. The metal is so clean in the fire that any colour can be used without the intervention of a flux.

Not only plaques may be treated in this way but beaten bowls. The silver foil should in this case be brought very nearly to the same shape as the flux-covered copper, and even if it does not settle into its place with perfect accuracy after the firing, the inequalities will not greatly matter, and may even add a variation of quality to the overlying enamels.

V. GRISAILLE—FOR LIMOGES ENAMELLING

Painting with an enamel white on a dark ground—in most cases black, the principle applying equally to any other which is dark enough—is very much the same thing as drawing with white chalk on a dark-tinted paper. And a further refinement may be adopted by painting a design with gold on a dark enamel, three paintings and firings probably being necessary. Fine lines can be struck out with the point of a needle where they are required before the plaque is introduced into the muffle, with very considerable sharpness of effect. Drawings on toned paper have been executed with gold lines in this same fashion ;

the relief of the gold standing for a rich method of enforcing lights.

For the moment, white on black is the process under discussion. This painting in grisaille, as practised by the Limoges enamellers, has been frequently dealt with ; but, in spite of all the information which has been supplied, it is a matter of no little difficulty to use white on a dark ground so that the semi-transparent white makes a grey or half-tone. The white itself is the main trouble. It is far from easy to buy a prepared powder, which must be almost as fine as dust to work properly. Much trouble is avoided where a satisfactory white can be obtained. If this type of work is seriously attempted, trials of various samples should be made—and any really good one gladly adopted. It should be so fine in quality that, when mixed with the refined *huile de pétrole* or even common paraffin oil—this is better than the more usually recommended oil of lavender—the white can be laid with a brush on a dark enamel, levelled and smoothed with a needle point, to show as a flat grey with no grittiness or white spots. That implies a long grinding.

It is barely possible to obtain the full effect with less than three firings : for, if the whites are loaded in the first instance, it is quite certain that the work will crack. Paint therefore all the greys first and observe that they fire darker than they are painted. Each firing must be just sufficient to glaze the surface. Otherwise the white sinks and tends to disappear. The work, in that case, has to be done again —and for each additional firing the greys tend to darken in proportion as the whites fade.

The danger of cracking is always present. If the enamel ground cracks on being placed in the muffle—and you will be able to hear it—the firing may correct the crack in the ground, but not where it occurs in the white. Even the best of the old Limoges enamellers suffered from this trouble, and it can be clearly seen—especially in the larger plaques—that they have painted over the cracks and only partially concealed them.

Supposing a satisfactory ready-prepared white has not

Plate 13

[*to face p.* 70

been obtainable, the best method is to grind some block white in a mortar with enough water to half fill it. As the water becomes milky with the finest particles held in suspension, pour it off into a basin. Continue this process until a fair quantity is obtained. Then let it settle down as a sediment and collect it. Place it on a flat glass slab and grind with a muller. It might even be recommended to do this grinding in shirt sleeves, as an ordinary coat-sleeve sheds a fibrous dust which gets into the white. Grind until it is quite smooth ; then dry and mix it with paraffin oil and use a muller on the glass slab to obtain a creamy mixture. In this condition the white will last well if protected from the air : the oil successfully preserves its quality. An idea of the importance which has been attributed to this laborious process can be gathered from the advice contained in an old recipe—' grind for three days ! '

The best way of painting with this slightly difficult material is to drop a little off the end of a brush and model it with a needle fixed in a wooden holder. With a fine clean brush, just damped with the medium, it is possible to cut out a space clear to the ground ; but a ridge may be left which will need to be flattened again with brush or needle. Here will be found the test as to whether the white is sufficiently ground. If it is imperfect, the effect will be spotty and lacking in that creamy softness which is desirable.

If, as in the old Limoges enamels, it is wished to mould drapery on a background with white and cover it with a transparent enamel, the white suitable for grisaille will be found to be scarcely hard enough in the fire to remain unaffected by the enamel laid over it. The white will probably come up in small specks. A harder white will be necessary. It can be made by adding a very small quantity of pipeclay and grinding it well together. This will harden the enamel, but at the same time deprive it of its glazed surface. This surface, however, will be restored in the subsequent firings when it is covered by a colour which does glaze. The quantity of pipeclay used must be very small.

A grisaille can be tinted with the vitrifiable colours which are used for painting on china. They can be bought in powder and ground on the glass slab with a medium such as 'fat oil' diluted with turpentine, oil of lavender, or even gum. They can also be bought in tubes like oil colours—in which case turpentine will further dilute them. The firing of these colours must be very slight, just enough to fix them. The flesh colour is the most difficult of all to use, because to bring it to a glaze, it may become too pale in the firing. Gold is excellent to finish with. Shell gold does very well, fired with just a touch of the flux sold for the purpose. This must be left to the last firing of all, to avoid any unnecessary loss of the gold by absorption.

VI. ENAMELLING IN RELIEF

The ease of tracing a design in relief upon distinctly thin metal is no greater than that of working on damp leather; but by itself such metal work is too unsubstantial to be satisfactory. Employed as a base for enamel it serves its purpose admirably; the thinness is a positive advantage, and the addition of a coat of enamel stiffens it into a solid piece of work.

The effect of the relief can also be heightened. Supposing the metal is thin silver—foil would be too thin—the rather florid type of design characteristic of Italian Renaissance work might commend itself. Well annealed and laid on wet leather, pressure with the blunt point and flatter portions of a steel burnisher—or even a pointed piece of wood—will obtain the effect, without any hammering. First the outline, and afterwards the modelling, will be the order of procedure. Enamel will be laid on the under side in the usual manner; and if simple transparent glazes are intended to be used upon the front, the enamel will need to be mixed with some gum tragacanth to enable an even coating to hold well over the relief—the tendency of the enamel, moistened with water only, being to slip down into the hollows. The same thing is likely to happen when the enamel is fused and flows over the surface like

Plate 14

[to face p. 73

Plate 15

[*To face p. 72*

so much treacle. To counteract this, the whole affair can be fired upside down by making an iron cradle to support it at the sides. If a thin piece of iron is taken, of the width of the muffle, and turned up an inch or so on the two longer sides at an angle of 45 degrees, the two bevelled sides will support a plaque placed face downwards—thus enabling the face of it to stand away from the lower portion of the cradle. The enamel, when melted on this structure, will tend to flow downwards, out of the hollows of the design, and regain its position, if it had lost it, over the spaces of the higher relief.

The pattern can be brought out with greater distinctness by using a dark or even a black enamel on the lower levels. Employ it in a thoroughly wet state all over the plaque, so that it sinks into the hollows and leaves the portions in relief uncovered. Absorb the superfluous moisture with a cloth, or dry brush, and either fire it in this state or continue to cover the bare metal with paler colours ; it may be done in one or two stages, as is preferred. The effect can be varied very considerably, according to the conception of the colour scheme—in gentle modulations or in more abrupt transitions. There will, at any rate with transparent enamels, be a varying depth of tone, and in addition, an excellent broken quality.

Should the metal be copper, it must be carefully cleaned and covered entirely with flux. After that is done, a very free use of wet and dry enamel, laid on its surface in rather an indiscriminate manner, irrespective of the pattern, can produce a partially iridescent effect in which reds, light and dark, greens, and drifts of golden yellow would predominate. The pattern can be left to look after itself, as the modelling of the metal will be sufficient to preserve the design.

An amusing variation approaches what has been called a ' stained glass ' effect. It is, in fact, a deliberate attempt to adapt a window design, on a small scale, to enamel. A piece of fairly thick silver foil is cut into the required shape, annealed, and placed on wet leather. A pointed lead-pencil serves excellently to draw the design, with pres-

sure, upon the silver. The black lead makes a smoothly running point, well adapted to depress the surface of the silver into shallow channels. When the design has been marked out in this way, it is necessary, first, to enamel the back only. A liberal coat should be fired on it in the muffle, the face of the silver resting on an iron sheet painted with clay. When it has cooled, paint this enamel, which has just been fired, with the clay solution. The object of this is to prevent it from sticking to the support when it is next fired right way up. A tendency to curl may be avoided by laying a coil of iron wire on the top of the unfired enamel.

Now run some finely ground black enamel into the grooves of the design and fire it. This will ensure the necessary strong black outlines ; and the subsequent firings of coloured glazes should produce a representation resembling the type of stained glass which is contemplated. A flat-iron can be used at any time when the enamel shows signs of getting out of shape. Turn it while red hot on to a flat surface and bring the iron lightly upon it. Sections of a larger pattern than the muffle would naturally hold, can be made and sunk in a panel of wood, according to their proper positions, to present an unbroken appearance of the whole design.

VII. PLIQUE À JOUR

By this description is indicated an open-work type of enamel in which the transparent glass, instead of showing the metal underneath it, is perfectly clear, like a small window, in the design. When the heat of the muffle, as may accidentally happen, becomes so intense that a silver ground burns through, leaving a hole, a transparent film of glass is often found covering it—a pretty effect which scarcely avails to make up for the injury.

This matter of the firing makes enamelling the most exciting of the minor arts. It is impossible accurately to forecast what is going to happen. The crushed enamel is a clean, delicate material, with the appearance of tinted frost as it lies evenly spread upon the plaque. This crystal-

Plate 16 [*to face p.* 75

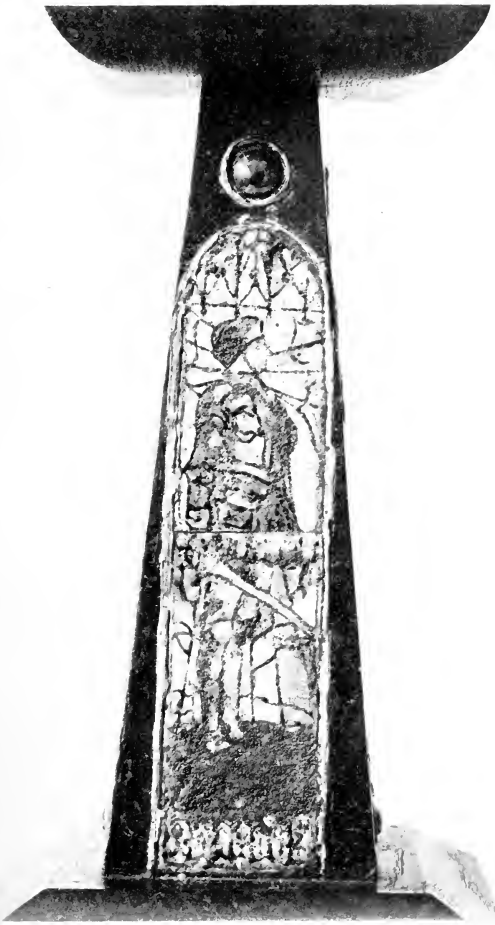

Plate 17

[*to face p.* 74

line freshness is fated to disappear when once it has been introduced into the heated cavern of the muffle, to be transformed into the smoothness of a mirror. Quickly the excitement grows as the molten surface is withdrawn, glowing with an incandescent flush of red. The colour then begins to flicker as it cools. The main anxiety centres round the reds. Will they fire true to their colour? Or will they have resolved themselves into a degraded brown? Gradually they settle to an even colour and come to rest—perfect. Heaven be praised! The other tones meanwhile have been passing through odd transitions. The greens especially hover round a number of random shades until they finally clarify into the limpidity that was eagerly anticipated. Blues are staunch allies. They cause little anxiety and can always be reckoned on with a reassuring confidence. If all is well, a sigh of almost surprised relief is drawn, that the experiment has stood the test and no further risks need be run. The fire has worked the miracle —and that is enough.

On the general principles of firing enamels a few words are necessary, with regard to the degree of heat needed. For one thing, in the muffle itself the heat varies very considerably, the further end being much hotter than that which lies nearer the door of the furnace. Many colours, especially the blues, rejoice in a strong heat, and on those occasions where the silver fuses owing to a too intense temperature, any blue enamel in that immediate neighbourhood will be found to show an especially fine quality. The greens, as a rule, are equally robust; and one is often encouraged to overfire in order to obtain some of this fascinating colour. The practice is, however, dangerous—particularly with opaque colours. Some, in fact, may become absolutely rotten and form small craters—like so much lava—necessitating a rigorous cutting out of the disaffected portion. Black is especially chary of overfiring, losing its lustre under such conditions. Transparent browns, yellows, and others—as will be discovered in course of experience—will be apt to resent more heat than is absolutely necessary to fuse them; and for this reason it is advisable

to lay the faster colours during the early stages of a piece of work and reserve any doubtful colour for the final chances.

To return to the methods of *plique à jour*. It is only in the hands of experts that this difficult process is likely to obtain a complete success, and fine specimens of the work are not often seen. Very special knowledge is necessary to make cups or dishes in this manner, and the work itself cannot be otherwise than fragile. The processes are likely to be kept as close secrets—the trick, for instance, of firing the enamel *in situ* with a quick hot fire. Filling the corners of the open spaces, first of all, with the enamel, and then, when this preliminary hold has been obtained, filling up the centre, is probably the method that will meet with the greatest success.

An easier way is to fire the enamel, where it is intended to show transparently, over thin foil—the foil afterwards being either pulled off, or, in those places where it refuses to budge, eaten off with acid. The back of the enamel is in this way removed. Some discoloration will be apparent and the enamel will need to be ground down and polished. As an alternative to hand polishing it can be refired: the enamel will hold over the spaces, with moderate care.

Another excellent device is to use a fretsaw and cut out portions of a design—as, for example, the backgrounds of an embossed piece of silver or spaces round which cloisonné wires have been soldered. This cutting should invariably be done after, and not before, such soldering has been done. Foil must then be arranged—supported perhaps by plaster or investment—to carry the enamel over the open spaces, and removed when the enamelling is completed. The effect gained by this method can be exceedingly attractive, especially in the case of jewellery. The pale and translucent enamels sold for this particular purpose are especially clear, and provide a thickness of enamel sufficient to bridge over the gaps and thereby preserve the necessary solidity of the whole.

Benvenuto Cellini is often quoted as explaining a method of producing this openwork enamel. A small iron caisson,

he says, was first made to fit the work and its interior covered with clay. The idea which is suggested is that any enamel fired over this clay would not adhere to it. But so far from this being the case, the more molten the enamel, the further will the particles of clay penetrate into its composition, and the surface in any case will be considerably roughened. Possibly the heating might be arrested at the point when the enamel had reached a consistency of putty. At that point there would be only a slight adhesion to the clay foundation, and a refiring, after it had been removed, might establish the enamel in its position and complete its transparency.

CHAPTER V

MANIPULATION OF SHEET-METAL

I

A PRACTICAL acquaintance with metal, for no very convincing reason, is far rarer than a knowledge of the management of wood. The average man recognises at a glance the problem of carpentry: he is dealing with a comparatively immobile substance which can be summarily hacked into shape; and he feels confident of making at least a creditable showing with the assistance of a few tools, a glue pot and a handful of nails. When the construction of things in metal, however, confronts him, he is often frankly bewildered. He fails to grasp the extent of the ductility of the metal with which he has to deal, the ease with which sheet-metal can be shaped into an almost endless variety of form, its plastic quality when detailed decoration is attempted, and above all, he may be baffled by the methods of fastening it together.

