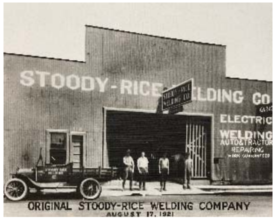
100 Years of Hardfacing



One hundred years ago, a revolution in welding began. In February 1921, Shelley M. Stoody, along with Elder Rice, opened their first welding shop in Whittier, CA – the "Stoody-Rice Welding Company." The early days were devoted mostly to reconditioning farm implements, which grew out of the expanding citrus industry in Whittier in the 1920's. Welding was then in its infancy. Most welding was done with cast iron, or bare high carbon rods, applied by the oxyacetylene method (OAW); coated electrodes were uncommon or unheard of.

The California oil rush altered the destiny of the company. Major oil reserves - "Black gold" - had been discovered in Santa Fe Springs in the flatlands south of Whittier. The Stoody shop was soon flooded with work from the burgeoning oil fields and the company quickly became involved with a new business – repairing broken drill bits from the oil rigs. In 1922, as the shop prospered, Shelley's father Charles, and his older brother, Winston F. (Bill) Stoody, were persuaded to close the family welding and machine shop in Huntington, West Virginia and move to Whittier. The two bought out Rice's interest for $1500 and joined Shelley as partners in the Stoody Welding Company. The company soon realized that downtime and the high cost of rebuilding drill bits were major problems for oil drillers.

HARDFACING

At the time, the standard repair for a dull bit was to cut off the worn portions of the tool, resharpen it and then harden it back to the original properties. Drill bits became shorter with each repair until they soon became useless. Stoody-Rice's search for better materials and methods set a new course for the young company - and gave birth to a new process called hardfacing, or the surfacing of metal with a coating of wear-resistant alloys.

Hardfacing extends service life, reduces unplanned downtime, and improves profitability by using lower cost base metals that are surfaced with a specialized alloy of superior durability, rebuilding worn components rather than replacing them. Hardfacing protects against most wear mechanisms and their various combinations, such as low- and high-stress abrasion, gouging, impact, galling, cavitation, erosion, corrosion, and heat.

To meet the needs of these applications, hardfacing electrodes have expanded over the last 100 years to encompass an extensive family of products that includes iron, nickel, chromium, cobalt, tungsten carbide, and vanadium-carbide-based alloys. A variety of industries rely on hardfacing, including oil and gas, power generation, cement, brick and clay, mining, construction, railroad, iron and steel, pulp and paper, sugar mills, and agriculture.

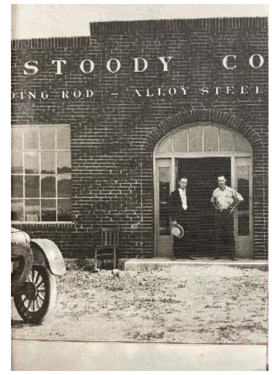
CURTAIN RODS TO CASTINGS

After preliminary success with the first alloy-coated high carbon welding rod and the first use of hollow curtain rods filled with alloy mixes, Stoody was determined to find a really long-wearing alloy. After hundreds of trials, a chromium and manganese alloy was discovered which would outwear the other materials available by a wide margin. "Stoody Rod" proved so successful that it has remained in use with only slight variations.

The 1920's were busy years combining constant testing and experimentation with continued service to customers in the oil fields, farms, and industries of Southern California. The Stoody Model "T" was a familiar sight around the oil fields, delivering and picking up work. The Stoodys also pioneered the use of air transport. They piloted the company's Lincoln-Page three-seater airplane from an airstrip adjacent to the plant to make distant deliveries and often making "drop shipments" out of the plane to the remote wildcatters below. Flying would continue to be an integral part of Shelley Stoody's life.

In this period (1922-1926), Stoody began applying hardfacing to drill bits using the Stoody Rod - later named "Stoody Self-Hardening" and it was available as a bare rod for OAW or coated for electric application. In 1924, they introduced "Stoodite," an iron-based cast welding rod that proved so superior that it also served industry for over 40 years with virtually no change in analysis.

