

# Metal Spraying in the United States: A JTST Historical Paper\*

W.B. Meyer

## 1. Introduction

THE METAL spraying industry had its beginnings early in this century when Dr. M.U. Schoop of Zurich, Switzerland, developed the first process for spraying metal. It consisted of pouring molten metal into a high-pressure gas stream. Later, Dr. Schoop passed metallic powders through a flame. These developments took place about 1910. Two years later, Schoop and his associates developed the first equipment to spray metal in wire form. The latter development led to the present industry, which for many years was called the "Schoop process."

## 2. Early Thermal Spray Companies

Early commercial applications for metallizing were developed in Germany and later in France. It was just before World War I that Dr. Schoop sold the rights to his patents, and to manufacture metal spraying equipment, to a group in Berlin. The Berlin plant was unique in that part of the building housed a machine and assembly shop, while the balance of the building functioned as a hotel and apartments. The machine shop was fairly large, was well equipped, and employed 35 or 40 workers.

A manufacturing company known as Metallizator was organized and, beginning in the early 1920s, sold spray units in Europe, England, and the United States. In 1920 or 1921, Richard L. Binder of Philadelphia saw one of the units that had been imported into this country and immediately fell in love with it. He contacted the New York importer of the equipment and contracted to become its sole distributor in the United States.

The German plant encountered financial problems in 1922 and needed additional capital. Richard Binder went to Germany, where he learned that the German mark was being drastically devalued and that U.S. dollars were badly needed. Accordingly, he made what he thought was a good deal by obtaining an option to buy all of the Metallizator stock for about \$150,000. Mrs. Binder subsequently inherited a considerable fortune from Peter Shemm, a prosperous Philadelphia brewer, and put up the required money. Binder now organized the Metal Coatings Company of America, capitalized at five million dollars, and became its president. The plant in Berlin continued to manufacture the equipment, but Binder took over its sale. The spray gun became

known as the "Meta-Layer." The sale of this equipment, both here and abroad, was only mildly successful.

Although the Metal Coatings Company had a modest machine shop operation, they concentrated only on experimental metal spray applications that might lead to the sale of equipment. Richard Binder was reluctant to give instructions and technical advice to customers. He felt that those who purchased his equipment for use in jobbing work should pay exorbitantly high prices for it. Because of this, he was rather unpopular with his customers, and the business expanded very little. As a result, Binder's financial problems multiplied. From 1926 to 1931, Binder was called back to the Berlin plant many times in order to try to straighten out the financial troubles. Each time he put more money into the venture in an attempt to save the company.

The year 1931 saw the rise of Adolf Hitler and marked the last trip of Richard Binder to the German plant. Because the plant employed several Jewish workers, the new regime was not inclined to allow the company to continue. Bank loans were called, and Binder either did not have more money to invest in the business or saw that it was no use.

He gathered all of the records, all of the finished and unfinished guns, and several boxes of spare parts and shipped them to Philadelphia. This was the end of the German plant. It is believed that neither Binder nor his estate ever received any further compensation from that venture.

Richard Binder made several comebacks after his return to the United States. He redesigned the equipment and then interested the Air Reduction Company in taking over its sale. However, American-made equipment came upon the scene in 1933. Binder lost ground and was finally forced to give up. He died in 1937.

## 3. Developments in the U.S.

William McMakin had joined Binder's Metal Coatings Company in 1928, just after graduating from Drexel Institute. McMakin is still active in the field (with the Metallizing Company of America), has never worked in any other field, and is considered the dean of metallizers. In 1928, McMakin, while working for Binder, sold metal spray equipment to the Arthur Tickle Engineering Works Company, Inc.

H.S. (Stu) Hammond joined the Metal Coatings Company in 1930. Early in 1932, he left to join Metalweld, Inc. of Philadelphia, for whom he is still a semiretired employee. While with the Metal Coatings Company, Hammond helped pioneer several production applications. One had to do with the application of copper on carbon resistors at the Wirt Company in Philadelphia. Another involved spraying copper on battery plates for Edison Battery Company. At the Briggs Body Works in Detroit, zinc was sprayed on imperfections in welds and then ground smooth.

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W.B. Meyer, St. Louis Metallizing Company, St. Louis, MO, USA.

In 1932, Metalweld, Inc. had been approached by Larry Kunkler with the idea of entering the metallizing jobbing field. Hammond had several interviews with John Oechsle, Sr. and Jack Childs, Sr., who then operated Metalweld. They decided to undertake the venture. The U.S. economy was in the midst of the Great Depression, and things looked rather grim. However, the decision was made to continue the effort for 1933, and some slight success was enjoyed.