To gain some idea of the degree of plasticity belonging to such a metal as copper, it may be a revelation to examine some remarkable examples of Renaissance repoussé work in which figures are raised from the background to such full relief that an arm or a head or a leg appears to be practically detached. The skilled hand of the craftsman has, as it were, moved and raised the metal like so much modelling wax; and it seems impossible to grasp the fact that the elaborate workmanship, which now stands in evidence, grew out of what was at one time a piece of ordinary flat, rather thick, copper. A blow with a hammer has the effect of squeezing the metal over the area of contact, rendering it thinner and creating the transference of a certain amount of its substance from one place to another. If the blows

are delivered in a sideways direction, the metal is actually moved forward in the same way—though with an infinitely greater reluctance—as clay would be moved under the pressure of a modeller's finger.

If, then, a hammer stroke is delivered straight down upon a piece of copper—in a direction at right angles to its surface—the metal is driven from the point of contact in each and every direction; while, delivered sideways, the stroke of the hammer diverts the metal in the direction of the blow. Cellini, for instance, would push forward, by a progressive process of hammering, the metal necessary for modelling an arm in relief—and very possibly, in doing so, he would reduce portions of the metal to such a thinness that it would break through and require soldering to repair the fracture. This would naturally be an extreme length of manipulation, and might even be regarded as scarcely a legitimate use of the material.

From such an advanced technique it is an extreme contrast to explain the ease with which a shallow dish—to serve possibly as an ash tray—can be hammered from a circular sheet of any ordinary metal, such as copper, that has already been annealed. This annealing is merely the softening of the metal by bringing it to a red heat; the 'spring' of the metal is taken out of it by the heating, enabling it to be beaten the more readily into any desired shape. In order to depress the centre, it is necessary to stretch it over a wider area, and this may be done quite simply by beating with a wooden mallet, having a rounded face, upon a sandbag. The arrangement of the particles of copper is thus disturbed: they move away from the portion which is being beaten. The deeper the hammering, the thinner becomes the metal at the point where the depression is taking place; and if persisted in, the hammering would render the copper so thin that it would crack and break through.

But this is not likely to happen under such gentle treatment as we are considering. If the dish of copper were only about six inches in diameter, it could be finished off—after its preliminary shaping on the sandbag—in some

form of concave mould, such as a large stoneware mortar or any similarly shaped wooden bowl. Proceed by tapping to induce it to conform closely to the shape of the mould. The creases which are constantly arising at the edge must be carefully watched; and as soon as they appear, work them out with gentle hammering until they disappear. Gradually the copper tray will be brought closer and closer to the underlying shape of the mould until every requirement is satisfied. A simple rim can be added by turning it upside down on wood or lead and punching with a round-faced punch a row of bead-like depressions round the edge, taking care that each blow is delivered well home.

Another form of small round or oval tray, with sides rising at an angle, can be beaten over a fairly hard piece of wood cut to the size of the bottom surface. Cut the metal wide enough to form the sides, after scratching a line round the wooden model on the metal sheet. With a scorper cut a shallow groove along this line to assist the turning over. With one or two annealings of the metal it should not be difficult to hammer over the sides, working with tentative care rather than heroic methods, until the sides rise regularly at an inclined angle.

The principle can be well illustrated by noticing what actually happens when a paper or parchment covering is tied down over a jam-pot. At the point where the paper is brought over the edge, it is quite obviously squeezed to its fullest extent and the superfluous paper has to accommodate itself in a number of crinkles. Exactly the same thing will happen with a sheet of copper. It will be squeezed in the process of being hammered over an edge; and the metal, which is driven forward, will have to go somewhere and find room for itself. It does this naturally by forming the creases round its circumference; and these, owing to the ductility of the metal, can be hammered down into a compact mass. The extreme edge, for this reason, will be thicker than the rest—because in it is consolidated the metal that has been driven forward. The creases, it will be found in some designs, are not beaten into a slightly thicker band, but are humoured in the form of regular waves or

Plate 18 [*to face p.* 80

scallops, which form a convenient method of distributing the additional surface.

The beating up of bowls or cup-shaped forms is a more ambitious enterprise. Copper or silver are the more malleable and responsive metals. For these deeper shapes a much wider circle—nearly double the size of the final rim—must be cut from the metal sheet. After annealing begin by hammering down an inner depression at the centre. It is advisable to mark out a circle with this intention at about half the total diameter. The appearance after this inner depression has been made should be very much that of a cardinal's hat or an old barber's dish—a concave formation with a wide brim. Fix in the vice an upstanding round-headed piece of wood, or a round-shaped stake, like the handle of a large screwdriver. Placing the metal ' hat ' over this head, use a wooden mallet or hammer —wood against wood and metal against metal is the general rule—to beat over the flat brim, with sideways blows, towards its edge. Continue this hammering round and round until it is gradually converted into something resembling a wide bowl. Anneal and repeat these two processes—again knocking out a central depression and again working the metal over more and more into the form of a cup. Much patience may be needed to secure a final satisfying result; but regularity of striking and the determination to work with deliberation and correctness should eventually build up a symmetrical shape. Greek and Roman models would suggest all manner of possibilities in the nature of fine proportions.

Occasions will arise when the use of pitch—prepared with plaster or brick-dust—is imperative as a firm, but yielding, substance, against which the more detailed hammerings can be directed. It should be melted into a metal bowl and be of just the right consistency, neither too stiff nor too soft; and the occasional heating of the work with a blowpipe will render the material still more pliable.

In all work of this kind the professional naturally has an advantage in the matter of tools and appliances. Within

reasonable limits, however, there is much that can be done of the utmost interest with quite ordinary means.

A comparison with mediæval methods may be of interest; and we gain a glimpse of them in descriptions by Theophilus of the manner in which church utensils were made. In the making of the paten, for example, we are told that you must first melt your silver and 'thin' it, by which is meant the beating of it into the form of a sheet. 'When you have thinned this, make a circle in the middle of it, and below this circle measure out eight spaces equally divided, and in each space make half a circle, that there may be as if eight bows'—the pattern of the dish is not purely circular, but has a broken edging of half-circles—'which you beat with a round hammer until they become hollow, and from below you hammer angles between these bows in ductile work, also a border round them of the width of the little nail, which may rise above the flat part of the whole paten'—an edging round the whole circumference. 'You sculp this finely and cover it with niello, and you polish it on both sides.'

The beating of a cup is also described in the course of the instruction for making the chalice. The melting and the purifying of the silver is the first proceeding—and this is especially interesting, as the same process of purifying silver has been in use from the earliest times down to our own day. The principle of 'cupellation' is that, when lead and silver are melted together in the presence of bone-ash and an adequate supply of air, the lead carries with it the foreign base metals and leaves the silver 'fine' or practically pure. The bone-ash is first placed in an earthen vessel. 'Then place the silver in it, and superpose a little lead, and, the coals (charcoal) being heaped over it, melt it, and have near you a rod cut from the hedge and dried in the wind, with which you will carefully uncover it, and will cleanse from the silver whatever impurity you may see upon it; and you will blow moderately upon it with a long stroke. If you see the silver boil up and fly out, know that tin or brass is mixed with it.' In which case you repeat the process with more lead and powdered glass. 'With

Plate 19 [*to face p.* 82

the rod remove the impurity of the glass and lead.' The silver will then be entirely purified. The reference to the ' rod cut from the hedge ' may appear curious. As will be explained later, the charring of this rod and the smoke from it would act as a reducing agent and counteract, for the moment, the oxidisation which would be in progress.

Chemistry has never supplied a mystical analogy more perfect and complete than in the paradox which is almost startling—that the clean whiteness of the precious silver is brought to its highest pitch of purity by the means of a metal the most notoriously dull and heavy. Even the last trace of imperfection disappears in a film ' with the magnificent appearance of a soap-bubble in sunlight.' Some idea of the kind may have prompted the reference—' take away the dross from the silver ; and there cometh forth a vessel for the finer. The fining pot is for silver, and the furnace for gold : and a man is tried by his praise.'

Having purified his silver, the worker is told to take his silver and divide it into two equal portions ; so much for the cup of the chalice and so much for the lower part. He melts the first half and ' pours it into the round mould.' In other words, he makes a small round ingot of his silver and then proceeds to fashion the cup by first beating it thinner.

' When it has been made so thin that it can be bent with the hand '—a rough gauge of the necessary thickness—' make circles inside, and outside, with the compass, and with a round hammer beat it inside according to the circles, that thus it may acquire depth, and outside upon a round anvil according to the circles as far as the rim, that it may become more narrow, and do this until at length you attain for it a form and capacity according to the quantity of silver.'

For variations in the shape of the chalice, ' wax,' corresponding to our ' pitch,' is used. ' After you have beaten out the melted silver as above, fill it with wax and beat it on the body, if you wish to have ribs flat or round ; these stand around like small spoons, both which kinds of work give great ornament to the chalice.'

II

The construction of such things as boxes or caskets presents a different problem. A strange but undeniable fascination exists with regard to this most homely and familiar type of object. It attracts the enthusiastic interest of the collector, and for his benefit a vast amount of ingenuity and artistic elaboration has been employed. Their values range within such wide limits that it is impossible to analyse fully their uses or characteristics. But the chances are considerable that a boy would be more excited at the prospect of making some kind of box out of metal than any other act of craftsmanship one could suggest. And the attraction is too general to be confined to the younger enthusiasts only.

Tailoring and metalwork—a surprising association—preserved so close a connection in the Middle Ages that a gentleman would be as accustomed to be measured by his armourer as any of us to-day by his tailor. The process might be more elaborate, and the fitting perhaps more uncomfortable; but, beyond that, the experience was very much the same. In both cases the various segments would need to be cut out in patterns of stiff brown paper as a preliminary measure; and the cloth or metal, as the case might be, cut to the prescribed areas—shaped and fastened to form an envelope to the figure.

It is evident that metal, available in sheets of varying thickness, is fairly amenable for such purposes; that it can be cut without much difficulty by means of shears—or sawn where cutting is inadmissible; it can be pressed or hammered into shape, riveted with the accuracy of a needle and thread, or soldered with a greater tenacity than belongs to any adhesive. It would be almost safe to say that any model, made from stout paper or cardboard, could be translated into a pliable metal with reasonable chances of success. This principle of the paper pattern, laid flat upon a sheet of metal and the outlines scratched upon its surface—to be cut out in due course—places within reach a number of propositions which at first sight would

Plate 20

[*to face p.* 84

appear altogether too formidable. To follow the same method, string or tape could be cut of exactly the length to indicate the amount of wire or metal band required for any particular purpose. A whole model could be built up to ensure a complete accuracy of fitting, and the various parts then dismantled to be used as proved patterns. A far greater probability of ultimate success could be counted on by the adoption of such a preliminary method than if the attempt were made in the first instance upon the metal itself.

With the simplest knowledge of geometry the pattern for a box with any number of sides is easily set out on paper, cut with scissors, and its shape scratched on the metal. In its turn the metal is cut with shears, scissors, or fretsaw. In using a fretsaw for any purpose of this kind, the very best type of saw is necessary; lubricated with a little oil or vaseline it is surprising how well it cuts through sheet-metal of a moderate thickness. A difficulty may be experienced from the tendency of the metal to jump violently; but if it is fastened by clips on to the under side of a piece of cardboard or very thin wood this trouble is greatly diminished and intricate patterns can be cut with a far greater smoothness.

A four-sided box would be the simplest design. The space representing the bottom of it would be set out on paper and on each of the sides right-angled spaces erected according to the height required. Something in the nature of a cross would be the result. Or any cardboard box of the size needed could be cut down at its corners and spread out flat. The shape of a pentagon, hexagon, or the like would not be difficult to set out and transfer to metal.

Where the paper pattern would be folded to bring the sides into position, the metal will need a groove cut with a graver—and a rocking motion of the wrist will assist the graver towards a steady progress, uninterrupted by a sudden dive in any direction except the right one. By means of this groove the sheet is turned back and carefully hammered to the correct upright angle.

When all the sides are thus turned up, the edges at the

corners should come exactly together. Bind round with fine wire so that everything is correctly in place, and solder on the inside each angle in turn. A strong join should be effected with little difficulty. The lid would be designed and constructed in the same way, the space for the actual top being made a shade larger to allow it to fit comfortably over the lower portion—its sides would naturally be more shallow.

As a box pure and simple the thing is done. For decorative purposes it is necessary to go a step further. If the intention is to set an enamel or other ornament upon the lid, a separate piece of metal should be cut in the shape of —and slightly larger than—the ornament, so that, with its edges curled up, it forms a miniature tray of the necessary shape. This is riveted in three or four places to the box lid—either before or after its sides are soldered. The edges are turned back over the ornament to hold it securely. An ordinary steel burnisher will work over the top edges, or a file can be employed with a motion of thrusting inwards. The burnisher by itself is preferable, as the surface is then not disturbed in the same degree.

Another method is neater. The lid, instead of fitting over the lower portion of the box, is made to close flush with it, a lining being inserted in the lower half over which it slides. The box therefore, when closed, has its sides level, only the dividing line being visible. The construction in this case is different. Roughly speaking, the principle is to solder together the side, top, and bottom, with the result that a hollow case is formed in the final shape of the box. The side is then sawn through, along a line exactly parallel to the top and bottom. The two sections thus come apart with the dividing line necessarily true.

To take the course of construction in detail. In the first place, cut a piece of wood with a fretsaw of the intended shape, whether many-sided, round, oval, heart-shaped—or any other more complicated form. The principle is the same in any of these cases, although the greater difficulty will naturally be found in shaping the side accurately

Plate 21

[*to face p.* 86

where the form is less simple. The wood should be cut strictly at right angles. A metal band of the determined height of the box should now be cut, a pair of callipers being used for the purpose. By drawing it carefully on the sheet-metal with one leg of the callipers following a straight-edge, two lines will be scratched exactly parallel with one another. If the box is to be angular, lines at right angles must be scratched at the points on the band where the angles occur—the distances being measured with the greatest accuracy. Slight grooves are graved along these lines to ensure that the bending of the angles is sharp and definite. The exact length required to go round the wooden model will be cut; and after securing everything in position with binding wire—the edges being set truly—the ends are hard soldered to form a continuous band.

There is now a complete side within which the model fits easily and smoothly. Cut the top and bottom symmetrically to overlap the side by a fraction of an inch, bind both into position, with the side lying between them, still keeping the model inside. Before doing this, however, bore two holes through the wood and pass a loop of wire through them: this will serve later, in case of need, to extricate it. Solder top and bottom—with soft solder if there is a reluctance to use the harder variety. A hollow case is now completed which should have sufficient buoyancy to float in water. The callipers are set to scratch a parallel line round the side and a fine jeweller's saw is used to cut along this line. The two sections come apart and the wooden model is withdrawn, ready to be used again if occasion requires.

The sections now correspond exactly along the line of division; and an inner lining must be introduced within the lower half, projecting a quarter of an inch or so, to allow the top half to close over it and so complete the fitting of the lid. Do not make this inner lining of too thin a metal, as it may be necessary to file it down in places, after it is soldered, to make an easy fit. Cut the lining carefully and take care, if soft solder has already been used, to bind everything firmly with wire before again soldering, as other-

wise the previous join will in all probability become loosened, even if it does not actually come apart.