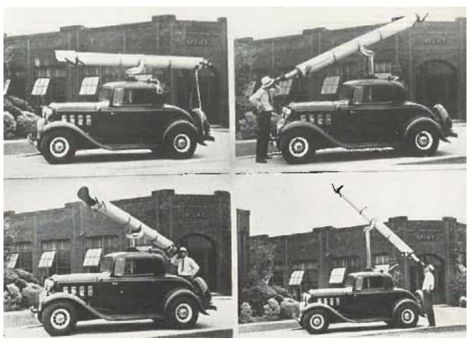
The initial success of Stoody Rod and of Stoodite a bit later had one inevitable consequence - the appearance on the market of competitive materials. In three short years the potential uses of hardfacing alloys had widened enormously, due in most part to the activities of the Stoodys in searching our applications on various types of equipment that presented severe wear problems and the production of materials that offered a simple, inexpensive solution; it was of course only natural that others should be attracted to the field which this company had originally explored and developed.



Stoody operations had outgrown the original quarters and in November 1924, the three announced their intention to form a new manufacturing concern. In 1925, a new plant was built for $325,000 on a 12 acre lot just south of Whittier, followed by incorporation as the Stoody Company. The new building was occupied in the spring of 1926, by which there were eight to ten employees in the shop and the company boasted one full-time salesperson. A second building for use as offices of the company was added in 1927. A third building was erected later that year to house a completely equipped laboratory and to supply room for the production and processing of Borium products.

Shelley Stoody's home, built in 1926 included a two-story tower. The second story of the tower served as an observatory complete with a roof that spun 360° with a roof hatch that opened to the sky. In this tower was a Zeiss Company, nine and one-half inch diameter refracting telescope.

In 1933, at the Stoody plant, the telescope was mounted to a 1932 Ford owned by Ed Turner who used it as a mobile teaching tool. From the July 1933 *Fusion Facts*:



"The primary object of such a mounting is the accessibility to locations of most favorable atmospheric conditions for the scientific study of the heavens. Conditions at certain fixed spots are sometimes such that observations cannot be carried out for several nights at a time or possibly for only a few mintues, while with this arrangement, this telescope may be taken to the most favorable locations."

In 1954, the telescope was sold to the Griffith Observatory. In 1955, it was mounted to their larger telescope as a guide scope to aid Griffith staff astronomer Paul Roques in the precise aiming and guiding needed for monitoring and searching for flare stars photographically with an automatic system between 1960 and 1971.

In 1939, a couple named Frank and Hannah Nixon bought the house and moved in with their three sons - Richard, Donald and Edward. Richard went on to become the 37th President of USA and the home is now often referred to as the Stoody-Nixon home.

BORIUM

Their next breakthrough came in 1927, when they manufactured the first cast tungsten-carbide material produced in the United States – trademarked in 1928 as "Borium".

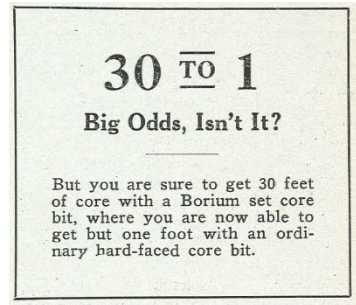
On February 19, 1927 the owner of a local drilling firm brought to the plant two small pieces of what he described aa ''Thoran metal" of German origin; his purpose was to determine whether or not this extremely hard material could be produced by Stoody Company. Analysis revealed that the samples were tungsten carbide, approximately 96% tungsten with 4% carbon.

Immediately after that analysis was made, experiments were begun in the possible production of the alloy. The first method attempted was that of placing powdered tungsten and carbon in a carbon crucible, which was then connected to two welding machines hooked up in parallel. The current was sufficient to bring the crucible to incandescence (a temperature above the melting point or tungsten. While most heats were failures, an occasional piece of tungsten carbide with the desired properties would come out of the carbon mold, a piece that was of extreme hardness and which could not be melted by the oxy-acetylene flame.

Tests continued with a larger furnace until the proportion of good heats rose from 5:1 to a satisfactory level through close control of the process variables.

The next problem was to determine possible uses for the Borium. In preliminary tests, cylindrical pieces coming from the crucible (about ¼" in diameter and 1" long) were centerless ground, set into holes drilled in the cutting edge of oil drilling bits, and then fixed in place by brazing. Drilling tests with this configuration were satisfactory, but the cost of producing and grinding Borium pieces made the price prohibitive - $350 to $400 per pound! It became apparent that a less expensive application method would have to be found.

