Painting with Metal Spray

How Protective Coatings Are Shot Into Place Under the Latest Procedure

By Robert G. Skerrett

ELECTROPLATING and galvanizing are well-proved and widely applied processes that have many fields of usefulness. Indeed, they would be resorted to far more extensively if there were not conditions that make this prohibitive. That is to say, many metal articles might be plated to advantage if their basic substances could resist the while the corrosive attack of the electrolyte employed; and the size and structural get-up of other metallic bodies are such that it is commercially impracticable to provide a zinc bath large enough to admit of their treatment.

Nevertheless, metal coatings have been devised that are handled more or less like paints, and to a point these have served fairly well although admittedly not as durable or satisfactory as the shielding film deposited electrically or by dipping in a bath of molten metal. The fundamental weakness of these painted-on or stuck-on coatings has been the lack of intimate union between the underlying and the attached metals. However, years of scientific research and inventive cunning have finally brought to a truly commercial stage a flexible system which makes it possible to form a covering film by spraying melted metal upon a variety of surfaces for protective or decorative purposes. In this the achievements of M. U. Schoop, of Zürich, Switzerland, are conspicuous.

The SCIENTIFIC AMERICAN has previously described the Schoop process—the last article appearing a little over six years ago. Since then this ingenious engineer has pushed steadily onward, improving the while earlier apparatus and creating still newer instrumentalities that add greatly to the capabilities of his spraying method. For a time Schoop relied upon an oxy-hydrogen flame either to melt powdered metal or to fuse a wire which, while in the molten state, was atomized by a stream of compressed air and driven at considerable velocity against the surface to be coated. Now, he employs an oxy-acetylene jet, and this has proved quite 50 per cent superior. The higher temperatures obtained in this way insure better results, give the metal coating pistol a longer effective range, and make it feasible to handle efficiently metals differing widely in their melting points.

A few years back the somewhat delicate mechanism that fed the wire into the flame of the blowpipe was operated by a small pneumatic turbine which made about 28,000 revolutions a minute. This meant that a rather complex reduction gear was required in order to transmit a far more sluggish movement to the fusing wire. The commercial demand was for a pistol of really rugged construction which could be entrusted to the average workman and his commonly unskilled manipulation. To this end, a pistol has been produced which is equipped with an air-driven Pelton wheel which makes between 4000 and 5000 turns a minute. The wire-feeding feature is, in consequence, now reasonably robust, and the speed adjustment of the feed is simplified to a marked extent.

But probably the greatest step forward has been in the substitution of the electric arc for the gas flame. In the "Electro-pistol," which functions with either direct or alternating current, two wires, moving toward each other, form part of the circuit. The two free or open ends of this circuit are brought together and then separated just far enough to induce an arc; and this distance is maintained as the wires are uniformly fed into this arc and fused. At the same time, the melting terminals are swept by a jet of compressed air, and this atomizes the

Transmission towers and spreaders for the Swiss electrified railways, which were galvanized by the spray system

metal and drives the plastic globules against the surface to be coated. The temperature of the arc is higher than 5400 degrees Fahrenheit and, therefore, sufficient to permit the melting and spraying of plati-

cent was deposited, the remaining 70 per cent being dissipated in the atmosphere and in a way to interfere with the breathing of the operative. The pistols now in use are able to deposit 90 per cent of the metal

atomized; and in the case of aluminum the factor of efficiency is 95 per cent. In the past only tin, lead, and zinc could be handled, but the list of metals that can now be precipitated by the process is a far longer one—in fact, it includes any that can be fused by either the oxy-acetylene flame or the electric arc.

In 1912 Schoop demonstrated that it was feasible to melt, to diffuse, and to deposit enamel, glass, quartz, etc., on suitable bodies, but he elected at that time to devote all of his energies to the problems relating to metal spraying. Within the past year, however, he has again taken up enameling, and his accomplishments open up new avenues of application for his broad system. Even when silicate of lead is added to reduce the melting point of enamel or glass, still temperatures running from 1112 degrees to 1292 degrees Fahrenheit are necessary, and it is therefore practicable to coat only materials that can withstand exposure to that heat without injury. The surfacing substance may be in a powdered or granular state or it may be in some other form which is not so readily fused. Care has to be taken to see to it that the driving medium, compressed air or inflammable gas, shall be so controlled that it will not exert a troublesome cooling effect before the vitreous material has reached the object to be covered.