The above is only a suggestion of construction which may, very likely, be vastly improved upon. Every individual worker has his own marked tendencies. He finds a ' better way ' for himself to which he sticks rigorously—and such independence of method is all to the good.

III

It will now probably be felt that some form of decoration is called for. A familiar device has from the earliest times been found in the use of wire, simple or decorative. The Jews cut narrow strips of gold which served the same purpose, and the Egyptians and Etruscans are believed to have anticipated the drawplate by the use of a pierced ruby through which a strip of gold was drawn to form a wire. Theophilus mentions ' two irons three fingers in breadth perforated with three or four ranges through which holes the wires are drawn.' He also speaks of a decorative beaded wire similar to a pattern which can now be bought ready made. A file is used, on the under side of which grooves are traced, like half-sections of a straw—' on both sides of it sharp ribs are filed. With this instrument golden and silver wires, thick and fine, are filed, so that beads may appear upon them.'

But wire twisted together is even more effective. The present day drawplates enable one to draw wire in the round, square, or oblong forms ; and these all lend themselves to decorative twists which relieve the heaviness of any piece of work and give an air of delicacy. It is a simple matter to twist wire in a multitude of patterns. The easiest of them is to secure two annealed wires in a vice—and, after clamping their other ends in a hand vice, to turn them round and round until the twist is sufficiently close. Such a wire can be used in the round ; or can be flattened with a hammer. Amongst the other possible variations are a single square or oblong wire twisted—effective by itself or arranged with other wires—and bundles of three

Plate 22

[*to face p.* 88

or more wires, similar or varied in character, all twisted together.

Suppose the intention is to run a decorative wire round the bottom of a box in the angle made by the side and the base. The wire must be cut accurately to the length required—erring, if anything, on the short side. A loop can be widened by tapping it round a circular shape such as the neck of a champagne bottle, but never shortened except by cutting out the superfluous length and resoldering.

This soldering of the ends of a loop of wire, though, to all appearances, simple in itself, can be one of the most awkward things imaginable. Hours may be wasted in the attempt to effect a join with hard solder, which in this case is absolutely indispensable. Adjust them as one will, by wiring so that they just touch, and they will jump apart just at the critical moment when they are brought up to a sufficiently high temperature—and to one's utter disgust, the solder remains attached to one extremity only. Again and again this may happen in spite of every fresh invention which may suggest itself. When the wire is quite thin, the two ends may be held by means of a pair of pliers in each hand, with the chip of solder balanced in the middle. With any luck the balance may be maintained over a flame until the solder flows ; but fortune will be an element in deciding the question. With larger wires, especially in brass and copper, the difficulty increases. A splice at the ends—a rare possibility—will help matters.

A small bridge of sheet-iron, to which the wire can be bound at a short distance from its extremities, may be recommended. Or a stick of the charcoal used by artists for drawing purposes may be used as a bed on which to fasten the ends of the loop with wire. An even better device is to bend a stout piece of iron wire into the shape of sugar tongs with its ends turned round away from each other. The advantage of this device is that, with the two ends of the wire bound to the extremities of the tongs, the whole thing can be held in the hand and the ends kept in a steady contact. Provided this contact is preserved,

the rest is easy. Paraffin and glass borax with a chip of solder over a Bunsen burner should effect a good join.

The loop is now completed and should slip nicely down the box side to the place it should occupy in the angle upon the bottom ledge. Bind it carefully in its place by carrying the binding wire over and over in every direction and twisting the ends firmly. Then nip it over the twisted loop to keep it fixed snugly. It can be soldered with filings mixed with a soldering flux—insinuated with spatula or brush behind the wire loop.

Much must be left to individual discretion on this vexed question of hard and soft solder. The important thing to remember is that all initial soldering must be hard, as subsequent heatings would inevitably loosen any joining with the more easily fused alloy. In the rare cases where the foundations, as it were, are laid with soft solder owing to the bulk of the object—and the consequent difficulty of getting everything up to a sufficiently high temperature—disaster may be avoided by binding the part so firmly with copper wire that it cannot slip. But the danger even then is considerable. Small boxes made in silver of about three inches across should be hard soldered throughout. Even then difficulties may arise and parts become unfastened. A coating of clay or tripoli over any adjacent initial solderings, which might be adversely affected, will help to protect the part thus covered from the dangers of an excessive temperature.

The face of the lid will now demand some similar decoration. It may be supposed that an enamel is to be set in it. A collar is cut to the correct length from a narrow ribbon of metal, and its ends soldered. The fixing of this collar, so that it lies exactly in its right position and in its right shape for soldering on to the lid, can be managed with the binding wire. A dummy of the size of the enamel could, in case of necessity, be cut out of dirty sheet-iron—which would not itself solder—and laid within the collar to preserve its position. One or two twisted wire loops may be similarly adjusted to form a kind of necklace round the collar. Finally, it only remains for the ornament to

Plate 23 [*to face p.* 90

be fitted in its place. The collar may be bevelled over its edges with a burnisher, or, as a further refinement, a very fine twisted wire loop may be made to fit within the collar itself over the ornament—keeping its position either by the tightness of its fit or by bevelling the collar over it.

The lower surface of a twisted wire had better be filed flat before it is soldered on to any base; otherwise the contact may be insufficient and the solder will be found liable to run up into the wires themselves, spoiling their appearance.

Before leaving this subject, a waved design of flattened wire is worthy of mention. It is made by twisting a wire of moderate thickness in conjunction with another which acts as a dummy. After twisting these two together—not too tightly—they are very gently separated; care being especially taken to preserve the coil of the more important one intact. It is left, when separated, in the form of a regular spiral. Placing it on a flat stake hammer from one end, bit by bit, until the whole lies as a flat band with a beautifully regular wave-like pattern, which can be used to add a finish to the outer rim of any surface. When about to solder it, begin by binding this band in place, so that about a third of the middle of it can be first soldered with a mixture of filings or small chips. Unwind and rebind the rest of the band to complete the circuit, cutting the ends so that they meet exactly; and then complete the soldering. Finally, cut out or file away the portions of the underlying surface which are showing outside the waved band, leaving a perfectly symmetrical fluted edge.

It will now be taken for granted that all traces of borax have been removed with dilute acid, and that only the final touches are necessary. Anything in the nature of an imperfection is removed with a file; the finest emery paper (ooo) is used to render the edges smooth and pleasant to the hand; and a last polishing with the aid of rouge and finely prepared whitening. It may be noted that all polishing is nothing more than a matter of scratching the surface of the metal, removing the larger scratches with others that are constantly finer until finally they become microscopic.

Emery would produce the deeper impressions necessary to get rid of rough and dirty surfaces; the finest quality of emery would improve again upon these results; rouge, which is nothing but iron rust in a fine state of preparation, carries the scratches to a more minute scale; and such materials as putty powder (an oxide of tin), whitening or chalk advance the work to any practical limit. A point that is often overlooked is the necessity of using separate cloths for the different polishing powders. Nothing is gained by employing a finer material on a cloth which has already been used for a coarser preparation. The deep scratches would still be constantly occurring, and no progress towards a really high polish could be relied on. Strictly speaking, as many cloths should be used as there are polishing agents.

IV

The worker in repoussé, although he models by a method of hammering, or otherwise stretching his material, regards his piece of metal very much in the same way as a carver regards his block of wood. He does not cut away the metal in the manner of the sculpture of bronze and iron which reached a high pitch of excellence in the early centuries: but he produces an effect of modelling which approximates to the idea of carving, without subtracting from the bulk of his material.

Reference has already been made to the plastic qualities of such metals as copper and silver, which permit considerable liberties to be taken with their surfaces, heaped up in one place, depressed in another—with the only limit of a possibility of breaking through altogether. For this reason it is important that the sheet of metal should be of an adequate thickness—in ordinary cases about half that of a sixpence Nothing is more unsatisfactory than to use too thin a sheet. It is more difficult to handle in actual working, it buckles in an irritating fashion, and it is impossible to obtain that quality of workmanship upon its surface which indicates that it is evolved from something really substantial,

Plate 24 [*to face p.* 92

capable of receiving fine gradations of texture. Thin metal always looks thin; it cannot conceal its flimsiness; its effect is either brittle or 'blobby' and has an unpleasant feeling of frailty when it is handled.

Simple effects, however, can be obtained with the thinner material; covered with enamel, it serves its purpose admirably. After being well annealed it can be treated almost as if it were so much blotting-paper. A rod of steel, with a point as smooth as a blunt soft pencil, drawn over its surface with pressure, will mark the design in a well-defined recess; and an even deeper impression can be obtained by fixing such a steel point into a stick of about fourteen inches so that the blunt end fits comfortably into the socket of the right shoulder. The pressure is in this way greatly increased and the right hand can direct the progress of the point.

A soft substance must be placed underneath the metal to lessen the resistance to the marking tool. A soft-grained wood, sheets of newspaper, or, best of all, wet leather will prove satisfactory. When the design is clearly outlined, the background is pressed or beaten down with a repoussé tool. After the background has been brought to an even state of depression the pattern in relief will stand out with a smooth but slightly shapeless character. In the case of thin metal, however, it is dangerous to attempt too great a refinement of this surface. Strongly marked work with a repoussé tool will tend to reveal the unsubstantial nature of the material. The effect will be brittle with unpleasant edges. If modifications are necessary, it would be better to turn the work on its back and rub with a burnisher rather than employ harsher methods. In other words, treat it much as you would treat damp leather and press out the modelling.

This more gentle way of working is described by Theophilus in the raising of figures. After annealing the metal he says: 'You will rub it with the curved instrument on the underneath part, inside the hollow of the head, slightly and carefully, and turning the plate you will again rub with the smooth iron upon the upper part, and you depress the ground that the relief of the head may be raised,' and so it

goes on, after another annealing, in which ' you recook it, by applying the coals.' Finally the relief is brought to ' the height of three or four fingers.' He is quite prepared, however, to find that this modelling has been carried too far, that the metal has broken through and that the fractured part has to be soldered. On the whole the work must have been very thin and fragile.

When a thicker metal is employed a more drastic treatment is possible. The metal must be backed up with a firmer cushion. A block of lead frequently allows the hammering to prove effective, but pitch is the substance most generally used—and its consistency must be regulated with just that nicety that the blows receive exactly the correct resistance. The flame of the blowpipe will soften its surface enough to receive the plate. The pattern is hammered out with a lining tool—a rod of steel with a small blunt chisel point. Its width will vary according to the character of the line required. There is no actual need to make the end of this tool ' run.'

Any line can be hammered out with definite strokes delivered with accuracy—and much depends on the head of the hammer descending absolutely truly on its objective.

The background can now be beaten down, but its surface may be left for the moment, as it will become necessary at a later stage to give it a fine quality of texture. The relief design, after the line has been hammered, now stands out rather loosely, and much of the original line may have been lost. All subsequent work must be directed towards hardening the effect. The underlying firmness of the pitch and the substance of the metal will permit of any refinement of detail ; edges may be sharpened by reinforcing the outlines ; and beating over the relief, so that it seems slightly to overhang the edge, will help to produce that fine sharp flatness which is characteristic of the best work. With this peculiar steepness of effect the surface in relief can be carried further by means of markings struck out with the utmost decision.

A good deal depends on the choice of the background texture. Tools with impressions of patterns can be ob-

Plate 25

[*to face p.* 94

tained, such as rings, dots, or various segments; but possibly one can manufacture for oneself something which meets the occasion. The end of a steel rod can be filed and polished according to the individual fancy. Perhaps no happier choice can be made than a shape resembling a thin brick on a very small scale. Its edges and corners must be carefully rounded off; and such a tool seems to possess the faculty of modelling the surface into a network of kinks and granulations calculated to supply that regular irregularity which helps to satisfy the artistic sense and redeems the entire effect from insignificance.

Other textures can have a fine appearance such as an effect corresponding to that of shagreen, or a pattern of rings. As Theophilus advises: 'In the meantime take a fine instrument which has a hole at the point, by the blow of which you produce a very fine circle. Hold this iron in the left hand and the small hammer in the right, and let the boy sit before you, who can hold the plate upon the anvil and adjust it in the places in which you are about to strike, and thus fill up a ground with very fine circles as closely as you can join one to another, gently striking upon the iron with the small hammer. All the grounds being filled in, in this manner, place the plate itself upon the hot embers, until these beatings take a yellow colour.'

Finally there is a suggestion of subject for beaten work in metal which somewhat quaintly reflects the feeling which existed—'should you possess facility of invention, you can make figures in gold and silver upon the books of the evangelists and missals, and animals and small birds and flowers outside upon the horse-saddles of matrons. Upon golden or silver cups or platters, in the middle, knights are made in the same manner, fighting against lions or griffins: the figure of Sampson, or David breaking the mouths of the lions; lions alone, also, and griffins: the same also, each strangling cattle; or other thing which it may please you, and which may be proper and fit according to the size of the work.'

CHAPTER VI

THEOPHILUS AND THE RENAISSANCE

I

THE province of technical books cannot be said to lie within the range of popular favour. They are very naturally regarded, for the most part, as a peculiarly dry form of literature. This is inevitable for the reason that a mass of detail, which is essential for the purpose, proves to many overwhelmingly dull; the underlying spirit which pervades them is difficult to detect, and only the most convinced enthusiast enjoys the complexities that are involved. There may be a few corners that excite a particular fancy; but, from the point of view of the main theme, it must be admitted that the total impression carries too much weight to be in any way generally appreciated.

Still, a definite spirit often inhabits the dull prose. Even behind the most prosaic of them lurks a common pleasure—a delight, which cannot be suppressed, in doing things for the sake of the mechanical employment—the familiar experience that time flies with an amazing swiftness under these engrossing circumstances. There is also the consideration that any insistent and active thought has the less opportunity—while the hands are busy with some craft—to prey upon itself. Robert Louis Stevenson whimsically complained that the practice of letters was miserably harassing to the mind and contributed to extinguish the 'more human portion of the author.' He clearly saw the advantages of an occupation less wearing to the nerves, more conducive to a settled composure. His advice was that 'it would be well for all of the *genus irritabile* thus to add something of skilled labour to intangible brainwork.' The calming influence of a more or less

mechanical craftsmanship appealed to his instinct. Even an occupation like painting—though painting can be no less disturbing than literature—he regarded as 'often highly sedative; because so much of the labour, after your picture is once begun, is almost entirely manual.'

With this opinion, however, we should draw issue. If Stevenson had practised painting seriously, the probability is that he would have found it no less distracting than his chosen profession. His fastidious criticism would have imposed an equally exacting standard upon his labours; and in neither event would he have remained satisfied with work which was 'almost entirely manual.' This is precisely where the distinction arises between the more imaginative arts and such crafts as enamelling and the like. The latter of these tax the nervous centres scarcely at all; they may truly be regarded as sedative, an anodyne for the mind—to use his own expression, 'that skilled sort of manual labour which offers a continual series of successes, and so tickles a man, through his vanity, into good humour.'