Using a larger crucible, slugs of variable shape could be produced. These were broken with a hammer into small, irregular pieces called "peas" and screened into four groups. Tests were made by welding the peas into drilling bit cutting faces and edges. In service, the peas would take the abrasive action on the bit holding the cutting edges out and vastly increasing the bit's service life.



As Borium production increased a sales promotion was undertaken in the Southern California oil fields so the radically new product could be proven in actual field tests. Stoody was willing to give a "30 to 1" promise – that an ordinary core bit would only drill one foot, while a Borium set core bit would drill 30 feet!

In the course of making Borium sticks and peas, a large number of pieces too small to be used as peas were produced. The growing accumulation of these costly but unusable pieces was cause for concern and a great deal of thought was given as to how it might be used. In June of 1927, a few ounces of the small scrap Borium were placed in the Stoody rod fabricating machine and several rods – the first "Tube Borium" were produced. The last six months of 1927 were spent testing bits welded with the rod on an experimental basis, and the first outright sale of Tube Borium was made in December – at $160 per pound!

Also in 1927, Stoody patented a machine, which had been in use with several improvements, to produce the alloy-filled tubes. A decades old machine, which is derived from this patent, is still in use in Stoody Company's factory today to make these tube rods! In January, 1928, Stoody applied for a patent covering Tube Borium and it was granted in May, 1930. Once Stoody began marketing the product, a period of litigation began which drug on for nearly six years. No validity as to the patent rights of Tube Borium was ever made, but the patent rights for the rod-making machine were upheld. But there is no doubt that the first product of its type was made in the Stoody plant.

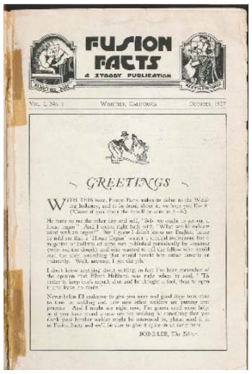
The company's sales of Borium products grew rapidly beginning in the first part of 1928; within a year, tungsten powder became the most important raw material used in the Stoody plant. It was natural that the idea of mining and refining tungsten for the company's own needs occurred to management. Therefore, in 1929, a search for such a source was undertaken and a group of mining claims in western Arizona was acquired. Boriana Mining Company, a Stoody subsidiary, was organized for this purpose. This mine had a small complex wolframite/scheelite ore as a dependable, low-cost source of supply. A development program was undertaken - an access road was built, a water well was drilled, employee housing was constructed, underground equipment and a mill for crushing and processing the ore were installed.

By 1932 the mine and mill were ready to go into full operation – just as the Great Depressions began. The demand for tungsten was reduced almost to the vanishing point and even the company's own needs were drastically cut. The mine was a considerable investment but there was no market for it, so one of the minority shareholders in Stoody (Security Investment Company of Whittier) was looking to exchange the complete mining operation for Security's interest in Boriana. Although the outlay in Boriana was far greater than the apparent value of this minority interest, the exchange was finally made and as later events proved, the outcome was most fortunate for Stoody, despite the financial loss at the moment.

The early part of the depression era, 1929 to 1933, was a trying time for the company. Although the years immediately preceding saw substantial growth in volume with constantly brightening prospects, the general economic collapse hit the young organization hard. Demand for the products was reduced to a trickle. The workforce was kept intact as far as possible, but several employees had to be released. Those that remained worked for much of this period on alternating weeks at any job available in the fabricating, coating, Borium or Stoodite departments. At times Stoody's survival appeared somewhat doubtful but as conditions improved, orders began coming in again once more and, by 1933, the worst was over and regular production schedules were again established.

MARKETING INNOVATIONS

Daniel Staley joined Stoody Company in 1927, quickly working his way up to Sales Manager. In October, the first *Fusion Facts* was published. It was intended inform readers of the latest developments in the hardfacing industry; to present improved hardfacing processes and procedures; and to relate experiences which have resulted in savings of both time and money (along with dashes of



humor and company news). *Fusion Facts* Volume 1, Number 1 weighed in at just 500 copies. In the infant stage itself at the time, the welding industry took little notice of this latest arrival.

Daniel Staley's son, George, began working at Stoody in 1928 as a metal pourer. George spent 60 years at Stoody in many capacities, including President and then serving on the Board of Directors. Many years later, the name "George Stoody" was given to a character played by Bob Newhart in the sitcom "George and Leo" by Dan Staley, the show's creator and executive producer, as a tribute to his grandfather.