It seems that by the admixture of coloring matter it is possible to give the enamel or glaze any desired tint; and there is reason to believe that this new evolution of the process can be used to advantage both in the field of art and in many departments of industry. The glaze or enamel imparts a brilliant and beautiful finish, according to the composition. Not only that, but the coatings are of a pronounced refractory character. Indeed, tests have repeatedly revealed that tin and other metals so enameled can be heated to redness in a Bunsen flame and then plunged directly into cold water without causing the film to peel off or crack.

As the Schoop system stands at present, the spraying pistols are of three types: and, whether the heating agency be oxy-acetylene gas or electricity, they render it feasible to deal with powdered metal or wire or vitreous substances. Each pattern of pistol has its virtues, and, therefore, is able to meet special requirements or conditions. These several apparatus may be operated from stationary or portable plants. The portable equipments are

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A terra-cotta box that has been bronzed by the spray method

num, molybdenum and other very refractory metals.

The electro-pistol weighs only 3.3 pounds, uses 40 amperes of current at from 25 to 30 volts, and calls for an expenditure of 17.6 cubic feet of compressed air

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A portable plant for the operation of the "electro-pistol," making it possible to deal with structures heretofore inaccessible

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particularly serviceable when outdoor structures, large castings, etc., have to be treated where they are located for the nonce or permanently. The Schoop interests have devised a "Metallisator" of moderate dimensions which permits the rapid galvanizing, tinning, leading, etc., of quantities of small metal articles. The latter are rotated in a tumbling barrel or drum, and attached to the supporting shaft is a spraying pistol which oscillates so that it will scatter the molten metal in every direction. By the aid of this machine numerous products can be handled quickly and cheaply. In zinc coating by this means the protective metal penetrates into the pores and interstices of the supporting mass and produces a uniform film which is so nearly permanent that it will give without breaking to hammer blows and repeated bending stresses.

The Schoop process has been employed beneficially in leading the iron buckets of Pelton wheels in hydroelectric plants abroad. Ordinarily, these buckets, when exposed to on-coming sand and gravel, are rather rapidly worn away. The lead coating arrests this destructive action, for the impacting abrasives actually tend to anchor the lead more securely to the underlying iron, while the grit or gravel exerts but a very moderate erosive effect upon the protecting film. Chemical vessels of iron have been made resistant to corrosion by surfacing them, according to the nature of the chemicals to be handled, with lead or aluminum. This expedient has insured longer life and brought about substantial economies.

As might be expected the main use of the metal-spraying process is for zincing. This system has gained extensive recognition in Switzerland, France, Italy, and Germany. Two years ago the Swiss Government adopted the Schoop method of galvanizing for the state railways and now employs it widely in the iron and steel shops and in the locomotive and car works at Neuhausen and Schlieren. The transmission towers and spreaders of the St. Gotthard electrified line, two railway bridges, and the underbodies of 20,000 cars have been zinc coated in this way. Rain falling upon laden coke and coal carriers absorbs some of the sulfur content of the fuels, and this water promotes deterioration of any iron or steel it may reach. A zinc film is much superior to paint and more lasting as a safeguard against this harmful action. The Swiss have also found it desirable to supplement the zinc coating of their bridges with one of sprayed lead wherever the steel or iron fabric lies in the sweep of gases from locomotive smokestacks.

According to the latest reports, the electro-pistol is said to be superior to the gas pistol both in a technical and in an industrial sense. The zinc coating ranges in thickness from .003 to .005 millimeters and a capable operative can galvanize a square meter of surface in the course of from 6 to 7 minutes. The potentialities of the process in the electro-technical and electro-chemical fields are too numerous to mention. A single example, however, will serve as a hint. It has been established that a substantial gain can be made in the direction of increased efficiency and greater operative safety by partly coating high-tension porcelain insulators with a film of copper deposited by spraying. The municipal electric plant of Stockholm has placed in one transmission line as many as 25,000 of these metal-coated insulators; and a porcelain factory at Hermsdorf is using a battery of Schoop pistols right along in the manufacture of insulators. The copper coating gives excellent contact surfaces, and owing thereto transmission resistances are reduced proportionately.

Theoretical objection to the Schoop system has been advanced by some critics on

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Starrett Universal Bevel Protractors may be had with 7 inch blade or 12 inch blade, or both, with or without leather cases. The protractor may also be had without the acute angle attachment, at a suitable reduction in price.

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the ground that oxidation would prevent the formation of a homogeneous layer of protecting metal. Practical results contradict this assumption. It is true that in most metallurgical processes gas and air do affect melted metal and frequently bring about rapid oxidation; and on the face of it one might imagine that the same phenomena would occur with atomized, molten metals. But the speed with which fusing, projection, and "freezing" of the atomized metal takes place, in relation to the comparatively moderate temperature employed, is greater than the rate at which reaction would have to occur to induce oxidation. In other words, it is feasible to melt and to solidify a metal so quickly that there is not time enough for the absorption of oxygen or other gases. In proof of this, Schoop has fused lead and then sprayed it with a stream of compressed oxygen, obtaining thereby a normal, homogeneous layer of the metal without any trace of oxidation!