This is undoubtedly the expression of a subtle truth. There are occasions when it is a relief to come down from the clouds to a more matter-of-fact set of processes—comparatively simple when once they are understood and happily productive of tangible results. The link between the successes and the good humour is too certain to be lightly disregarded—and, what is more, these successes are solid and substantial. They call for little of that elusive criticism and distracting doubt which are connected with the mere expression of ideas. This, perhaps, is the explanation of those glimpses of genuine enjoyment which may be caught amongst the dullest details of description. 'I have not hesitated,' says Theophilus, 'to convey to your virtuous disposition how sweet and agreeable it is to indulge in the exercise of diverse usefulness,' and suggests that he himself is 'the humble and quiet man working in silence in the name of the Lord.'

II

Of quite a different type, that of the restless and excitable artist, was Benvenuto Cellini, who, living five centuries later, invites an inevitable comparison with Theophilus as a writer on the arts. With a characteristic assurance Cellini claimed that he was the first to write any sort of book of instruction upon the crafts in which he excelled. So far from this being the case, it has been definitely stated that Theophilus not only included all that Cellini relates, but was more comprehensive in his range and technically favoured by a wider experience. Cellini, however, was abashed by no such minor considerations. His life is described in his Memoirs with the most copious details. Even his ancestry is considered worthy of mention; and his extraordinary career is known to us with a wealth of picturesque detail encouraged not a little by the vividness of his imagination. His technical genius ran with a degree of egotism and self-conscious exaggeration which made him a d'Artagnan of the arts; a fiery spirit whose eccentricities were described with an amount of unreserve perhaps unparalleled in the history of autobiography. His amazing confidence in his own powers, his reckless audacity, and entertaining swagger have ever since made an impression upon the world sufficient to establish him as the foremost representative of Renaissance art.

He also furnished an excellent example of the wide range of accomplishment attained by the artists of the period. A man was rarely content with one accomplishment only: he might paint, but he would also practise other crafts according to his fancy. The brothers Pollaiuolo were silver workers, bronze sculptors, and painters. The Ghirlandaios made 'garlands' in gold and silver after the ancient fashion; they were also celebrated fresco painters and architects. Francia was another example of the goldsmith-painter.

But the importance of any comparison between Theophilus and Cellini lies in the fact that they stand for entirely

different phases of the art movement which culminated in the Renaissance. It will be misleading to regard the Renaissance as having any fixed date or to attempt to isolate it in any way. So far as the arts are concerned, it is more convenient to regard the five centuries which divided these two men as one long period of development; the one may be regarded as marking the inception, the other the climax of the movement. To place them in their approximate places in relation to our English history, it would be safe to say that Theophilus was, in all probability, alive on the day of the Battle of Hastings, and Cellini we can place quite definitely in the reign of Henry the Eighth. These familiar landmarks of history may convey some impression of what was happening in the latter days of mediævalism throughout Europe.

The earlier period, that of the Norman Conquest, in which Theophilus finds a place, indicates that an awakening was in progress as if from the stillness of death. Mention has already been made of the threatened extinction of artistic culture subsequent to the Byzantine period. Eraclius in his indifferent Latin verse had lamented the fact that there was no one to teach them afresh. It was as though the nervous energy of the world had for the moment perished, so far as the arts were concerned. From this paralysis Christianity and feudalism together were gradually leading Europe into a new state of living. Whenever it happens that a struggle of this character is initiated; when the efforts that are being made to regain a new consciousness are purely tentative and directed by the search for a new line of progress; then it is certain that work breathing the spirit of a strong primitive force will be evolved. The nerve fibres are gaining a fresh hold; small, struggling rootlets are being thrown out; and there is a concentration of energy which forces into prominence something supremely vital, even if its form is imperfect.

This phase of growth was in progress during the centuries on either side of the Norman Conquest; and it is a return to this backwater of mediævalism—as it appears to us to-day—that has made so strong an appeal to the men of

later generations. It was this 'new courtesy,' the spirit of Chivalry, which issued from the combative tradition of feudalism modified by the idealistic influence of the Church. It was the same spirit—or rather the same combination of two tendencies—which produced the quaint legends of the *contes pieux* and the exploits of the knights of Charlemagne in the 'Song of Roland.' The Arthurian legends as they grew up in close succession, wove the two influences into one form, and supplied the most notable inspiration of the Victorian age.

With this early movement in literature coincided the revival of craftsmanship of which Theophilus was the spokesman. It was no less vigorous an outcome of the same spirit. But its main significance lay in the fact that during the period while the effort was purely tentative—before it became conventionalised—it maintained a freshness which is to be found in the early development of all fine arts. What was great at this period might be said to be the greatness of imperfection. The perfection which came in due course was of a more stereotyped character. In literature the same development was seen in the carefully constructed convention of the *Roman de la Rose*. In art a technical perfection of workmanship had also reached its zenith with Benvenuto Cellini. The fine enthusiasm had lost its potency when it seemed that the limit of development had been discovered. The summit of achievement reached, the energy of the movement failed from exhaustion. Design became mechanical—and fixed as if crystallised. The final shape of a style had been taken; and the freedom of its making shattered for ever.

III

Any discussion of the technical conditions in the Middle Ages is liable to a suspicion of staleness, unless we are able to envisage something of the sentiment which accompanied it. Perhaps it has never been better expressed with paint or pencil than by Rossetti. The details of his scenes carry a curious conviction with them; they form a setting for

the romantic atmosphere with an admirable certainty of touch. He can depict quite vividly

> A garden faire, and in the corneris set
> Ane herbere green, with wandis long and small
> Railit about; and so with treis set
> Was all the place, and hawthorn hegis knet.

Even to this day the 'old-world garden' has become a commonplace; and we are apt to forget that no romantic scene would have been tolerated without this appropriate scenery. No less necessary was the suggestion of music:

> And on the smalé grenë twistis sat
> The lytill suetë nyghtingale, and song
> So loud and clere the ympnis consecrat
> Off lufis use, now soft, now lowd among,
> That all the gardyng and the wallis rong.

So it was with the favourite decorations. Everything was dainty, refreshing, almost childish—'small flowers, or birds, or animals, or small windows.' A lively imagination conjured up landscapes such as Blake has given us—'the four rivers of Paradise' and 'the likeness of flowing water.' Much of this imagery has been lost to us; and even when we get it, there is too conventional a flavour of the modern studio to convey a faultless impression.

But the typical mediæval studio was also conventional enough. Theophilus in his writings shows us that the instruction was stereotyped to the last degree. If he had been asked—as has been asked by many inquiring spirits—how to paint clouds, how to paint trees, he would have supplied a formula upon the spot. Precise details are given by him as to the correct tones for the beards of youths as well as for those of old and decrepit men—down to their eyebrows, nostrils, and finger-nails. He must have had the instinct of the born teacher; and he excites us even now by a description of 'the drawing which imitates the appearance of the rainbow.' The much-debated 'Venetian

herbere] garden plot. hegis] hedges. twistis] twigs.
ympnis] hymns. lufis] lovers.

secret' actually pales before such an excellent method as will enable the merest tyro to represent pictorially, amongst other objects, thrones, branches of trees, round towers, and mountains.

No wonder that he is able to say with confidence, 'Thou hast decorated with the utmost beauty ceilings or walls with various work, and showing forth with different colours a likeness of the paradise of God, glowing with various flowers, and verdant with herbs and leaves. Nor is the eye of man even able to decide upon which work it may first fix its glance: if it beholds the ceilings, they glow like draperies: if it regards the walls, there is the appearance of paradise: if it marks the abundance of light from the windows, it admires the inestimable beauty of the glass: if it regards how much rejoicing is in heaven, and how much suffering in the flames of hell, it is animated by hope for its good actions, and is struck with fear by the consideration of its sins.'

The embellishment of the church was his first consideration. Upon this object he concentrated all his energies. In the course of his investigations he travelled vast distances, and evidently, from all accounts, incurred considerable danger. Stained-glass windows probably fascinated him more than any other form of church decoration—and it must be remembered that this art had been already carried to great lengths of perfection. His visit to Constantinople was in the nature of an adventure, but in spite of the risks he ran, the result was so complete as to enable him to describe the processes of stained glass in a manner which might be followed successfully at the present day.

He tells how he 'approached the porch of holy Sophia, and beheld the chancel filled with every variety of diverse colours, and showing forth the nature and utility of each. From which, having forthwith entered with unwatched footstep, I filled up the storehouse of my heart fully, out of all. But since the practice of this kind of embellishment cannot be of quick apprehension, like a diligent inquirer I have greatly laboured to inform myself, by all methods, what invention of art and variety of colour may beautify a

structure and not repel the light of day and the rays of the sun.'

Then follows a description of the way in which 'pot-metal' glass is made, the single pieces of gloriously coloured glass set to their fullest advantage in the lead divisions. The worker is exhorted 'in the morning, at the first hour,' to take the iron tube and place the end of it in a vase containing the specially prepared molten glass of which a tablet is to be made. 'When it has adhered to it, turn this tube round in your hand until as much as you may wish has accumulated round it; then, withdrawing it, bring it to your mouth and blow slightly, and instantly removing it from the mouth, hold it near your cheek, lest, in drawing breath, you may by chance attract the flame into your mouth.' By blowing and dabbing the glass on a flat stone before the window you bring it to 'look like a long bladder.' An opening is made 'with the piece of wood fitted for this work,' the opening is widened, and finally the flat sheet of glass is formed by flattening out what were the sides of the bladder with the help of a 'smooth piece of wood and the pincers.' 'When these have become cold, use them in composing windows, by separating them into pieces as you wish.'

The way in which the design is drawn on the glass corresponds closely to our present method. When the outline of the design has been set out 'with a red or black colour' you 'take a leaden cup, and put chalk, ground with water, into it: make two or three pencils for yourself from hair, either from the tail of the marten, or badger, or squirrel, or cat, or the mane of an ass, and take a piece of glass of whatever kind you like, which is in every way larger than the place upon which it is superposed, and fixing it in the ground of this place, so that you can perceive the drawing upon the table through the glass, so portray with the chalk the outlines upon the glass. In the same manner you will mark out all kinds of glass, whether for the face, or in draperies, in hands, in feet, in the border, or in whatever place you intend to place colours.'

You are further instructed in the matter of design to

'make circles and branches, and upon them flowers and leaves, in the same manner as they are made in painted letters. You can also sometimes insert in the same circles small animals and little birds, small insects and nude figures.' The colours are blue, green, and red, and from these 'you paint boughs and leaves in borders, flowers and intricacies: and you will use in the faces of figures and in the hands and feet, and everywhere in the nude members that colour which is called posc (a warm grey half-tone). You will not make much use of yellow glass in draperies, unless in crowns and in those places where gold is placed in a painting.'

IV

The old engraving, of which a reproduction accompanies this chapter, describes in the fullest detail the character of an old workshop. It might even supply many hints for a tidy orderliness which is in every way admirable. On the left wall may be seen sets of pincers, callipers, files, and other tools, while on the shelf are mortars, pestles, and crucibles. To the left of the window are drills, soldering irons, and engraving tools. Against the window are hung completed pieces of jewellery. On the right callipers, shears, and pliers. The well-dressed gentleman who is standing is engaged in firing an enamel in an excellently constructed furnace; while the man at his back, wearing spectacles, is evidently painting a plaque which will be fired in its turn. On the other side of the table repoussé work or engraving appears to be in progress. The occupation of the boy at the drawbench is to produce wires or decorative mouldings.

The 'work building,' as described by Theophilus, belongs to an earlier date, but was arranged on similar principles—with one apparent difference that a table was not set down the middle of the room. It appears that a window on the south side came down to within a foot of the ground, and in front of the window was dug a trench, boarded in. The workmen descended into this trench, sitting with a kind

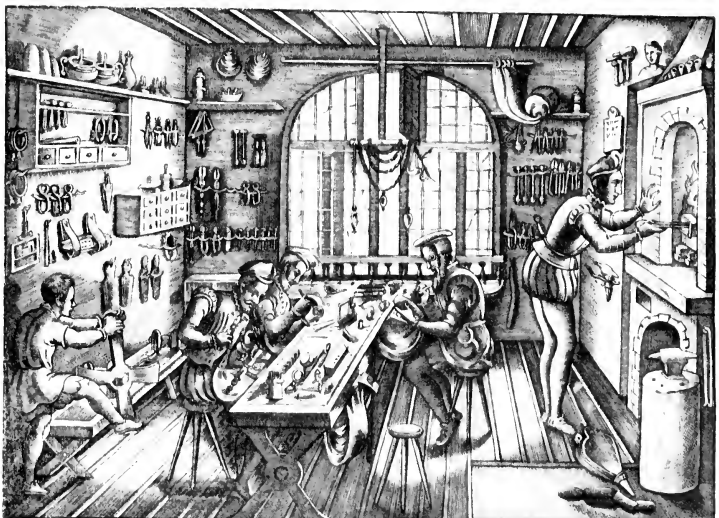

Plate 26

[*to face p.* 104

of table covering their knees. On this they did their more delicate work.

Half of the building was a foundry—and this again was subdivided, for melting gold in one part, and silver in the other. The furnace was set up in a corner—composed of stiff compressed clay. The bellows, made from the skins of rams, had an iron tube fixed into a wooden head—with leather straps to fit the fingers—and their first employment was to place the nozzle in the hole of the furnace, and fire and charcoal at the back and front of the furnace, and blow, that the furnace may become dry.'

A number of 'anvils' are mentioned which include those that we recognise by that name, and also a variety of others which we should know as 'stakes.' There is for instance a kind which is 'round at the top, like half an apple.' Hammers were of all shapes and sizes, and the 'pincers' included tongs, pliers, and 'cutting pincers, large and small, made in two parts, and fastened together with a rivet.' Drawplates are mentioned and an instrument called the 'organarium,' from which were struck round beads of gold and silver. From different sets of grooves we are told they were made like beans, peas, and lentils, and so on in smaller sizes. Files were used; and one kind was hollowed underneath to cut gold and silver wires at regular intervals 'so that beads may appear upon them.' Finally, the 'irons' are a large family of tools which we may regard as our chisels, gouges, gravers or similar contrivances. The list is quite a moderate one, and however simple they may appear, were adequate to the making of the works of art in metal which belonged to the period.

The description of cloisonné enamelling has a peculiar interest, if only as a comparison with our more extended modern methods. Any broken portion of an old enamel will generally reveal the use of narrow fillets of metal—still adopted in very fine work—instead of the more usual wire. Theophilus bids us to 'cut small bands of exceedingly thin gold, in which you will bend and fashion whatever work you may wish to make in enamel, whether circles, or knots, or small flowers, or birds, or animals, or figures:

and you will arrange the small pieces delicately and carefully, each in its place, and will fasten them with moistened flour over the coals.' Ordinary flour paste is indicated as a temporary adhesive. 'When you have filled one portion, you will solder it with the greatest care, that the slender and fine gold may not be disjoined nor liquefy.' The grinding of the enamel is thus described. 'Taking separate pieces of the proved glass, place them in the fire one by one, and when each one has become glowing, throw it into a copper vessel in which there is water, and it instantly flies into small fragments'—breaking with a hammer on an anvil is a cleaner and more simple method of doing the same thing—'which you break with a round pestle until made quite fine, and you will thus wash it, and put it into a clean vessel, and you cover it with a linen cloth.' To fill the cloisons with the powdered enamel you take 'a goose-quill cut to a point, as if for writing, but with a longer beak and not split, you take out with it one of the colours of glass, whichever you please.' A kind of iron muffle is used. You place the enamel 'upon a thin iron, which may have a short handle, and cover it with another iron, which is hollow like a cup, and let it be perforated finely all over, so that the holes may be inside flat and wide, and outside finer and rough, in order to stop the cinders, if by chance they should fall upon it.'