Stoody Company became known for not only the industry-specific product literature which was disseminated in guidebooks used by welders throughout the last century - guides that remain the standard today – but also for some unique publicity approaches. In 1928 the company purchased a second, larger, airplane – a six passenger Fokker. This aircraft was believed to be the most expensive and nicely equipped plane west of the Rockies. In November of that year, Captain William A. Frye took the plane on an 8,000 mile, thirty-two day journey to Denver, Chicago, Detroit, New York, Tulsa and El Paso. More than 200 people were taken on short air trips as guests of the company.

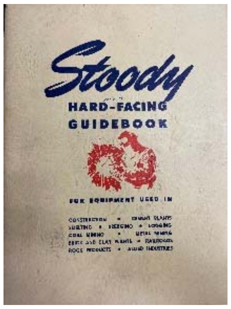
Also that year, the company put out a drama – produced by a Hollywood motion picture corporation and directed by a well known director named Mr. Curran - called "Three Hard Faces" as an appreciative boost to the City of Whittier and, of course, to the Stoody Company processes and products. The one-hour film dealt with the manufacturing process of Stoody Company in their making and selling of hardfacing alloys and rods. Acting in the film were employees of the company and it also included a love theme. The picture began with a short history of the industrial high-spots (and then focusing on Whittier) as well as Stoody and its ten years in the welding industry. The drama is introduced when a plane, circling above Whittier, makes a forced landing across from the Stoody plant due to a clogged oil line. Mr. J. C. Blake, the Stoody sales manager, strikes up a conversation with the pilot, Ted. During this discussion, one of the Stoody employees notices that the plane's tail skid is also broken. Ted is upset that he will have to get a new skid from the aircraft manufacturer. Of course, Mr. Blake tells Ted that the tail skid can be repaired in short order with Stoodite. As the repairs are being made, Ted is given a tour of the Stoody facility, including the furnaces for melting and pouring, as well as the actual welding itself.

At this point, a telegram is received from a customer in Bakersfield, CA requesting delivery of some Borium the next morning. Mr. Blake says that is not possible but Ted offers to fly the Borium – and a welder - to Bakersfield. In Bakersfield, the crew of the drilling rig are shown being unable to continue drilling. They get word that the Borium is on the way so they back the bit out of the hole. The bit is repaired and Ted returns to Whittier where in his absence, Bill Stoody and J. C. Blake had been discussing the advisability of owning a plane for just these type of deliveries. Blake invites Ted to come to work for them, and he initially turns him down, until he saw Bill Stoody's secretary (Miss Molly Malone) and from this point on, the love theme is developed.

1929 saw the beginning of the relationship between Victor Welding Equipment Company and Stoody, when they started sole distributing Victor products in specific areas of California, and Victor started distributing Stoody items. Victor remained a distributor until 1949 when the relationship was discontinued. The two companies would come together again under Pacific Lumber/Thermadyne many years later. Stoody purchased a tungsten mine in the Walapai mountain range which was rich in ore assaying from 3 to 60% tungsten. Later that year, Stoody announced "Borod" (Borium Rod) which allowed either electric arc or gas-welded application of a continuous tungsten carbide surface.

The patent-prolific Stoody brothers continued amassing over a dozen hardfacing and welding patents throughout the 1930's. In 1939, Stoody received a patent for a cobalt-chromium-tungsten welding alloy containing 40-50% iron for hardfacing. This was a unique approach to reformulating the Stoody 1 and 6 alloys which were much more expensive, to allow them to be more economically used for hardfacing. By 1944, experimental centrifugal castings had been produced in Stoodite, Stoody 6 and Stoody 1. Tests in various applications proved highly satisfactory, and by 1950, Stoody centrifugal castings were gaining wide acceptance. The exceptional service life of these parts - 10 to 20 times the life of tool steel parts - helped to establish the Stoody Company as a leader in the manufacture of cast wear-resistant alloy parts.

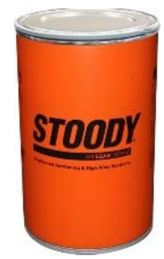
By 1940, Shelley Stoody had a $75,000 residence in the hills of what is now Hacienda Heights, CA. After World War II, he relocated to an 8,000 square foot Palos Verdes Estates hilltop home. In 1948, he purchased a helicopter to cut his commute time from 1.5 hours to only 20 minutes. Later, he replaced the helicopter with a twin engine airplane.