In Germany wooden tobacco pipes and the inner surfaces of beer kegs have been "metallized" to protect them against fire in one case and to make them tight and more durable in the other. Telegraph and telephone poles have had their buried ends and a section immediately above the ground sheathed with a film of lead to prevent rotting; and the blades of aircraft propellers have been coated with aluminum. Metal-spraying pistols are being used to surface with aluminum or copper aprons, smocks, gloves, etc., worn by workers in chemical factories and laboratories where the fabrics might otherwise absorb chemicals and become dangerously combustible if brought close to a flame. The point to be noted is that materials which are normally considered more or less inflammable can be covered with a skin of metal without being injured in doing so. Clay models and many other works of art can be gilded, silvered, coppered, bronzed, etc., by means of the Schoop apparatus. The work is of such a character and the texture so true to the nature of the metal that the eye is readily deceived as to the identity of the underlying supporting substance.

Housework in the Laboratory

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tween sewing and sweeping and washing. Washing at the tables of varying elevations exacted different ratios of heat output: Twenty-one calories were required when the subject worked in a comfortable position, 25 calories when the pan was so stationed as to necessitate raising of the arms, and 30 calories when dishwashing was reduced to a back-bending job. The unpleasantness of the task was not broached by the experimental conclusions.

Laundry operations, both washing and ironing, were not outside the province of these observations. The work was done on towels 16 inches square. The washing equipment comprised a small galvanized iron tub and a scrubbing board, while the ironing was accomplished with a 5-pound iron on a table of suitable height. A towel was rubbed on the scrubbing board 40 times in 30 seconds, wrung by hand for 15 seconds, and then exchanged for another towel, 15 seconds being allowed for transferring. The energy output in washing was 49.6 calories per hour, thus earning for the assignment the classification of laborious toil. The presence of water in conducting the experiments would undoubtedly have increased the figures of heat requirement, as it would have enhanced the weight of the towel as well as wet articles would have offered more resistance on the scrubbing board and in wringing. Ironing proceeded at a rate of 70 strokes in 50 seconds, 10 seconds being allowed for exchanging towels. A cold iron was used lest heat should obstruct the measurements in the calorimeter. The energy expenditure was 24 cal-

ories an hour, thus ironing being classified as moderate toil.

The woman subject reposed in a common bentwood chair while knitting, crocheting, and hand sewing. Motions, other than those involved in the immediate task, were kept at a minimum. An uncompleted sweater was the object employed in the knitting operations, 23 stitches being administered to the minute. A simple pattern and fine cotton thread were used in the crocheting experiments. Hand sewing included varying types of work: Making a plain unpadded scallop (blanket stitch) on the edge of a small piece of fine linen, at the rate of 18 stitches a minute; simple running on light cotton goods, 6 stitches being taken on the needle, one to one beat of the time-measuring instrument, then the thread pulled through to four beats, with a total of 30 stitches per minute; hemming on light cotton goods, at a rate of 30 stitches to the minute, the thread being pulled all the way through after each stitch; darning light-weight cotton hose with a thread about 24 inches long. Such tasks entail a relatively small expenditure of energy, ranging from 7 calories an hour for sewing with the running stitch to 10 calories per hour in hemming. The heat output while knitting, 10 to 11 calories an hour, slightly exceeded that entailed in crocheting, 8 to 9 calories. The variation is attributed to the wool sweater being knitted weighing more than the cotton lace which was crocheted. Also a more liberal play of hand and arms was involved in knitting. The materials in hand sewing being approximately of the same weight the differences in heat expended are attributed to the extent of movement required. With a running stitch, 7 calories per hour, the movement of drawing the thread to its full length was made only every six stitches or five times a minute, whereas with hemming, 10 to 11 calories an hour, it was made after each stitch or 30 times a minute. Needleworkers, in practical operations, avoid the long thread because of undue exercising of the arms.

Advocates of modern conveniences in the home, it would seem, can draw an effective object lesson from these experimental conclusions which accurately determine energy expenditure in the performance of household tasks. Even under the most pleasing environments the housewife spends liberally of her reserve forces; when the home is devoid of modern facilities, certainly the toll exacted is not a mere calculation of effort wasted but a sacrificial exaction where human values pay dearly and even the tenure of life is abridged.

Simplifying the Coupling of Trains

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