This iron muffle would be a very rough and ready method to adopt nowadays. For one thing, any piece of iron sheet would throw off a considerable amount of iron oxide unless it was very carefully painted with a coating of thin clay, and this spotting would cause serious blemishes on the surface of the enamel. Also the fumes of the furnace might lustre the susceptible enamels which we are in the habit of employing. However, as a proof that a makeshift of this description is quite practicable, we know of a clergyman who constructed a stained-glass window for his church, and actually fired the segments of glass between an arrangement of two frying-pans in the fire of his kitchen range.

The description of the firing follows. 'You arrange the coals round and above it everywhere, and taking the bellows

with both hands, you will blow on every side until the coals glow equally. You have also a wing of a goose, or other large bird, which is extended and tied to wood, with which you will wave and fan strongly all over it, until you perceive between the coals that the holes of the iron quite glow inside, and thus you will cease to fan. Waiting then about half an hour, you uncover by degrees, until you remove all the coals, and you will again wait until the holes of the iron grow black inside, and so raising the iron by the handle, you place it, covered as it is, in the furnace behind, in a corner, until it has become quite cold. Then opening it, you take out the enamel, and will wash it.'

Considering the roughness of the handling which the enamel has undergone in the furnace its surface would probably be none too good, the transparency might be impaired and much lustreing be caused by sulphurous fumes. A 'fire polish' which is generally a satisfactory conclusion to enamels fired in our modern furnaces, would not be sufficiently perfect; and the simplest way of polishing with a stone and a natural lubricant is briefly described as a concluding process.

In reading this primitive, yet wonderfully practical book the prevailing feeling is one of astonishment that the work was carried out in the face of so many difficulties. Nowadays within a mile or so of Ludgate Hill it would be possible to order every manner of material in metal, glass, or appliances, with the assistance of which work could be started on the following day. It is almost impossible to read oneself into the conditions that prevailed during the period which we are considering. A studio which contained a small foundry suggests that the stock of metal must have been kept in a comparatively crude form. No convenient mills would have rolled out the sheet-metal in the thicknesses that might be required; most of the glass would have to be manufactured on the spot, and valuable time spent in preparing the coloured enamels. A thousand initial proceedings would appear to be inevitable before any artistic work could be set on foot. No doubt the workers were detailed to their various tasks; but,

even then, the standard of individual training was wide enough, as has been indicated, to make each man capable of a considerable latitude of craftsmanship. In these days a man is spared an endless amount of preparatory labour and inventiveness. He starts at least half-way on any artistic enterprise, and with no trouble to himself can be supplied with materials which in earlier centuries would have had to be collected with an infinite amount of elaborate foresight.

To these monkish craftsmen may well be applied the words of Stevenson—'Indefatigable, adventurous pioneers. O toiling hands of mortals! O unwearied feet, travelling ye know not whither! Soon, soon, it seems to you, you must come forth on some conspicuous hilltop, and but a little way farther, against the setting sun, descry the spires of El Dorado. Little do ye know your own blessedness; for to travel hopefully is a better thing than to arrive, and the true success is to labour.'

CHAPTER VII

ON LUSTRE

It is no uncommon experience to find that a portion of an enamel after it has been fired, has become tarnished by a blackish iridescence that has spread over its surface. The clearness of the enamel has become blurred by an opaque film, entirely destroying the value of its colour; and until this blemish has been removed, the character of the work is destroyed.

The phenomenon is interesting from a scientific point of view, while at the same time the accident is not entirely irreparable. What has happened is that the conditions of the firing have caused the lead, of which a large proportion exists in the enamel itself, to become separated, and it is, in point of fact, appearing in a lustrous and metallic form upon the surface of the glass. In other words, the lead has been 'reduced' by a faulty adjustment of the gas flame; an insufficient amount of oxygen has been present while the enamel was in a state of fusion. Fortunately the blemish can be removed. It is possible to grind down the surface, clean it with hydrofluoric acid, and glaze with another colour; or, by firing it once more after ascertaining that the flame of the gas furnace has a full, clear centre, it is not unlikely that the trouble will disappear of itself.

An explanation of what has happened opens up a considerable field of inquiry and involves a clear understanding of the meaning of oxidisation and reduction. Metals possess a strong inclination, especially when heated, to seize upon the oxygen of the air. Of this tendency rust is the most familiar example. Tin also, when melted in a ladle, forms a scum upon its surface which is an oxide of tin—having assimilated oxygen from the air; and as a proof of this addition, if its total weight is taken after such oxidisation, it

will be found that the mass is heavier than it was before, owing to this absorption of another element. Another illustration—which is more to the point in the coloration of glass—may be taken in the case of copper. This metal, when heated, forms first of all a red oxide on its surface, which can be arrested in rather an interesting manner. If, by way of experiment, a piece of thick copper foil is heated red hot and immediately plunged into cold water, it will be found to be coloured a fine rich red, the initial oxide. But if the copper is allowed to cool gradually, it will absorb a further amount of oxygen and form a black oxide, which can be scraped from its surface and used as a valuable, yet curious colouring agent in connection with glass.

It will be interesting to follow the behaviour of this black oxide of copper when it is ground up with glass and fused. The components of the oxide, as will readily be understood, are only metallic copper and oxygen, and a conflict takes place, while the mass is being brought to a high temperature, for the possession of any oxygen that is present. If another material is introduced which is also anxious to seize upon any available oxygen, and is more potent in that respect than the copper, it will take from the copper oxide even the oxygen which it already possesses, leaving the metal in a pure form. In other words, the copper has the worst of the battle ; it cannot retain its oxygen in the face of a stronger adversary, and rises in its metallic form to the surface of the glass in a thin film. In other words, it forms what we recognise as a lustre such as may be seen in the iridescent surface of many majolica dishes.

What, then, is this adversary which is able to take up the available oxygen and so decompose, or break up, an oxide into its integral parts ? The commonest is smoke, which contains minute particles of carbon with an insatiable appetite for combining with all the oxygen it can find. Other similar ' reducing ' agents, such as tartar or even iron, can be used, but the action of all of them is the same, to starve any metallic oxide which is entering into competition, and compel it to renounce a portion, at any rate, of its oxygen.

A matter of considerable interest appears in the various colorations which become apparent during such a struggle. If the copper oxide is fused with glass in front of an open muffle—that is in full process of oxidisation, being exposed to a considerable volume of air—the glass is coloured green. If, on the other hand, this green glass is fused in the presence of some reducing agent such as smoke, which exhausts the air of its oxygen, the oxide necessarily loses the amount of oxygen to which it owes its green colour and becomes a dull red. If the process of exhaustion is continued still further a brighter red is seen—and further still the copper becomes once more metallic and spreads as a thin film over the surface. The separation has in this case become complete.

It is to be noticed that only green and red—the extreme complementaries—have been so far mentioned. They are the more usual phenomena that may be observed. But it has been scientifically conjectured that all the colours of the spectrum might be obtained by the use of one metallic oxide only—iron particularly has been mentioned—if the process were carried out with varying proportions, at different temperatures and with different durations of melting. What is known as *Flambé* ware illustrates a number of these transitions. By various ingenious methods the same oxide can be made to display upon the same object the red passing through violet into pale blue and then into green. Even white may appear. The secret of the effect lies in the treatment rather than in the basic material. In fact, where a thick glaze has been subjected to a particularly powerful reducing agency in the furnace, the process may go so far as to produce in places a brilliant splash of pure metal, in addition to the many other broken tones which have not yet reached such an extreme point of reduction.

The passage of colour is indeed so remarkable, and, theoretically, so complete that a comparison may be raised with the progress of an express train which stops at the customary stations of green and red (we are particularly considering the instance of copper salts), but which might

conceivably be stopped at other stages of coloration—though with a far greater difficulty. The *Flambé* ware goes far to prove the probability that these transitions do actually take place all along the line between the stages which are clearly visible—but are so inconceivable in their rapidity and lack of permanence that they cannot be arrested at each particular point, with any certainty, in their progress.

The most stable colours are necessarily only employed in enamel. Green, red, and turquoise are the familiar products from copper ; green and brownish-red from iron ; a vivid emerald green from chromium, and, with the least fraction of tin added, a pink. Gold, besides colouring glass red, can, in extreme cases of insufficient oxidisation, make a blue. The ruby colouring is due to the gold being present in the glass in the form of a colloidal solution ; it is, so to speak, suspended in infinitely small particles within the continuous medium of the glass. And this phase of colouring may account for colorations which occur with other metals in those cases where, at some stage or other, they may not be completely absorbed.

In the well-known lustres of Persian ware, the Hispano-Moorish platters and Italian majolica, special means were adopted to introduce reducing agents to bring about a metallic film. In the Spanish plates it is easy to detect a copper lustre from its rich pink colour and a silver lustre from the golden-yellow tone which prevails. In either case the surface was painted with a specially prepared glaze embodying one of these metals and then exposed to an atmosphere containing as little free oxygen as possible during the firing. This would ensure the reduction of the metal and the retention of the necessary metallic film. The reversal of the process would also be possible—it would be equally easy to reabsorb this metallic film by refiring it in the presence of a free current of air. The lustre under these conditions would entirely disappear, and an ordinary transparent glaze would take its place—imperceptibly tinted green by the film of the copper, or yellow by the film of the silver.

The finest lustre, in the artistic sense, is to be seen in some of the most notable pieces of Italian majolica. The ruby and kindred lustres were obtained, it is believed, from gold reduced to a metallic state, but the secret is probably not known at the present day. There is a story that some composition was found which had evidently been used for the purpose, and the discoverer produced by its employment results corresponding to the old work; but, as so frequently happens, the only information which was vouchsafed on the matter was that plenty of rags were used in the firing—'and the dirtier they were, the better.' This points to the probability that any increased density in the smoke helped to expedite the process. De Morgan in the same way recommended the burning of sawdust, wood, rubbish—'any kind of rubbish'—to contribute towards a satisfactory reduction of the metallic lustre.

The very transparent and brilliant lustre glazes which are now in frequent evidence are almost too perfect and uniform to be artistically pleasant. Bismuth probably plays an important part in their manufacture, and this metal has the property of spreading itself, if anything, too uniformly over the whole surface. The old majolica lustres owed much of their beauty to their imperfections and accidental variations in the same way that old pot-metal glass gave a distinction of quality due very largely to the crudity of its manufacture and a certain unreliability in the matter of the materials used. An irregularity of this character lends a firmness and solidity of effect that compare favourably with the slippery surface reminiscent of a soap-bubble. If the iridescence of a lustre becomes too emphatic or too obvious, a great part of its charm is destroyed.

Throughout all these sequences of transformation the copper, silver, or other metals appear to remain almost indestructible. They preserve their individuality, absorbed one moment in the body of the glass, at another appearing in pure metallic form—according to the conditions that are improvised. It is almost as if a human being would be liable to turn white or black according to the atmosphere

and climatic conditions to which he might be periodically exposed. Or, to follow closely the balance of the colour scheme, the imagination might picture a cuprous gentleman in the strictly reducing atmosphere of the rooms at Monte Carlo turning an apoplectic red from being deprived of his normal portion of fresh air ; while, if he went a few hundred feet upwards to La Turbie and Mont Agel, his complexion would be converted to a more equable green.

But an analogy confined more strictly to facts may be seen in colorations under natural conditions. The appearance of a green apple with streaked and veined markings of red upon the side exposed to the direct light of the sun, and even that of the bloom upon a peach, suggest a comparison with such examples of Chinese porcelain as *clair-de-lune*, where a pale green turquoise glaze has been transmuted to splashes of red and purple by a direct reducing action. In the case of the apple, however, the action is not of reduction but is due to the radiant energy of the sun developing a red pigment. The markings are curiously similar. There is the same mottled appearance as occurs when the metallic silicates are broken up beneath the surface of a glaze exposed in a molten state to the action of reducing gases. The same interplay of colour is in evidence in the appearance of the orange and purple patches in autumn leaves, the result of the presence of decomposed products of chlorophyll : and what is especially noticeable is that disturbances in even such remotely related substances as those we have mentioned appear to resolve themselves into a variety of form and colour which have much in common.

With regard to the simpler phases of colour there is also a resemblance to be noted. It is well known that very considerable differences in colorations from metallic oxides are brought about by the constitution of the glaze employed, whether it be a soda, potash, lead, or tin glaze. The peculiar beauty of the Egyptian blue and turquoise is, for example, only to be obtained by the use of the native soda. In the same manner the purple colouring of the Iris can be converted to crimson, green, or blue grey by being treated

with acid, soda, or alum; and in the natural growth of plants, the direction, in point of colour, taken by the anthocyan—the colouring matter dissolved in the cell sap—is determined by the acidity or other quality inherent in the plant itself.

The beautiful iridescence of ancient glass is quite another matter. The play of colour is exquisitely dry in quality. The surface is not smooth: it is, in fact, so sensitive as regards the stability of colour that it must be handled carefully. Any rubbing would tend to break up the thin scales of glass which have resulted from decay and the decomposition of ages. This decomposition has not produced a metallic film typical of lustre, but has disturbed the surface of the glass to such an extent that it forms a network of silicious prisms to which is due the intricacy of colour. It is not in any sense an effect of pigmentation, as may be proved by scraping away a portion of such a surface and melting it—a glass which is entirely colourless will be the outcome of the experiment.

It has been noticed that nature frequently displays a partiality for complementary colours. Copper passes naturally in its association with glass from red to green. Oddly enough, silver in very thin leaf is transparent when held up to the light and appears blue, while it stains glass yellow. Gold leaf in the same way is a green transparency, and produces a red colour in glass. While in nature the bronze tone of the copper beech is due to the fact that the green of the leaf is viewed through a red pigment, which disappears on being dipped in boiling water.

One other curious example exists in the case of the red enamel seen in old Roman work. A piece that has been fractured will often disclose an interior coloured a sealing-wax red, while the surface is of a green like verdigris—also opaque. This occurrence has been found to be so frequent that when old armorial bearings are discovered decorated with enamel colours, it is usual to assume that the portions appearing green were 'gules'—that is, red—and any researches undertaken to trace the family bearings would be made on this assumption.

An explanation may be found in the fact that this red enamel was fusible at a distinctly low temperature, and that the colour was not so much fused as suspended in the glass. If the maker had left it in the fire a little longer it would have become black, then a dirty green, and finally, in all probability, a dark green. Even in pouring the enamel from the crucible it very likely would have flowed as a bright red and cooled with a green surface where oxidisation would naturally be taking place. It is indeed open to conjecture that in actually working with this colour the green surface was ground down until the fine red substratum was reached and then polished. The colour would be so unstable under ordinary conditions that this might quite conceivably be the only way in which the red enamel could be obtained so as to display its full value.