Stoody Company developed the industry's first application for submerged arc welding for hardfacing in 1946. Later that year, the flagship *Hardfacing Guidebook* was released – the most used (and copied) piece of literature in the field. In the Introduction, the company stated, "The Stoody *Hardfacing Guidebook* is designed as a handbook for selecting the alloy producing the greatest service life, considering such factors as inisitial cost and speed of application." Also available to welders was a short film (https://youtu.be/X_StTB8uHVg) "Pointers on Hardfacing Plowshares with Stoodite" which was a step-by-step video tutorial – again, the company providing premier hardfacing information to distributors and customers long before the age of YouTube! In 1947, Stoody launched its hardfacing welding school, which included lectures on basic metallurgy, proper welding procedures and application of various Stoody products.

In the early 1950's, Shelley Stoody bought a 425 acre ranch in Carbon Canyon, CA and he also owned a cattle ranch in Nevada. The "Double S" Ranch had a show ring as well as an airstrip for his private plane. It was during this time that Shelley Stoody also received patents regarding cattle. Unfortunately in June 1961, Shelley Stoody was killed in an airplane landing at his Carbon Canyon ranch.

In 1955, small (7/64" diameter) wires were developed for open-arc application with semi-automatic welders. This was an innovation in the welding industry, because, for the first time, Stoody made it possible for welders to deposit metal 3 times faster than with manual electrodes and be able to select from several analyses. This breakthrough eliminated the need for hand-held flux hoppers in semi-automatic welding.



In March of 1960, Stoody introduced a new, more effective way to package fabricated automatic welding wire. Later named the Payoff Pak (POP), the advantages it offered were immediately clear to consumers. The now ubiquitous orange POPs provided superior feeding characteristics, reduced tip wear and all but eliminated twisting. In 1969, further improvements to the POP included a foil vapor barrier in the wall of the drum, and a rubber gasket on each lid – both to reduce moisture entry in to the drum.

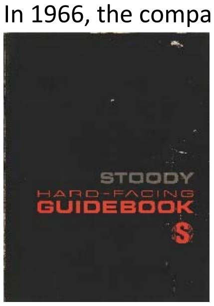
1960 proved to be a busy year for coated electrode products. Thirty-eight years after its introduction, Stoody released Self-Hardening (the original Stoody rod) with iron powder in the coating. This new Stoody alloy produced a dense deposit having excellent impact strength and weldability, good abrasion resistance, and higher deposition rate. At the same time, they released Stoody 1105 – a coated equivalent of the ever-popular Stoody 105 wire. Stoody 1105 is another iron powder coated electrode, which was quickly proven to work as well in metal-to-metal wear applications as the original 105 wire. These electrodes are still popular sellers today.

FAMILY TRADITION OF INNOVATION

Another Stoody idea was the introduction of alloy-cored fabricated stainless steel SMAW electrodes. Up to this point, nearly all coated electrodes utilized a solid core wire. In making hardfacing and high-alloy electrodes, it is desirable from both a coating thickness and weldability perspective to be able to place some of the alloying ingredients in the core wire upon which the coating is extruded. A new arrival on the SMAW scene in 1960 was Stoody 2110, a tubular electrode which was designed to match the versatility of Stoody 110 wire. Then, in 1965, Stoody 31 was introduced - a coated tubular-core SMAW electrode which quickly became, and remains, an all-time best seller for general hardfacing.

Also in 1965, a patent for a method and apparatus for coating welding rods was issued to Charles A. (Charley) Stoody – Shelly's son. Charley continued the legacy created by his father by making his own contributions to the world of hardfacing. Stoody had ventured into the world of high-alloy joining by beginning development of products such as Stoody SOS (**S**elf shielding, **O**pen-arc **S**tainless) and continuous casting, particularly of cobalt alloys. In 1966, Stoody's book *Stainless Steel - What It Is and How to Weld It* was issued. This book was written to provide basic guidance regarding the selection and use of stainless steel – as well as a section dedicated to a completely new approach to making stainless wire and electrodes. It would later lead to the Stoody *Stainless Welding Engineering* book.