Metalweld interested several companies in lining railroad tank cars with zinc and aluminum. These were used for shipping glycerin, transparent lacquers, and petroleum products that required "water-white" purity at their destination. Sometime later, the Navy Department was interested in having ship tanks coated. Coal barges operating on the Delaware River were protected with sprayed zinc.

Applications were gradually picked up from industrial plants as time went on. Later, the U.S. Army Corps of Engineers was interested in spraying zinc on the Panama Canal emergency gates that were being constructed by the American Bridge Company of Pittsburgh. These were completed just before the start of World War II. In the meantime, much work was done in East Coast shipyards, spraying various tanks in cruisers, destroyers, and aircraft carriers with both zinc and aluminum.

In 1929, Peter G. Dennison of Milwaukee, while an employee of the Allis-Chalmers Company, operated Meta-Layer equipment. He established his own shop, the Metal Spraying Corporation, in 1933. He currently serves as chairman of the board of directors of that organization. In his 41 years of service to the metal spraying industry, Dennison has contributed innumerable innovations and has been responsible for many thousands of successful applications.

#### 4. Industrial Growth in the U.S.

The successful promotion of the process in this country, however, was by a group of young entrepreneurs who really didn't have much choice in the manner by which they earned their living. Their "push" came in the early days of the Great Depression that followed the stock market crash of 1929. Jobs were few and money for capital investment was scarcer still. Yet it was during this difficult period in history that the process of spraying metal made its first real impact on the American industrial scene.

As previously discussed, metal had been sprayed in this country long before the appearance of these young men. We have seen how these few efforts were performed with European equipment. No one really knew all of the advantages that sprayed metal coatings could offer industry and the public. In Europe, a few lock gates, dam gates, tanks, and bridges had been coated with zinc. These coatings were affording excellent protection against corrosion.

Money was tight and few industries were willing to invest in seemingly nonessential coatings, the effectiveness of which was claimed by a group of youngsters reciting vague stories of applications performed in lands beyond the Atlantic Ocean. Claims were made that it was even possible to spray hard metals, such as steel, onto worn machine parts, and then remachine such coatings back to proper size. No one had yet found an effective method for firmly bonding such coatings so that they would not come off.

Sometime before 1931, a metal spray contract shop known as the Metallizing Company of Los Angeles opened, operating with Meta-Layer equipment. The company consisted of two people, Charles Boyden, Sr. and Charles Boyden, Jr. In 1931, Larry Kunkler and Richard Jensen bought part ownership of the company, after they had sold a lumberyard they had been operating in California. Soon they were joined by Rea Axline and Charlie Stipp, both graduates of the California Institute of Technology. The company name was changed to the Metallizing Company of America. Larry Kunkler was its president, Richard Jensen its secretary-treasurer, and Charles Boyden, Sr. its chief engineer.

The first metal spray equipment marketed by the Metallizing Company of America was essentially a copy of existing French and German equipment, with some design changes. The equipment was called the "3-in-1 Metallizing Unit" because it was sold with three sets of interchangeable gears. This allowed the spraying of high-melting-point metals, medium-melting-point metals, and low-melting-point metals with the same gun.

Kunkler, Stipp, and Axline traveled the United States, establishing distributorships and selling equipment. Axline worked the eastern states; Stipp, the midwestern and southern states; and Kunkler, the western states. Many are the tales, now made humorous by the passage of time, of their impoverished travels in the interest of spraying metal.

These young people—Larry Kunkler, Rea Axline, Charles Boyden, Sr., and Charles Stipp—pushed metallizing into the American industrial scene. The fact that they did this in the depths of the Depression indicates that metallizing had to be good in order to gain acceptance. That it was accepted was proof of its worth.

In 1931 or 1932, Axline exhibited a 3-in-1 Metallizing Unit at a meeting of the Galvanizers' Institute at the Hotel Statler in St. Louis. The gun (which sprayed zinc with hydrogen) was set up and operated in the hotel's kitchen. The next day, Axline called on the Schroeder Welding Company in St. Louis and sold them the first 3-in-1 unit ever marketed. Armin Schroeder, affectionately known as "Pop" to the metallizing industry, was the owner and operator. Sixteen years later, the American Metallizing Contractors Association was founded in that same hotel.