CHAPTER VIII

ETRUSCAN GRAIN WORK IN GOLD

THE ancient Etruscan ornaments have always attracted attention for what has seemed a well-nigh impossible form of decoration. Minute granules of gold were employed to give a surface texture and were soldered upon a sheet of gold in certain patterns, generally outlined with gold wire. And further—what appears even more remarkable—surrounding certain small embossed figures fine lines were in some cases drawn which consisted of nothing except these tiny grains set one against the other in single file—literally, a method of line drawing in a multitude of infinitely small particles. The hairpins worn by the women were also surmounted by round golden balls, closely covered with the same granulations—an effect which, apart from the marvel of its workmanship, imparted a peculiarly rich colour to the gold itself by reason of the numerous reflections caused by the broken surface. Two mysteries have, in current opinion, surrounded this surprising result—firstly, how the grains of gold were obtained, and secondly, how they were securely soldered.

It has been stated by certain authorities that each granule was made separately and, presumably, soldered separately. This conjecture may, however, be safely rejected, as the art would scarcely have been so generally practised if the process had been so infinitely laborious. A simpler solution must be discovered to be acceptable.

In Professor Flinders Petrie's *Arts and Crafts of Ancient Egypt*, granulated work in gold is mentioned and illustrated to prove that this form of jewellery was made fully 3000 years B.C., and an equal number of years before the Etruscan work of the same character was produced. The grains could only have been made in one of two ways,

either by running up a tiny fragment of gold under heat into a round bead—as may readily be proved by experiment with a blowpipe—or by a simpler method which an Egyptian five thousand years ago may have discovered by an accident. If by any chance he had dropped a crucible or a piece of charcoal with gold in a molten state, he might have found out something of which he could make use. The molten gold will act differently according to the impetus it has gained in the act of falling. With a fall of a few inches on to a tile or piece of flat metal it makes a splash-form, like a solidified blot of ink. But if it falls three or four feet on to a pavement or floor it breaks up into a multitude of small grains.

Such an accident, in fact, recently led to the recognition of this occurrence. A drop of molten gold, happening to fall on to the floor, to all appearances disappeared; it was, however, subsequently found to have broken up into innumerable grains such as appear in the Etruscan work. By a simple device a large box, carefully lined with paper, was so arranged that it contained an inclined surface upon which the molten metal could be dropped. It thus became possible to collect a very considerable number of grains from within the box, which only required to be sorted into appropriate sizes to provide a means of decoration. The most minute, strangely enough, were found to be so buoyant as to float in water.

It seems highly probable, therefore, that an explanation may from this experiment suggest itself of a simple method of manufacture which would render the making of this particular type of jewellery a less toilsome occupation than is generally supposed.

But how was it possible to solder these minute fragments of gold with such amazing regularity as to form definite patterns?

We should naturally look for information on this point from the Italian jeweller Castellani, who succeeded in reproducing the Etruscan work with great accuracy, as may be seen from examples in the Victoria and Albert Museum. There is the same incrustation of tiny grains on hanging

balls and on flat surfaces; just as if they had been sifted so as to form a superficial skin. Castellani published a paper in 1861 in which he discussed the difficulty of soldering these almost invisible grains. He stated that he had consulted Pliny, Theophilus, and Cellini, and had studied the works of Indian jewellers and those of the Maltese and Genoese goldsmiths with little success. It was only in a remote corner of the Marches of St. Angelo in Vado that he found in use some of the processes employed by the Etruscans. Some of these workmen were taught by him to imitate the ancient jewellery, and the method of soldering adopted, according to his account, was the substitution of arseniates for borax as a flux. He filed the solder into impalpable dust to obtain his results.

In the following year Castellani again wrote on the subject. 'While inspecting some ancient Etruscan ornaments in our own collection,' he says, 'we were led to make the following important observation, namely, that the places from which the granulated work had been broken off presented the same appearance as those gold surfaces from which the enamel that once covered them has been torn away.' This discovery induced him to try a new process which solved a problem that had engaged his attention for twenty-four years.

This may all appear somewhat complicated; but if the principles of soldering are understood, the difficulty disappears. If at any time a piece of enamel is chipped off a piece of copper, the bare metal will appear perfectly clean —the glass itself has absorbed the impurities. This is exactly the condition necessary for successful soldering; the metals will amalgamate in a molten state under a condition of perfect purity. Enamel will in fact act as a flux; and it is quite possible, where a join is necessary at the same place where some enamelling is being carried out, to add the solder chips and the two processes will take place simultaneously. The method is not to be recommended in general practice; but, if it were by any chance adopted, it would be further possible to eat away the enamel with hydrofluoric acid—another tiresome process. Obviously

the softer borax is serviceable enough under ordinary conditions, and can be removed with comparative ease.

One thing is clear; that in this matter of hard soldering there are more ways than one of arriving at the same result. In a previous chapter the more ordinary—and easiest—method has been indicated. It may be of interest to compare the older methods which Castellani appears to have rejected.

Pliny in his fifth chapter of the thirty-third book—he was nothing if not encyclopædic—speaks of chrysocolla, or malachite, as being used to solder gold, mixed with nitre and other ingredients in a brazen mortar.

Theophilus, in addition to a method which has already been quoted, mentions a mixture of wood ash, lye, soap, and pig fat which is rubbed on to copper. This is heated red hot, cooled in water, and the 'burnt' copper is scraped off. This residue, containing a compound of copper, is mixed with the alkaline lye mixture once more, boiled and ground. The result, he says, is a solder for gold.

Benvenuto Cellini describes gold soldering with venderaine (acetate of copper) or verdigris. This is ground into a paint with borax and nitre, and applied along the joins. He then heated the object on charcoal until the 'first skin of the gold begins to move.' It is then sprinkled with water to stop the melting going further.

At first sight these methods would appear perplexing in the highest degree; but the connection will be understood when it is remembered that a solder is an alloyed metal which melts sooner than the metal which it is proposed to unite. The curious fact exists that a metal may be mixed with another metal which is more obstinate than itself in melting—yet the combination of the two may be more fusible than either of the two original metals. Thus silver alloyed with copper—which is harder to fuse than silver—melts at a temperature below the melting point of silver, and is therefore an excellent soldering material. The readiness, in fact, with which these metals fuse together may be discovered in enamelling if by any chance a piece of silver lying in direct contact with copper is

submitted to an enamelling heat. The silver disappears at once.

Now, malachite and verdigris are respectively carbonates and acetates of copper, ' verdigris ' being a term commonly applied to any ' greening ' of copper. With either of these compounds can be introduced the necessary amount of the foreign metal to form a fusible alloy which will act as a solder.

In our more modern practice we use a small sheet or stick of solder which is composed of certain proportions of metals melted together. The mixture has in this instance already been made. If the ancients used malachite or verdigris, they were introducing copper contained in these compounds instead of in a form in which it had already been incorporated by melting. In fact, they appear to have skipped a stage in the proceedings and used the most direct, though probably in practice the less reliable, method of all, the result being precisely the same in either case.

A historical coincidence of some interest exists in connection with the use of malachite for soldering purposes. Pliny, writing in the first century A.D., mentions that tablets covered with a malachite paint had been found which the Egyptian women used for painting their eyes. It is not unreasonable to suppose that the Egyptian goldsmiths may have made use of the same substance. If any doubt exists as to whether these old methods are actually practicable, the reader can be assured that the Cellini method with verdigris does certainly work with gold grains and wire. The cohesion is absolutely firm—and that without leaving any trace behind, after pickling in acid. The perfection of the method is illustrated in a way that a mixed solder alloy fails to equal.

There seems to be no reason why a compound of copper carbonate, such as malachite, should not do equally well. If a paint of this character were used to mark out a design upon gold, it is feasible to imagine that an experienced workman would be able to distribute his gold granules evenly upon the sticky areas of paint, apply the necessary heat—preferably from below in order not to disturb the

positions of the granules—and thus complete the process of a firm soldering in the ancient manner.

It therefore appears to be the easiest explanation that the ancient goldsmiths discovered, by the merest accident, an association of metallic substances that enabled gold to be soldered under the most delicate conditions. Upon the application of heat there must have taken place at the critical moment the composition of an alloy which served to unite the adjacent surfaces in what was apparently the simplest manner. The difficulty of the process has probably been exaggerated; but it is none the less the strangest of mysteries that has, with considerable success, resisted the efforts of later experiment to rediscover.

CHAPTER IX

NIELLO AND SOME TRIVIALITIES

I. NIELLO

THE process of decorating silver, and, more rarely, gold with black markings in the manner of niello—or nigellum, to use the original word—has lost some of its interest in modern times. But it is none the less an attractive form of inlay, very definite, and possessed of a beautiful surface. It has been incorrectly described as a black enamel. So far from its being vitreous in character, it is entirely metallic, forming an integral part with the metal on which it is melted.

An intimate connection exists between niello and the process of printing from an engraved surface; although historically it may be said to have resulted from an accident. One of the most familiar forms of decoration has always been that of excising a pattern; just as a design might be engraved from a flat landscape by the digging of ditches and laying bare flat spaces. In fact, the heraldic emblem of the 'White Horse' may be found carved in this manner on our chalk downs. With metal the same method has been employed on an infinitely smaller scale: the ditches and spaces were filled up, sometimes with enamel, or, more simply, with a black alloy, flush with the surrounding ground. It occurred to an artist working in niello to preserve a record of his design by filling the ditches which he had engraved on his metal with printing ink and pressing a sheet of paper over the surface. By these means he obtained an impression upon paper, that is still in existence, of an early silver and niello pax; and thus the curious coincidence happens that as the result of a simple experiment Finiguerra, by profession a goldsmith,

has been credited with the invention of a form of engraved printing, which was later to be developed as a distinct art.

The niello discs, therefore, which frequently decorated bowls, cups, and book-covers, can be legitimately regarded in the light of black metal prints on a silver surface; and this method was adopted—according to Theophilus—as a means of decorating chalices designed with ribs 'which should be alternately gilt and blackened . . . you portray Greek foliage in those places which you wish to make black, and carve with a bold stroke, and you sculpture their grounds with graceful circles and with fine work.' Then he instructs his readers how to make and employ the niello.

There is no necessity to follow out the old receipts for making the mixture, as it can be bought ready made and is not difficult to apply. Niello is in fact nothing but a coloured metal alloy, a black solder which is melted into the depressed silver spaces prepared for it. To make it, silver, copper, and lead are melted together in a variety of proportions—they may be taken almost at haphazard according to the hardness or softness which is desired—and sulphur is added which has the effect of blackening the composition. This mixture is sold as a black powder, and needs about a twentieth part of sal ammoniac to be well blended with it before use.

The pattern is cut out of the surface of the silver with engraving tools, or—a method which is simpler—etched and bitten fairly deeply with nitric acid. A combination of the two, etching and engraving, will produce the best result, scorpers being used to clean up the lines and leave a little 'bite' on the ground of the pattern.

The mixture is laid into the hollows very much in the same way as powdered enamel, and the whole work is heated until the niello melts and more than fills the engraved spaces; at which stage Cellini, who writes most fully on the subject, explains that he smooths down the melted niello into the engraved silver with a thick, clean iron wire until the surface is evenly covered. It may be necessary to fill up spaces which have been left vacant and to repeat the

Plate 27

[*to face p.* 124

firing; but it should not remain longer than is absolutely necessary over the flame, or in the furnace, as the lead in the composition will be apt to combine too freely with the silver and burn through it.

The surface must then be cleaned up with a file or scraper and all superfluous niello removed, revealing the lines of the design with the greatest clearness. The final polishing is done with tripoli and other polishing materials. As a last finish the slightest touch of wax polish may be rubbed over the surface.

II. JEWELLERY

To touch on the question of enamelled jewellery except in the lightest manner is obviously inappropriate, considering that the making of jewellery is a highly specialised art. But one or two considerations may be mentioned. Opinions may vary as to how far enamel justifies itself in every case. To judge from examples belonging to the Tudor and Victorian periods, one is inclined to the conclusion that white enamel on gold tends to a hard and inartistic effect. There is also the fact that in such forms of jewellery as chains, watches, and the like enamel is liable to a considerable amount of jarring, and is therefore likely to suffer in the course of continuous wear. Any accident may cause it to split and scale off, and for that reason its use should be confined to a class of jewellery which receives the tenderest of treatment. Should fractures, however, occur, it should not be difficult to repair the parts which are damaged—at any rate, in those cases where a single firing will be sufficient. When white has been used, with decorations painted in vitreous colours, any repair would necessitate a fresh ground of white and an entirely new painting. In ordinary cases the injury is not so disastrous as would appear at first sight.

One advantage of enamelled jewellery is that fine artistic effects can be obtained at a comparatively low cost. The combination of stones with coloured enamel may be sympa-

thetic in its general effect. And here an opportunity presents itself for exploiting the less fashionable, but none the less beautiful, gems which suffer a neglect they scarcely merit. A well-cut topaz or amethyst can be set off with a light setting of some finely balanced shade of enamel selected to bring out the character of the gem. The less precious stones may even appear to a greater advantage with a treatment of some freedom on these lines of contrasting colour than when they are displayed in a more formal manner. The opal, 'star-stones,' and *chatoyant* varieties would, all of them, present interesting problems with which to experiment.

It is important to exercise restraint in the amount of enamel used. In a brooch, to take one example, the intention is to enhance the preciousness of the stone. On the score of durability alone, it may be well to use some form of cloisonné with gold wire, which can be laid on silver directly, if silver is used, without the necessity of soldering. An amethyst may be set in a circlet containing a scheme of some variant of its own colour with an opposition of green. A strip of silver must first be cut to form a collar round the stone, the ends soldered and the claws, which will hold the stone, cut with a file or fine saw. A wire for setting stones can be bought with the claws ready set, but a difficulty may arise from its liability to fuse with an irritating readiness. An alternative would be to hammer a twisted or waved wire very thin, so that its top margin could be closed down over the edge of the stone.

The collar is soldered on to the small domed piece of silver which is to be enamelled. The centre will then be cut out with the fretsaw to make room for the stone, which will naturally not be secured until everything else is finished. The dome is enamelled: the pin and catch, either bought or made, are firmly soldered on to the back, while a little ingenuity may be necessary to make the final adjustments. Such simple ornaments frequently harmonise very charmingly with the colour of a dress. A star sapphire associated with a pale olive, or a topaz surrounded by a narrow band of vivid green, may supply a pleasant note of

Plate 28

[*to face p.* 126

colour. Above all, a treatment *à jour* in the palest tones might well secure an admirable effect.

A form of ornament worn in the hair presents opportunities which were fully recognised in the 'garlands' made by the Greeks and Romans. A modern version could be treated with small detached masses carrying a suggestion of the foliage of the smilax. The leaves would be separately enamelled on gold or silver with a surrounding gold wire; and gold wire veinings would add to their strength. Constructed with a loop, they could be hung on a central twisted wire to pass round the head with the whole treatment kept very slight and unobtrusive. In all such work delicacy must be combined with a sufficient degree of strength, while the work is kept small in scale. Often by cutting out intervals in the backgrounds a delicacy suggestive of lace-work can be obtained. In any case heaviness must be avoided. The colour which is selected must also be employed with the utmost reserve.

III. FOIL IMPRESSIONS

The manipulation of thin foil to obtain impressions of such decorative surfaces as coins, medals, intaglios, or even original designs in gesso and wax, opens up a field of amusing experiment. There may be charming objects of this nature of which one would wish to possess a replica, and thin foil enables remarkably close impressions to be taken.