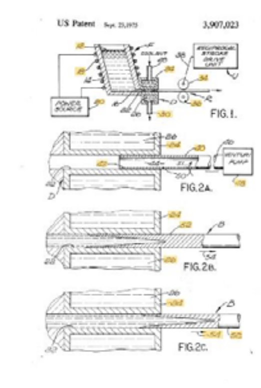
In 1966, the company reissued the industry-standard *Hardfacing Guidebook*. Winston Stoody died in February, 1967 at the age of 74 and company leadership was assumed by Charley Stoody. Long time *Fusion Facts* readers would remember Winston's informative and often humourous column "Arcing Along" which ran in the late 1920's and early 1930's. As the industry grew, so *Fusion Facts* grew also, until in 1967 over 35,000 copies were mailed each quarter to readers located in some 39 countries throughout the world. To glance at the pages of past issues of *Fusion Facts* is to glance at the history of the welding industry, particularly as it applies to hardfacing. The Stoody reputation for providing incredibly useful guide books for both distributors and end users continued.



In 1970, Stoody introduced the self-shielded stainless steel wire (later branded "SOS"). The company also introduced extrusion-coated cobalt SMAW electrodes which marked a great improvement over the previously dip coated rods. Fingernailing was eliminated, restrike characteristics were superior and spatter and slag interference were reduced.

In the more conventional hardfacing realm, Stoody was granted a pivotal patent for a 1/16" diameter wire being manufactured with high filler percentage. Once again, the Stoody Laboratory was at the leading edge of the industry - inventing this small diameter hardfacing wire, which has grown into an incredibly large market.

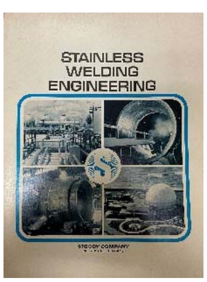
1971 saw even further advancements. The revolutionary SOS product and its method of manufacture were patented in June. A second patent for a system for depositing build-up metal on a work piece – rebuilding worn tractor rollers without disassembly - was also issued. Stoody also received a patent for manufacturing rebuilding gyratory crusher mantle-bowl structures. The patent had a redesigned straight mantle and utilized Chromium Carbide hardfacing to protect both the bowl and mantle to reduce the cost versus the bell shaped mantle and Hadfield's hard metal steel often used at the time. Stoody also began an industry-leading practice of identifying the lot number on each individual stainless steel SMAW electrode.



In 1973, after leading Stoody Company as owner and president, Charley retired at age 50, beginning a fulfilling life of adventure with his family. Others – like George Staley and Howard Farmer (a metallurgical engineer and acknowledged expert in welding stainless steel) along with research director Al Zvanut, continued to drive innovation in both the hardfacing and high-alloy joining fields through the 70's and 80's. The company also continued with its trademark literature for welders to indoctrinate them in the proper selection and application of hardfacing and began what would become a longstanding tradition of distributor training.

After four years of work, Stoody received a patent in 1975 for a process for starting an operation to continuously cast metal rod – which became the cornerstone process in the industry for manufacturing cobalt and nickel welding rods. The continuous casting technique had been use for 8-10 years in the steel industry but was not easily applied to cobalt alloys because of their narrow plastic range. Although cobalt-base alloys of the time were produced to exacting chemical standards specified by the U. S. government and the AWS, mold materials - cast iron, sand, coated sand or glass - inevitably contributed small but significant amounts of impurities to the rod surface and affected both chemistry and weldability. Continuous casting eliminated the mold altogether, and with it the necessity for surface grinding – the method usually employed to remove mold contamination. The newly named Stoodex 1, 6, and 12 alloys were not ground as the surface is completely clean; grinding actually would add a measure of contamination from embedded abrasive material and from the compounds used.

The company finally outgrew its location in Whittier and in 1976, a new 300,000 square foot facility was opened in City of Industry, CA. The original plant had survived an earthquake in 1933, interior flooding in 1937 (which temporarily halted work and resulted in a five-foot dike being constructed around the property) and two major expansions. The new facility was intentionally built within a 10 mile radius of the Whittier building so that the company's employees could continue working there without uninterruption.



1978 proved to be yet another innovative year for the company. Stoody published the industry standard *Stainless Welding Engineering* book, which was a valuable reference well into the late 1990's. In response to a worldwide tungsten carbide price hike and decreased availability, Stoody introduced VanCar-E and –G. These vanadium carbide rods have approximately 95% of the wear resistance of tungsten carbide at a price 2/3 that of tungsten carbide. Stoody also received a patent for fabricated welding wire for Type 409M corrosive-resistant stainless steel – which was being introduced for automotive use with catalytic converters. 409M steel billets are not ductile enough to draw economically. The solution was to make a tubular wire with a carbon steel sheath and the appropriate sources of alloying contained within it.