In 1932, a California automotive machine shop, Baker and Biggs, purchased a 3-in-1 unit, and Arthur E. Bender became its first operator. Bender recently observed that the only wires that were then sprayed were baling wire (10 carbon steel) and bed spring wire (120 carbon steel). The wage rate in those days was \$0.80 to \$1.00 per hour.

In the early 1930s, R.L. Crane purchased metal spraying equipment and installed it in his Iroquois Machinery Company in Buffalo, New York. William C. Reid, a native of Oxford, England, who had spent some time with Dr. Schoop in Zurich, joined the Crane enterprise. Out of this was formed the Buffalo Metallizing Company, which consisted of Bill Reid and Bob Crane, Jr. Reid went to work at no salary, until such time as a volume of work came in. This happened very quickly and business became quite brisk.

In 1932, Reid and Crane metallized the inside of an elevated water storage tank with zinc at Erie, Pennsylvania. This tank is still in operation today [1970], and the zinc coating still affords perfect protection. Soon afterward, Reid and Crane processed

two more such tanks at the Washburn Crosby Flour Mills in Buffalo. Reid left Buffalo Metallizing Company after 18 months to join the Metallizing Engineering Company, Inc., where he installed equipment in large refineries in Venezuela, Curacao, and Aruba.

## 5. Formation of Metco and Other Companies

Rea Axline settled in the New York area in 1933 and founded the Metallizing Engineering Company, Inc. He had financial assistance from Joseph Gossner, owner and president of the Imperial Export Company, Inc. The new company, to be later known as Metco, Inc., contracted metal spray work and sold Metallizing Company of America equipment in the eastern portion of the United States. Axline was joined in this venture by two people who have contributed greatly to the development of metal spraying ever since. One was George S. Lufkin, a Cal Tech classmate and third-generation Californian. The other was Arthur P. (Bud) Shepard, a former tree surgeon, who designed many new metal spray equipment features over the years. These two men of widely different backgrounds, together with a later arrival in the person of Herbert Ingham (also from Cal Tech), helped Axline establish the flame spray industry on a sound footing.

Charlie Stipp settled in the Chicago area, where he founded Metallizing, Inc. in 1933, also with financial assistance from Joseph Gossner. Met. Inc., as the new company came to be known, distributed Metallizing Company of America equipment in the Midwest and contracted jobbing work.

Larry Kunkler, with Dick Jensen and both of the Boydens, remained on the West Coast and operated the Metallizing Company of America, where the equipment was built. In 1935, their company marketed the Mogul Metallizing Unit, the first real American breakthrough in the field. This unit was designed by the senior Boyden and was designed to use acetylene more effectively than previous units. It also used much larger-gage wires. It was really the first reliable wire metallizing gun.

Also in 1935, the sale of metal spraying equipment in the Midwest was taken over by the Metallizing Engineering Company, Inc. Metallizing, Inc. in Chicago thereupon became strictly a jobbing shop. Dick Jensen set up the Chicago office for the Metallizing Engineering Company and ran it until Bill Reid returned from the Caribbean in mid-1935. Reid remained in charge until September 1937, when he moved to New York as vice president and sales manager of Metco. He was succeeded in Chicago by Walter B. Meyer.

## 6. North American Spray Shops in the Mid-1930s

The following metal spray contract shops operated throughout this country and Canada in the mid-1930s:

- Acme Machine Company, Fresno, CA
- All Weld Company, Ltd., Toronto, Canada
- Arthur Tickle Engineering Works, Inc., Brooklyn, NY

- Brodie Systems, Inc., Brooklyn, NY
- Buffalo Metallizing Co., Buffalo, NY
- California Steel Products Co., San Francisco, CA
- Capital Machine Works, Sacramento, CA
- Commercial Gas Company, Minneapolis, MN
- Eugene Machine & Foundry Co., Eugene, OR
- General Metallizing Co., Tulsa, OK
- General Welding Products Co., Indianapolis, IN
- Greer Welding Co., West Palm Beach, FL
- H.W. Loud Machine Co., Pomona, CA
- Hanson Pump & Machine Works, Phoenix, AZ
- J.C. Biggs and Son, Tucson, CA
- Jere Foutz Company, Avenal, CA
- John Nooter Boiler Works Co., St. Louis, MO
- Libby Welding Company, Kansas City, MO
- Metal Spraying Corporation, Milwaukee, WI
- Metalweld, Inc., Philadelphia, PA
- Pacific Coast Engineering Co., Oakland, CA
- San Pedro Machine Works, San Pedro, CA
- Schroeder Welding Co., St. Louis, MO
- Sprayed Metal Coatings Co., Cambridge, MA
- The Dextone Company, New Haven, CT
- The Nashua Steam, Press & Boiler Works, Nashua, NH
- Tuthill Spring Co., Chicago, IL
- Victor Metallizing Company, Miami, FL
- Wilson Machine Co., El Centro, CA