A medal, for instance, is to be copied. Cut out a piece of foil slightly larger and very carefully anneal it over a flame. It will be found useful to construct a kind of small wire tennis-racquet to support the foil, and this can be easily made by bending a thick wire into a circle, about the size of a large saucer. Twist it at the ends into a handle and across the face of the racquet cross and recross lines of binding wire. Upon this support bring the foil slowly down to a flame so that the silver just flushes into red. As it will fuse at the edges with the least provocation, it must be quickly withdrawn before any damage is done. The foil will now have lost all its spring. Put it in water

and place it, still wet, on the medal. Holding it in place, rub over the surface with the finger until a faint definition is obtained. Then improve upon this first impression with such soft-surfaced and yielding implements as a pointed piece of indiarubber, the blunt end of a wooden match or even that of a wax match. After a while, the silver begins to stiffen once more ; and if it sets too hard before the impression is altogether satisfactory, anneal again, damp it, and get every detail as distinct as possible.

The back of the impression can be filled in with pewter by laying it on its face in a tray of fine sand and packing it gently. The pewter is melted in a small tin dish over a Bunsen burner, the dross is removed with a piece of stick, and the metal poured into the silver impression the back of which has previously been painted with a liquid soft soldering flux. The pewter must not be at too high a temperature or it will burn the silver. A good plan is to pour the molten pewter into another tin and then on to the silver. That will allow it to cool down to just the right heat to ensure a satisfactory result.

Or the foil can be enamelled. The process is the same as that described with reference to an impression in the manner of stained glass. The back must be first filled with a counter enamel before the face of it is dealt with. Before the foil is removed from the medal paint over it a thickness of about a quarter of an inch of investment, and when this has set, turn the whole thing on its back and remove the medal. The back of the foil will present itself ready to be filled with a good covering of enamel. This is fired and the investment removed in water.

Much depends on the use to which the enamelled medal is to be put. It can form part of a design, such as the interior of a wreath, or it can be enamelled by itself. In either case it had better have a bed of enamel on which to lie, such as a small enamelled copper plaque. In being fired it will settle down and preserve the detail of its surface. Only a pale tone should be used if the detail is to remain clearly visible, and a still more effective rendering can be obtained by rubbing the least amount of a coloured oxide

Plate 29

[*to face p.* 128

into the depressions with some celluloid varnish or other medium, and gently polishing the relief. Lay a coat of enamel on the surface, and the result, with luck, may be a satisfactory coloured representation of the original design.

Another method would be to enamel the design with different coloured enamels—especially when gold foil is used—in the manner of some typical examples of Renaissance work. Such work, however, was occasionally done on cast metal, in which cases the enamel was almost certain to break away. Cellini rightly recommends that all solid objects intended for enamelling should be worked in repoussé and soldered together. The enamel would in that case hold, without breaking away.

Foil can also be cut into patterns with the assistance of scissors and a sharp knife blade. If the pattern is marked out on paper and fastened on to the foil the cutting will be easier. Various treatments with enamel may be invented. The foil pattern can be laid over an enamelled plaque to which it will adhere in the furnace, and can be afterwards glazed. Or it may be employed to form somewhat of a raised design in the following manner. Paint fairly thickly an opal or other enamel directly on to the cut foil and fire it, supported on a piece of iron gauze, over a Bunsen flame. Repeat the process if necessary until the covering is considered to be sufficient, and then allow it in the furnace to sink into its place upon the background of coloured enamel which has been prepared for it. Probably the background will require reinforcing in places with a further firing, and the raised enamel may need to be gently filed into an even surface. The method will ensure a good definition apart from the advantage in effect gained by its being raised in relief. A semi-transparent opal design over a blue-grey ground can look well, and other combinations of colour will readily suggest themselves.

One other method of treating an impression is to employ a soft vitrifiable colour as an excellent form of patina, heightening the effect of the modelling and allowing the silver or gold, as the case may be, the full value of its relief. Mixed with a thin ' retouching ' varnish, or a shellac solu-

tion, the powder can be rubbed directly over the surface of the metal; and if the finger is occasionally dried on a piece of rag this rubbing can be continued until the effect is felt to be satisfactory. A slight firing with blowpipe or Bunsen flame will melt the colour; and the background can be further reinforced by a fresh application of colour with a brush, and again fired to complete the effect.

IV. GLASS GEMS

The range of colour in enamel is so wide and has such close analogies with the coloured precious stones that the desire may be natural to fuse it into symmetrical shapes with a view to a setting in gilt gesso or other materials.

In a muffle it is possible to heat broken pieces of glass or enamel upon a piece of fireclay, or even on metal, so that, softened by the heat, they become rounded into cabochon-shaped imitation gems. But they tend to lose their shape, and may sink too flat to be satisfactory. A circle of fine wire would help in this respect to contain the enamel, and enable it to be built up a little.

An alternative plan is to fuse the enamel on small pieces of shaped silver. A circular punch is excellent for cutting out small rounds of silver foil upon a piece of lead. A tiny dish, nicely hollowed, comes away; and if this is filled with enamel and placed on a piece of iron-wire gauze it can be fired over a Bunsen burner to form an excellently shaped glass bead upon its silver base.

For a larger size a different method may be adopted, and the assistance of what is called a 'doming stamp' becomes necessary. Cut out foil with the scissors in the size of a sixpence or shilling after scratching round the edge of the coin with a needle point. Anneal and shape it into the form of one of the dome cavities. The broad rounded end of a stick will help to do this. Hold the silver, when it has been well shaped, at the edge with a pair of tweezers, and with a brush paint thinly over its surface the wet enamel, stiffened with a little gum. Place it on the wire racquet and very cautiously dry it over a Bunsen flame. Bring it

Plate 30 [*to face p.* 130

down closer until it just fuses. The surface of the enamel will be rough, but it will give a good hold for the next thin painting, done in the same way. This time fire it more strongly until the surface is shining and perfectly smooth, so that it reflects like a mirror. This enamel will hold well without cracking, even though the reverse side is not enamelled. Gesso will be an excellent material with which to fill it and make a setting.

There are also glass imitations of so-called 'gems' or intaglios; and these can be made by two reliable methods. In the one, use is made of a silver foil impression obtained in the way that has been described, and the method is exactly the same as when the back of the foil was filled in with enamel. Only, in this case, the enamel is used of which the gem is to be composed. Successive coats must be fired until the thickness is at least an eighth of an inch, and it may be necessary to press it down gently if it shows signs of becoming distorted. The investment beneath the silver will give the necessary support, and preserve the sharpness of detail in the impression.

There is now shut up in the foil an excellent cast of the model, and it will be wise to let it cool very slowly to avoid any cracking. The foil may possibly be peeled off, but, if it refuses, it can be eaten away with nitric acid.

The other method is more directly a cast and avoids any discoloration caused by the silver. The model is slightly greased and placed on its back upon a folded cloth. Upon its surface is painted a thick cream composed of four parts tripoli and one part plaster of Paris well mixed. This is set, when fairly dry, with more plaster into a box lid or one of the small tin cooking-dishes which will be found useful for many purposes. When the mould is perfectly dry, smash into small pieces the glass or enamel, and fill up the mould so that the glass stands in a small heap. Put this slowly into a well-heated muffle; and, when it begins to fuse, withdraw it and carefully press on the top with a piece of clean sheet-iron or an old knife, pushing the softened glass into the margins where it refuses and also into all the hollows. The glass need not reach

more than a ' putty ' stage of softness. With a little pressure it will take the impression sufficiently well. If it is melted too far, it will become too closely associated with the material of the mould and suffer in consequence. It is possible to use enamel or pieces even of chemists' blue bottle glass or hock bottles, but the latter will require more heat to fuse them than the enamel. The cast will require careful annealing by leaving it in the muffle or covering it with hot sand in a saucepan and placing it on the top of the furnace.

When cold, remove the mould, and it may cause a momentary shock to notice its roughness. But a brass scratch-brush and a little tripoli will take away the grit of the mould, and it can be polished with tripoli, rouge, and fine precipitated chalk. It may be necessary to grind the back and edges of the cast into shape with carborundum and water. This will supply the test whether it has been perfectly annealed. It is best to begin with small work, but with practice pieces of the size of a crown can be attempted. Beyond this size there is a considerable likelihood of cracking.

V. CASTING IN METAL

Cire perdue—or the ' waste-wax ' method of casting in metal—may be sufficiently interesting to suggest an experiment with an easily-fused metal such as pewter. Harder metals, like bronze, present greater difficulties in view of the higher temperatures required.

The principle is much on the lines of the apple-dumpling —if the apple is regarded as the object which it is desired to reproduce in metal. The mould, which corresponds to the pastry, may be taken as being capable of resisting heat. Imagine that the apple is made of wax, which runs out, when heated, leaving an empty space. This space is filled with a molten metal. When everything is cool, the outer casing is broken up and the metal cast remains.

The process is so clearly described by Theophilus that it is possible to follow him both in practice and principle.

He has, it may be presumed, modelled in wax one of the handles of a cup, wishing to reproduce it in silver. At one end of the wax model, he says 'place a little wax, round like a slender candle, half a finger in length, but let it be somewhat thicker at the top; this wax is called the funnel, and which you will make fast with a hot iron (that is, to melt the wax at the juncture of the "funnel" with the wax model, for a good join). Then take clay well beaten, and cover carefully, so that all the hollows of the sculpture (of the wax model) may be filled up. When these (the first coat of clay) are dry, again cover equally over all, except the top of the funnel, and do thus a third time. Afterwards place these moulds near the coals, that when they have become warm you may pour out the wax.' The clay mould is well baked, and while still hot receives the molten metal, poured in through the funnel from which the wax had already made its exit. It is merely a matter of metal and wax changing places. 'When they have become cold remove the clay' by breaking it up. Cut off the funnel which had been added in wax—and is now metal—and a replica of the original wax model remains.

The process is simplified for us by the use of 'investment,' which sets hard and when carefully dried will not behave as capriciously as mere clay. Four parts of brick dust to one of plaster would also serve the purpose.

Under the older system, if anything went wrong—as might easily happen—the work bestowed on making the wax model would be lost. The model itself would naturally have disappeared—and in any case for each metal casting a separate model in wax must necessarily be made. To safeguard against accidents and to render possible more reproductions than only the one, a plaster cast of the model would now be made. Should the model be a medallion, it would only be necessary to wet the plaster cast and pour melted wax on it, trimming it up with a knife when cold. If the model were in the round, two or more sections of plaster moulds would be required. These would be joined together wet and wax poured in. The wax cast would shrink and require retouching, but any number of

such wax casts could be taken and as many metal facsimiles reproduced. A separate investment mould would, of course, be necessary on each occasion.

The casting of a large and important piece of work, such as a statue—which must also be hollow—is not, at the first glance, the easiest thing to understand. The problem, briefly, is to cast a thick skin of metal—very much as one might wish to make a cast of the skin of an orange. The proceeding in such an event would be as follows. The inside of the orange would first be prepared as a 'core,' of some rather soft fire-resisting plaster. Over this core would be laid a layer of wax which would be modelled into the desired form. Bars of metal are now thrust through wax and core; and everything is invested within a substantial mould. If heat is now applied, the melted wax will naturally flow out through some convenient opening; while the core is at the same time still held securely in position by the cross-bars of metal. Through the same opening, from which the wax issued, is poured a molten metal. Supposing that the friable core can be extracted from a specially made hole, what is finally left is a metal shell representing on its surface exactly the form of the originally modelled wax.

The excitement of such an experiment on a large scale is best realised by the description given by Cellini in his Memoirs of the casting of his 'Perseus.' The 'Medusa,' which lay at the foot of the group, had been already cast, and the anxiety and worry entailed by the prospect of successfully carrying through the main figure had worn Cellini into a state of fever. The chances of failure, as well as the discouraging prophecy of the Grand Duke Cosimo, that the Medusa's head, which Perseus is holding at arm's length above his head, would not fill with the metal, still further aggravated his disquietude. Everything seemed to be conspiring against the success of the venture. The story, as told by himself, describes his rising from his sick-bed and throwing a hundred pewter plates, one by one, in front of the canals of molten metal which had just been opened, some also into the furnace. The final result

Plate 31

[*To face p.* 134

proved a triumph. The furnace exploded under the additional pressure and the metal flooded the moulds. The head of the Medusa proved to be perfect, also the head of Perseus; but when the left foot was reached, the toes were deficient—due, probably, to the resistance of imprisoned air or other gases in the lowest portion of the mould, the place where such an accident was least expected to happen.

VI. SUGGESTIONS OF COLOUR FOR WOODWORK

An old type of carved and coloured furniture, in which coloured wax was used as a further embellishment, opens up the possibility of an interesting variation. The design, in these examples, was excised and defined with a wax which was, first of all, blended with a pigment and then poured into the recesses while still fluid. Some kind of a small coffee-pot may have been used for the melting and pouring of the composition. Sealing-wax naturally suggests itself as a convenient equivalent; and some experiment with melting it into the channels provided for it, scraping and rubbing away with sandpaper the superfluous material, and finally restoring the surface with a piece of warm metal or methylated spirit should secure some interesting results. But a more reliable method, though less rapid, may be preferably recommended.

If the carving of the design were as finely executed as in the case of the well-known Chinese screens, there would be no occasion to furnish any concealment; no attempt would be needed to bring the coloured material flush with the surface. The perfection of the carving was so beautiful in itself that nothing but a dull colouring in rather faded tones was felt to be necessary, barely to cover the exquisitely modelled hollows. In a rougher type of carving, however, there is a necessity to fill the recessed design with a substantial body of colour.

The object may be to decorate the main part of a piece of furniture, or separate panels which can be later incorporated in the body of the work. In either case the surface

of the wood had best be darkened, even if it is not made a positive black. With a fairly small gouge, scrolls and lines can be cut out of a firm-fibred wood like mahogany in the designs characteristic of old oriental lacquer work; and the cleanly-cut impression can be most effective in its precision and regularity. The larger spaces are worked out with gouge or chisel to the depth of about an eighth of an inch. The intention will then be to fill up the decoration with what may be called a coloured mastic. Instead of a coloured wax, which may be found a little unmanageable, an equivalent can be found in the nature of a coloured cement. Strictly speaking, all oil pigment which has been mixed with flake white is an oil cement: but for our purpose it is advisable to use a form which is as quick drying as possible. The powder of ordinary coloured distemper, mixed with Japanese gold size to the consistency of a plastic mass, works satisfactorily, pressed into the interstices with a palette knife, brush, or other suitable implement. It is better not to lay it in too thickly, but rather to apply moderately thin coats which will have time to dry before the next is added. It will not take long, however, to bring the preparation level with the surface, and all superfluous pigment can be removed, when it has reached a suitable consistency, by means of a chisel or flat cutting-tool. Care must be taken not to cut into the surface of the wood in doing so. Irregularities can be filled up and everything brought to a smooth surface, which should present the appearance of a mosaic in coloured pigment. Especially for the final stages, an oil cement composed of gold size mixed with equal proportions of carbonate and oxide of zinc can be conveniently employed, and powdered pastel or other colouring, even ordinary oil paint, introduced to give the required tint—a thick consistency of course being required.