SOS
"SELF-SHIELDING OPEN-ARC STAINLESS

Realizing that many of their distributors were based on the east coast, Stoody decided in 1979 to take the hardfacing school "on the road." After carefully reviewing, editing and updating the basic format of the school, Stoody took a completely new approach to the presentation of hardfacing and stainless steel metallurgy and application. Highlighting the points that were essential and vital became the focal point of the newly designed school. Special emphasis was placed on semi-automatic hard-facing products, but of course the favorites, as always, were retained in the new format - Howard Farmer's famous tricks of the trade section was updated but still included the basics learned with 50 years of experience in this industry.

Flying again resulted in tragedy for the company in May 1979 as two Stoody employees were killed aboard American Airlines Flight 191 in Chicago. Kenneth Lamb, the domestic Marketing Director and Al Zvanut, Director of R&D both perished in the crash, which was the deadliest aviation accident to have occurred in the US. Later, in October, Gordon Macshane joined Stoody as the Director of R&D.

In 1981, Stoody introduced 100XHC wire – similar to the industry standard 100HC, but designed to achieve maximum hardness in only one layer. Also introduced was the "Dualloy" process – an energy efficient system combining high quality alloy wires and pure granular alloys in the submerged arc welding process to produce extremely high deposition rates with no increase in welding material costs. By using the excess arc heat to melt the pure Dualloy granular alloys, deposition rates are increased, base metal distortion caused by excessive heat is virtually eliminated, and penetration is minimized. Further – a compact new line of Maintenance and Repair products – dubbed the "Tiger Brand" – was introduced. These seven products were designed to accomplish over half of all typical M&R needs. Always the marketers, the introductory photo included the president, executive vice-president…and Sultan the tiger!

Howard Farmer retired from Stoody in 1984, having trained 3,000 people in 49 local and 150 field Stoody Hardfacing and Stainless schools. His unique approaches to "breaking the ice" with his students was unique. During the Whittier days, Howard's first official act was to invite all the new, raw students to the local Cat Patch watering hole for beer and pretzels. It didn't take long for his students to get to know one another in this relaxed atmosphere. Another opening day diversion sometimes included three 6-packs of beer, a couple of cans of peanuts and Monday night baseball or football, depending on whether you were attending the spring or fall school.

Howard's metallurgical expertise and his unique capability for communicating a relatively complex subject in an understandable layman's language put him in great demand as a public speaker. He had appeared before 225 groups through the years, mostly American Welding Society chapters, but also including American Society for Metals gatherings, technical sessions of the National Association of Corrosion Engineers and the Welding Institute of Canada.

IC Industries sold Amsco Welding Products to Stoody in 1985.

KENTUCKY ERA

The 1990's marked the beginning of a new chapter in the Stoody history. In 1991, Stoody's operations were moved from City of Industry, CA to its new facility in Bowling Green, KY. With this move came new research leadership when in December of 1993, Dr. Ravi Menon joined Stoody as the R&D Manager. Today, Menon serves as vice president of global R&D filler metal for ESAB and holds numerous patents. Innovations continued to emerge from the Stoody laboratories when the Thermaclad line of steel mill roll rebuilding consumables took the industry by storm. Thermaclad has become the de facto standard for roll rebuilding and now comprises over 30 specialized alloys designed specifically to suit the combination of galling wear, heat, and corrosion found in steel mills today.

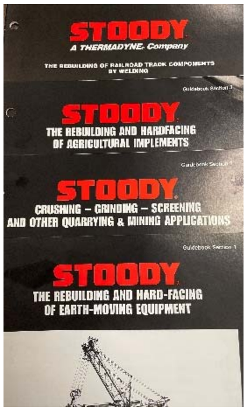
In 1996, Stoody patented a new cavitation erosion resistant welding alloy. Hydroloy 914 is a high strength stainless steel alloy designed specifically to combat cavitation erosion in hydropower systems, particularly on turbine runners. Hydroloy produces the same microstructural deformation characteristics that give more expensive cobalt base alloys their outstanding cavitation resistance.