## 7. Patents

Among early patents involving metal spraying that were issued in this country were the following:

- May 11, 1915, to C.F. Jenkins (#1,139,291), for "Coating with Fusible Material." "The general object of this invention is to coat metallic or other objects with metal or other fusible materials, and this object is attained by fusing the coating material and driving small particles thereof against the object to be coated at a very high velocity."
- April 9, 1918, to G. Stolle (#1,262,134), for "Apparatus for Making Metallic Coatings." This patent states, "Be it known that I, Georg Stolle, a citizen of the German Empire, residing in Kiel, in the Kingdom of Prussia, Germany, have invented certain new and useful Improvements in Apparatus for Making Metallic Coatings; and I do hereby declare the following to be a full, clear and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same." A part of this patent covers the melting of metal with an electric arc.
- December 26, 1933, to Charles M. Saeger, Jr. (#1,940,814), for "Metal Coating Method." This concerns an electric arc method of metal spraying.

## 8. Applications in the 1930s

In a 1938 issue of *The Metallizer*, Charlie Stipp (then president of Metallizing, Inc. in Chicago) wrote that approximately 75% of the metallizing contract business was the repair of old equipment. The other 25% consisted of applications on new equipment. Today [1970], this ratio in the job shop business is about 50:50.

What was sprayed in the 1930s?

- Dental light bulbs were sprayed with lead.
- Clamps on power-line hardware were sprayed with copper.
- Refrigeration cold plates were sprayed with zinc.
- Metal lamp posts were sprayed with bronze and then oxidized.
- Laundry machinery and degreasing tanks were sprayed with zinc.
- Welds in galvanized sheet metal assemblies (such as steel drums) were sprayed with zinc.
- Printing cylinders were rebuilt.
- Cavitation damage in the runners of hydroplant turbine wheels were filled and ground smooth.
- Many castings were saved by filling blowholes and other defective areas with "Spra-iron A" and "Swedes Iron."
- Ammonia pistons were coated with babbitt.
- Meat wagons were protected with zinc.
- Auto and airplane engine manifolds were protected with sprayed aluminum.
- Battery boxes were sprayed with lead, as were some filter plates.
- Flaker drums were rebuilt with hard metals.
- Wood caskets were sprayed with copper and other decorative metals.
- Many rods, shafts, rams, and brake drums found new life through metallizing.

With the advent of World War II in Europe, American industry shifted into high gear. This placed a great strain on industrial equipment, and replacement parts soon became in short supply. Rebuilding worn parts by metallizing them was a quick, economical method for returning broken-down machinery to service. For the first time since its introduction in the Depression, metallizing was given a great opportunity to show itself to good advantage. It came through with flying colors.

Even our military services used sprayed metals to repair mobile equipment, vessels, and ground equipment. Walter Meyer and Tom Lufkin worked with the Army in the China-Burma-India theater, where they installed equipment and instructed both military and native personnel in its use. Knowles Smith worked at metal spraying while in the Navy. Many military units were outfitted with metallizing equipment.

The great impression made by metallizing during the war firmly established it as an industrial process. Its use for repair and for production enjoyed a phenomenal increase every year. At the same time, metal spray equipment was constantly improved. Spraying capacities were increased and operations sim-

plified. New bonding techniques were developed and spray materials improved.

## 9. The 1950s: The Age of Ceramics

The spraying of ceramic coatings became of age in the mid-1950s. Prior to that time, the Armour Institute, the Norton Company, and the Continental Coatings Company had been promoting such coatings throughout the country. The Norton patents involved the feeding of ceramic sticks through an oxyacetylene flame. The patents of the Armour Institute (later assigned to the Continental Coatings Company) were built around the spraying of ceramic materials in powder form through an oxyacetylene flame.

Metco, Inc. promoted the spraying of ceramic powders through their oxyacetylene powder spray unit. For a brief time, they also marketed a ceramic spray gun. However, most of the ceramic rods that are sprayed under the Norton patents are deposited by equipment manufactured by the Metallizing Company of America.