A rough but satisfactory lacquer surface can be made by polishing with a thick solution of orange shellac dissolved in methylated spirit. All that is necessary is to continue adding shellac to a half-filled bottle of spirit until a dark solution of a treacly nature is obtained. Over a surface in

which the coloured mastic has completely dried, this shellac solution can be rubbed with a piece of linen. As it is very quick in drying, the work must be done broadly without any niggling with a sticky surface. A drop of linseed oil, placed with the finger on the linen pad which carries the shellac, will assist in a convenient slipperiness. Be careful, therefore, not to worry the work or do too much at a time. A few coats should give a rich appearance, and if on the surrounding portions an old and broken appearance is desired, a little black or brown powder can be taken on the pad and rubbed in with plenty of shellac. Any correction can be made with another pad damped with methylated spirit, which will dissolve any solution which needs to be removed. In this method we have known a chest decorated—the sides in old Chinese lacquer designs and the top with a varied coloured chrysanthemum pattern—which was pleasantly criticised as resembling ' an antique in a good state of preservation.'

It is, of course, possible to use hard-drying varnish, letting it dry thoroughly and rubbing it down to a good surface with glass paper. A few repetitions of this process will produce a fine finish, but it will be found to take longer to produce. The greater part of old European and English lacquer was carried out with oil varnishes. The Eastern method corresponds more closely with a shellac process, which may be found to be a more expeditious method, and also productive of an excellent warm tone. Should the surface be felt to be too shiny, it can be rubbed down with rouge and linseed oil—a very reliable polishing composition—and this will produce something a little closer to an ' egg-shell ' surface.

VII. GESSO

Beside the colouring of woodwork upon the flat, or upon the concave designs of Chinese screens, an easy and effective method of obtaining a decorative effect in relief is found in the use of gesso. As a plastic composition it is most familiar in the modern picture-frame, and resembles

in its application, with certain reservations, the laying of decoration in sugar upon elaborate forms of confectionery. As a ground for painting and design in relief, its use goes back as far as early Egyptian and Persian work; and no better proof of its durability could be required than the survival of some of these examples. As an accessory to the setting up of enamels, it is often invaluable, gilded or slightly coloured with brown pigment; and if it is rubbed down lightly with pumice powder the newness of the effect can be pleasantly broken.

It will save a good deal of unnecessary trouble to purchase a ready-made gesso powder or one of the preparations which only needs the addition of water to form an easily running modelling fluid. Thin hot glue can be used with the ordinary quality of gesso powder. Nothing is better for the purpose than a common glue-pot in which the powder and thin glue is mixed to form a creamy fluid which works well off a brush. The ground upon which it is painted must give as much 'bite' as possible to prevent the composition breaking away. A rough surface is therefore advisable; a layer of thin canvas—or, for thicker work, some small tacks half driven home—will give an excellent hold. In the older uses the gesso would vary in its consistency according to any requirements; a thick putty-like substance for stamping and modelling, or of a thinner consistency for painting in relief. A little experiment will soon indicate its possibilities. Upon a coloured lacquer ground subtle modulations can be raised in gesso, smoothed down, again lacquered with a shellac solution, painted in gold colours, and finished off with a final reinforcement of the design by means of thin, black lines in oil paint. A few touches of additional colour will be useful in adding a certain liveliness of effect.

VIII. CASTING IN CLAY

A slight experimental acquaintance with clay is possible with an enamelling furnace. No great expectations, however, of any results of importance should for a moment

be entertained. For any serious work an elaborate kiln becomes imperative—or at least opportunities of access to some reliable means of carrying work to a legitimate conclusion.

But, if only a slight knowledge of the principles of ceramics is desired, much can be learnt from the simple experiment of casting a piece of terra-cotta. The crude material may lie close at hand in a patch of yellow or blue clay. A small decorative flat ornament can be taken as the model; and there should be no great difficulty in reproducing it in terra-cotta or carrying it so far as to glaze it in the manner of a ginger-beer bottle—or possibly with a more ambitious colouring.

If the experiment is made with a lump of crude clay, it must first be thoroughly washed in a bucket of water and cleaned from any rough components by being kneaded in the hands or pounded with some kind of stick. Most of the gritty matter can be removed in this way, leaving a mass of sticky clay, of which the finest particles are required for our purpose. Stir it up well in fresh water until sufficient of the clay remains in suspension to colour the water a turgid yellow. Pour off this thick fluid into a separate vessel and repeat the process until a fair quantity of the muddy water has been obtained. Leave it at rest until the sediment has fallen to the bottom and pour off the clear water. Collect in a cloth all the fine clay which remains behind, and let it dry to such an extent that it is possible to knead it into a ball of the consistency of modelling wax. A wooden box which has been lined with plaster of Paris will assist the drying, if the cloth containing the clay is placed inside. There will now be available a rough-and-ready example of a workable clay.

To cast the clay in any required shape a mould of plaster of Paris is required. Oil the object, place it on a flat surface, with a card or lead collar around it, and take the cast in the usual way. Work the stiff ball of clay into an approximate shape, press it into the plaster mould—which must be dry—and laying a piece of linen on the top, level it as far as possible.

The drying of the clay is hastened by the absorbent property of the dry plaster, which soaks out the moisture. The clay itself contracts in the process and will come away from the mould when it has reached a certain degree of dryness.

This was, in fact, the method in which the ancient Egyptians constructed the small glazed forms of flowers, which were placed with the mummies, the only difference being that the moulds in this case were made of a baked clay and that a siliceous paste of fine white sand was worked into them. When the cast had been removed and thoroughly dried it was dipped into powdered glass and fired. This compound of sand and glass under great heat would actually fuse into a porcelain, and enable the blue enamel to assume its magnificent colouring.

The clay when it has been cast will need a thorough drying. Exposure to the air for a few days, and finally in some conveniently warm place, will complete the drying process. Placed in the cold muffle and subjected to a gradually increased temperature in the furnace, it should finally reach a bright heat, and on cooling, be found converted to terra-cotta. Any moisture or defective manipulation will inevitably cause cracking and splitting in a furnace which is not intended for these purposes; but the conversion of clay into a form of pottery will have been illustrated. Prepared white clay can be obtained which would necessarily give much finer results; or, more reliable still, a finely sifted fireclay. It is possible to glaze the cast by painting on it one of the soft glazes prepared for pottery and firing it; but the cast may possibly split on a second firing. Any imprisoned moisture or gas is liable to effect a cleavage.

As an alternative to a vitreous colouring, a cast in white clay can be treated with oil colour diluted with plenty of turpentine. The painting should be done with directness and without fumbling. To obtain a brilliant surface pour over it a small pool of Japanese gold size, and with the finger spread it evenly. Leave it to dry in a flat position.

A similar method of painting clay was freely practised

in Europe before vitreous glazing became generally known. When once the experience of obtaining a covering material more appropriate to pottery was gained the art made rapid progress. Luca della Robbia was the first to apply successfully a fine white glaze which gave to his figures modelled in clay the appearance of white marble. And later Bernard Palissy carried the technique of glazing a step further in connection with various forms of pottery, amongst which his *pièces rustiques* have gained an unenviable artistic reputation. These strange dishes may be frequently seen as museum specimens, and the method of their construction throws a curious light on the possibilities—by no means worthy of imitation—of casting in clay. These dishes, it may be remembered, are crowded with an odd collection of leaves, beetles, small snakes, fishes, and shells. His method was simplicity itself. On a pewter plate he arranged the miscellaneous objects—including '*les petits bestions*'—and fastened them in their places with fine thread. A plaster cast was then taken of this monstrous composition. '*On dégageait ensuite les animaux de leur enveloppe de plâtre*,' says a contemporary writer. In this way he had at his disposal a mould from which it was a simple matter to obtain a clay reproduction, capable of being treated with appropriate glazes and colourings. Fortunately these studies of natural history have not commended themselves as a pleasing fashion. The representation resembles too closely the nature of an abominable salad to be regarded otherwise than as an indelicate example of ingenuity.

Sufficient has been said to show that work in enamel and metal supplies a wide road for the adventurous craftsman. There remain a few byways along which he will in all probability be tempted to pursue kindred crafts. The main ideas and principles involved vary comparatively little. Only the material itself requires a modification in the handling to suit its peculiarities. And perhaps the best way to ascertain these peculiarities is to plunge into the problem ; to take it, as it were, *per breves capillos* and

struggle through the difficulties to some sort of conclusion. An entanglement suggests an extrication; a riddle may be solved in the most unexpected manner to pave the way for new intricacies. The Irish remark that 'the only way of really learning rocks is to run on them' conveys more than a grain of truth in these practical matters.

At any rate, it is little use attempting to prophesy how many twists and turns may lie in the road when once the quest of artistic adventure has been set on foot. A man's achievement will advance only as far as he is able to visualise: ever groping in the dark, all will depend on the illumination before him—how far ahead the exploring lights open out fresh avenues.

PRACTICAL NOTES ON THE ILLUSTRATIONS

FRONTISPIECE.—Adapted from an illustration of a *Russian Morse*. The base is of stout brass; with brass spaces and decorations—also the twisted wire edging—fastened in position with binding wire and then soft soldered. The centre enamel is on silver; the drawing made directly with a black oxide on the metal and covered with transparent flux. The background is pale amber yellow, the drapery soft blue, and gold is introduced in places. Small enamelled silver plaques, purple, violet, turquoise, and blue grey, set around; the top one of all being red on gold. The small settings are opal on silver discs; and in the corners red on gold discs.

Page 16.—*Cross*, in Quattrocento style. Silver and enamel on wooden base. Central quatrefoil has an inner circle in gold paillon; the letters left in gold surrounded by full purple. Outside that is rich turquoise. The outer quatrefoils enamelled on silver, the design drawn with iridium oxide. Faces and hands are transparent flux, slightly tinted with vitrifiable colour. Robes in violet, purple, reddish brown, etc. The intervals in cloisonné work; coloured with alternate purple and rich blue turquoise enamel.

Page 18.—From an illustration of a *Russian Morse*. The base is stout brass; collar, wires, etc. wired in position and soft soldered. All the enamelling is on gold; with the exception of the small points and drops, which are opal on silver.

Page 22.—*Copper Dish*, enamelled in two parts; the upper in soft red over which is a pattern in a warm violet glaze; the lower in opaque and other enamels separated by cotton thread before firing.

Page 26.—*Enamelled Copper Cup*. The lid cut on the flat with fretsaw and hard soldered down one side. Opaque enamels with which various coloured oxides are ground to break up the colour slightly. The top ball made of two shaped pieces of enamelled gold fastened together.

Page 32.—*Small Enamelled Dish*. The upper portion turquoise on silver, with variations of transparent colour. The lower half enamelled in semi-transparent opal enamel.

Page 46.—*Brass Casket*, mostly riveted. Panels in soft red with rich violet pattern laid within cotton thread before firing.

Page 50.—*Cloisonné Enamel* on silver. The parrots are pale green touched with darker green—against a blue background. The oval band transparent flux on the silver. Tree trunks red brown; quiet opaque green foliage with warm yellow fruit. Corners brown purple with turquoise centre. After the coloured enamels were fired, the whole was covered with very transparent flux over the level of the wires, rubbed down with carborundum, washed with hydrofluoric acid, and 'fire-polished' in a final firing. Counter-enamelled on the back.

Page 52.—*Cloisonné Enamel* on silver. Brilliant blue ground. Green foliage; pæonies clear flux and purple. Enamel not carried to the top of the wires.

Page 56.—*Cloisonné Enamel* on silver. Emerald green ground, lilac leaves. Circles mostly enamel on gold.

Page 60.—*Silver Box*. Copper plaque enamelled with black, on which Celtic pattern was fired in white grisaille. A bright green enamel glaze thrown over the whole; an effect of black and green familiar in Persian ware.

Page 66.—*Large Brass Box* entirely soft soldered. Everything securely bound together with copper wire throughout the process. Centre of lid cut out with fretsaw. Panel of a blue ground, on which a fish in silver foil is enamelled in pale greenish yellow and orange red.

Pages 68, 70.—*Grisaille White* painted on a black ground.

Page 72.—*Casket*—front and back views. Three panels form a triptych. On thin copper; the design depressed with a blunt point, the grooves filled with black enamel under a covering of transparent flux. The sky then painted in opaque enamel and the rest in a variety of colours used freely.

Page 74.—*Candlesticks*—panels enamelled on silver to suggest stained glass; set in gilt gesso.

Page 80.—*Six-sided Copper Box*, stained with a sulphide solution. Butterfly drawn in black on gold foil and enamelled in yellow, green, etc. on red background; set in a copper frame riveted to the lid and surrounded by a double twisted wire.

Page 82.—*Copper Box*. Enamel on copper. The band round the bottom is soft soldered, with a small ornament to strengthen the join.

Page 84.—(Left). *Silver Box*, lid fitting within the side. The centre a pale transparent green cast from a five-shilling piece. It is held inside the collar with a fine silver twist. Next the collar, a single oblong wire twisted. Beyond, double round-wire twists. At the

bottom, a drawn moulding, soldered into a loop, with double round twist above it.

(Right). *Silver Box* with similar decoration. The outer wire is a flat tape cut from silver sheet, annealed, twisted as far as it will go. Cloisonné enamel in blue, green, turquoise, and purple.

Page 86.—*Silver Box* with flat waved silver edging. Enamel of Japanese character with yellow ground, surrounded by a beaded wire.

Page 88.—*Silver Repoussé.* Venetian-oriental style.

Page 90.—*Copper Paper Knife*, repoussé in thick copper. Head riveted to lower portion. The lining tool is used with deep hammering, on pitch. Scales marked with small gouge. The outside shape afterwards sawn out with fretsaw.

Page 92.—*Copper Spoon* in thick copper. Lines deeply hammered. Chisel used to cut the bevelling and the interstices cut out afterwards.

Page 94.—*Book Cover.* Clasp in repoussé silver, enamelled purple and green turquoise. Small silver rivets soft soldered on the reverse side and cut short. The leather is calf, soaked in water and squeezed out. Repoussé with the same tools as in metalwork upon a base of marble or metal. Relief raised from the back with steel burnisher. Shagreen effect of the background worked with small round punch.

Page 104.—*From an Engraving* by Étienne de Laune.

Page 124.—*Silver Cover* of glass trinket-case. Decoration in niello. The silver etched with a half-and-half solution of nitric acid after the background had been painted with an acid-resisting varnish, leaving the design bare.

Page 126.—*Two Brooches*: the larger an amethyst surrounded with green and purple enamel; the smaller a topaz set with emerald green.

Page 128.—*Comb Ornament* on silver with strongly marked cloisonné wiring. The edge cut out with fretsaw after the wires have been soldered. Green turquoise ground associated with blue, emerald, and small spaces of purple.

Page 130.—*Glass Cast* in transparent blue enamel. The quatrefoil is of sheet silver with an oblong single twist round the centre. The rest of the wiring is ordinary cloisonné wire and small double round twists—with transparent green enamel between. The whole soldered on to a drawn moulding, soldered in a circular form. Four crystal beads fixed with silver pins; pieces of silver wire being fused to form a head at one end.

Page 134.—*Pewter Cast* by 'waste-wax' process: from head of paper-knife.

INDEX

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