The turn of the century found Stoody still hard at work with several new products, patents, AWS honors for two well known research leaders, and of course, literature refinements and expansions. Another innovative new wire was developed – Stoody CP2000. CP2000 is a specially formulated chromium carbide alloy designed to produce a high concentration of uniformly distributed small primary chromium carbides in an austenitic matrix. The optimized formulation provides a superior weldability for a broad range of single and multiple layer applications. The high concentration of small primary carbides greatly improves wear resistance and toughness over conventional chromium carbide alloys.

Stoody patented Thermaclad Rollbuild 3 in 2000. This product is a low alloy build up material with an unlimited deposit thickness which has good impact resistance, tempering resistance and temper embrittlement resistance along with an optimum combination of strength and toughness. In 2001, Stoody developed and introduced the industry's first line of nickel based all-position flux cored wires (Stoody 82, 182 and 625T-1) for use in LNG applications.

Howard Farmer was inducted into the AWS 2001 Class of Fellows for his pioneering achievements in the area of hardsurfacing resulting in many of today's applications because of his methodical approach to this "black art" segment of welding metallurgy. Ravi Menon was inducted into the AWS 2005 Class of Fellows for his significant contributions to the development and application of flux cored wires for hardfacing and high-alloy joining. Specifically, alloys and hardfacing application for steel mills and power plants and the first truly all-position nickel based flux cored wires in the industry.

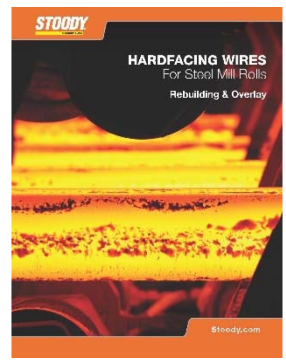
The digital age had begun, and Stoody jumped into the fray – first with its "Product Information Library" on CD. Later came the "Stoody Express" and "Interactive Distributor Training" CD's.



In 2003 and again in 2007, Stoody re-issued the "Hardfacing Guidebook" as a four section set: Earth Moving, Quarrying & Mining, Agricultural and Railroad Track Components.

In the 2010's, patents for microalloyed hardfacing products continued. StoodCor 136, an iron-based erosion and corrosion resistant alloy was released as was StoodyCor 400 - a titanium carbide bearing, modified 420 deposit with excellent abrasion resistance, as well as good resistance to wear, heat corrosion and thermal fatigue. Two other new product with improved crack resistance were patented and released. Stoody 964 and 966 are specially formulated alloys with small primary carbides in a martensitic matrix which can, under proper conditions, be applied crack free on parts where cross-checking is undesirable.

In 2015, Stoody published the *Hardfacing Wires for Steel Mill Rolls* brochure which had all the details of the ever-expanding Thermaclad line of products.



Castweld 57 consumables (wire and coated electrode) for use in welding cast iron – were patented in 2016. These consumables produce a weld deposit having improved ductility, fracture toughness, and resistance to cracking. The product has good tolerance for the high phosphorus often found in cast iron.

NON-CHROMIUM BEARING

In addition to improving performance, the company also offers options that reduce and mitigate hexavalent chromium fume generation during welding. Hardfacing traditionally relied on chromium carbides to provide wear resistance at an attractive price. Current Occupational Safety and Health Administration standards strictly limit hexavalent chromium exposure in the workplace. In closed work environments, such as mining repair, welding operators may need to wear respiratory protection equipment such as powered air purifying respirators, and shops may also be required to install ventilation systems. Vanadium can be substituted, but it is cost prohibitive.

Through a significant engineering investment to develop a formula that provides a wear resistance and hardness equal to or greater than conventional chromium-carbide deposits without cracking, Stoody launched a series of non-chromium-bearing filler metal options in 2015. Designed for hardfacing repair and maintenance, the "chrome-free" alloys include the patented 968-G gas-shielded wire, 968-0 open-arc wire, 968-E SMAW electrode, and the more impact-resistant 970-G gas metal arc welding wire.

ART TO SCIENCE

In the years after Shelley Stoody filled a curtain rod with alloys, the process of developing hardfacing rods, wires, and electrodes was regarded as a black art practiced by alchemists. Today, it is a complex material science with application-driven solutions created by engineers and PhDs working in advanced laboratories. Hardfacing products address the wear caused by abrasion, impact, corrosion, and heat in the industry's most severe environments. With today's financial pressures to improve productivity, coupled with a desire to drill deeper, run hotter, and dig faster, hardfacing is sure to play an even more prominent role in the coming century.