In October 1960, a "Missile Coating Conference" was held at the Norton Company in Worcester, Massachusetts. This conference was sponsored by Johns Hopkins University, Bendix Corporation, McDonnell Corporation, and the Norton Company. In attendance were:

- W.E. Campbell, Bendix Corp., Missile Division
- Fred W. Gartner, Jr., F.W. Gartner Company
- Raymond Cravens, St. Louis Metallizing Co.
- Henry A. Nelms, McDonnell Aircraft
- Eugene Rusert, McDonnell Aircraft
- David D. Reiff, Johns Hopkins University, Applied Physics Laboratory
- Walter B. Meyer, St. Louis Metallizing Co.
- F.L. Curtis, Norton Company
- Charles C. Esty, Norton Company
- W.G. Fallon, Norton Company
- Elmer G. Hurd, Norton Company
- G.H. Powers, Norton Company
- R.W. Robbins, Norton Company
- W. Ken Sears, Norton Company
- Dr. Louis J. Trostel, Norton Company
- Roland J. Westerholm, Norton Company
- W.M. Wheildon, Norton Company

At this meeting, a specification for "Zirconia Refractory Coating for Stainless Steel" was drawn up. This was based on an original draft by D.D. Reiff of Johns Hopkins. This specification is still in effect [1970] for coating the combustion chambers of guided missiles.

The flame spraying of ceramic coatings is still accomplished by passing powdered or rod material through an oxyacetylene flame and also by passing powdered material through a plasma stream. Each system imparts different characteristics to the "laid-down" ceramic coating. The spraying of ceramics has

been one of the most successful chapters in the half-century history of the flame spray process.

Today, ceramic coatings are used to resist wear on pumps, to insulate electrical equipment, to withstand heat oxidation, to resist chemically corrosive conditions, and to impart especially desirable properties to new equipment. It is not unusual for a ceramic-sprayed pump to outlast its unsprayed counterpart by a ratio of at least 5:1.

## 10. Plasma Spraying and Growth into the 1970s

Plasma spraying came into its own in the early 1960s and has since carved out a niche for itself in the industry. It is used predominantly to apply hard surfaces of tungsten carbide or chromium carbide in elevated-temperature and/or impact applications.

Other high-melting-point materials enjoy wide usage as coatings when sprayed by plasma flame techniques. The service life of equipment that is subject to vibratory wear, such as jet engine parts, computer components, and mold holders in the glass bottle industry, is greatly extended by such coatings.

## 11. Glossary of Companies and Individuals

These lists have been compiled from the main text of this paper. The companies and people mentioned in Sections 6 and 9 are not included.

### Companies

Air Reduction Company  
Allis-Chalmers Company  
American Bridge Company  
American Metallizing Contractors Association  
Armour Institute  
Arthur Tickle Engineering Works Company, Inc.  
Baker and Biggs  
Bendix Corporation  
Briggs Body Works  
Buffalo Metallizing Company  
Continental Coatings Company  
Edison Battery Company  
Imperial Export Company, Inc.  
Iroquois Machinery Company  
Johns Hopkins University  
McDonnell Corporation

Met. Inc.  
Metal Coatings Company of America  
Metal Spraying Corporation  
Metallizator  
Metallizing Company of America  
Metallizing Company of Los Angeles  
Metallizing Engineering Company, Inc.  
Metallizing, Inc.  
Metalweld, Inc.  
Metco, Inc.  
Navy Department  
Norton Company  
Schroeder Welding Company  
U.S. Army Corps of Engineers  
Washburn Crosby Flour Mills  
Wirt Company

### Individuals

Rea Axline  
Arthur E. Bender  
Mrs. Binder  
Richard L. Binder  
Charles Boyden, Jr.  
Charles Boyden, Sr.  
Jack Childs, Sr.  
R.L. Crane, Jr.  
Peter G. Dennison  
Joseph Gossner  
H.S. (Stu) Hammond  
Herbert Ingham  
C.F. Jenkins  
Richard Jensen  
Larry Kunkler  
George S. Lufkin  
Tom Lufkin  
William McMakin  
Walter B. Meyer  
John Oechsle, Sr.  
William C. Reid  
D.D. Reiff  
Charles M. Saeger, Jr.  
M.U. Schoop  
Armin Schroeder  
Peter Shemm  
Arthur P. (Bud) Shepard  
Knowles Smith  
Charlie Stipp  
G. Stolle