FUNDAMENTAL MANUFACTURING PROCESSES

Plating & Surface Coatings

SCENE 1.
PS01A, GRAPHIC: FBI warning
white text centered on black to blue gradient

WARNING

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SCENE 2.
PS02A, GRAPHIC: disclaimer
white text centered on black to blue gradient

Always read the operating manual and safety information provided by the manufacturer before operating any plating or surface coating equipment.

Make sure all machine guards are in place, and follow all safety procedures when working with or near plating or surface coating equipment.

SCENE 3.
PS03A, GRAPHIC: PCC/SME screen
white text centered on black to blue gradient

This program was produced using the technical resources of the Plastics, Composites & Coatings Community of SME.

For more information on plastic thermoforming, please visit our website at:

www.sme.org

SCENE 4.
PS04A, SME logo animation, with music

SCENE 5.
PS05A, FMP open, with music
PS05B, peter carey narration
PS05C, blue background

MUSIC UP AND UNDER

NARRATION (VO):

THE FUNDAMENTAL MANUFACTURING PROCESSES VIDEO SERIES, EXAMINING THE TOOLS AND TECHNIQUES OF PRECISION MANUFACTURING.

SCENE 6.
PS06A, GRAPHIC: Plating & Surface Coating
white text centered on black

NARRATION (VO):

THIS PROGRAM EXPLORES THE FUNDAMENTALS OF PLATING & SURFACE COATINGS.

SCENE 7.
PS07A, tape 936, 04:07:46-04:07:58
plating operation
PS07B, tape 933, 01:23:30-01:23:51
zoom out, porcelain enameling operation

NARRATION (VO):

THE USE OF PLATING...,
AND OTHER SURFACE COATING TECHNOLOGIES ARE PRIMARY FUNCTIONS THROUGHOUT MANUFACTURING.

SCENE 8.
PS08A, tape 945, 13:03:30-13:03:48
zoom out, hot dipping operation

NARRATION (VO):

THESE COATINGS ARE DEPOSITED AS THIN FILMS TO PART SURFACES FOR PROTECTION, DURABILITY OR DECORATION.

SCENE 9.
PS09A, tape 949, 17:12:44-17:13:00
zoom out, coil electroplating operation
PS09B, tape 936, 04:08:51-04:09:01
rack going into electroplating operation
PS09C, tape 633, 13:26:25-13:27:07
flop image, parts pulled from electroless plating solution
PS09D, tape 948, 16:05:43-16:06:00
parts going into anodizing bath
PS09E, tape 944, 12:26:44-12:26:53
zoom out, hot dipping operation
PS09F, tape 933, 01:27:09-01:27:16
zoom out, porcelain enameling operation

NARRATION (VO):

NUMEROUS PLATING AND SURFACE COATING TECHNOLOGIES ARE USED TO MODIFY AND FINISH PARTS, WITH SOME OF THE MOST COMMON BEING:
ELECTROPLATING...,
ELECTROLESS PLATING...,
CONVERSION COATING...,
HOT DIPPING...,
AND PORCELAIN ENAMELING.

--- FADE TO BLACK ---

SCENE 10.
PS10A, GRAPHIC: Electroplating
white text centered on black

SCENE 11.
PS11A, peter carey narration
PS11B, tape 936, 04:15:53-04:16:09
zoom in, parts coming out of electroplating tank
PS11C, tape 635, 15:11:43-15:11:58

NARRATION (VO):

ELECTROPLATING IS THE ELECTROLYTIC PROCESS OF CATHODICALLY DEPOSITING A THIN METAL LAYER

electroplating of plastic
PS11D, tape 937, 05:02:28-05:02:54
zoom out, barrel electroplating of metal

ONTO ANOTHER METAL...,

PLASTIC,

OR OTHER SUBSTRATE MATERIAL THAT IS OR HAS BEEN MADE ELECTRICALLY CONDUCTIVE.

SCENE 12.
PS12A, tape 937, 05:18:41-05:19:03
parts going into electrolytic solution

NARRATION (VO):

ELECTROPLATING IS PERFORMED IN AN ELECTROLYTIC SOLUTION, WHICH IS COMPOSED OF VARIOUS CHEMICAL COMPOUNDS THAT MAKE THE SOLUTION HIGHLY CONDUCTIVE.

SCENE 13.
continue previous shot
PS13A, ANI: positively charged plating metal ions an electrolytic solution being drawn to the negatively charged part surface, coating it
PS13B, GRAPHIC: positive symbol
PS13C, GRAPHIC: negative symbol
PS13D, CGS: Anode
PS13E, CGS: Cathode

NARRATION (VO):

USING DIRECT ELECTRIC CURRENT, POSITIVELY CHARGED PLATING METAL IONS IN THE ELECTROLYTIC SOLUTION ARE DRAWN, OR PRECIPITATED, OUT OF THE SOLUTION TO COAT THE NEGATIVELY CHARGED CONDUCTIVE PART SURFACE. THE POSITIVELY CHARGED PLATING METAL IS REFERRED TO AS THE 'ANODE', AND THE NEGATIVELY CHARGED PART OR PARTS, THE 'CATHODE'.

SCENE 14.
continue previous animation, circle appears with close up view of plating surface

NARRATION (VO):

AS THE ELECTRIC CURRENT FLOWS, THE METAL IONS GAIN ELECTRONS AT THE PART SURFACE AND TRANSFORM INTO A COATING OF METAL.

SCENE 15.
continue previous animation, with circle
PS15A, still, michael faraday
PS15B, tape 935, 03:19:50-03:20:18
wide, electroplating operation
PS15C, CGS: The Amount of Metal Deposited by an Electric Current Passing Through a Solution in a Cell is

NARRATION (VO):

THIS PROCESS, KNOWN AS ELECTROLYSIS, WAS EXPLAINED IN 1883 BY MICHAEL FARADAY, AND IS KNOWN AS FARADAY'S LAW. IN SUMMARY, IT STATES THAT THE AMOUNT OF METAL DEPOSITED BY AN

Directly Related to the Quantity of Electricity that Flows
PS15D, CGS: The Amount of Plating Metal Deposited by the Electric Current is Directly Related to the Weight of that Plating Metal

ELECTRIC CURRENT PASSING THROUGH A SOLUTION IN A CELL IS DIRECTLY RELATED TO THE QUANTITY OF ELECTRICITY THAT FLOWS. FURTHER, THE AMOUNT OF PLATING METAL DEPOSITED BY THE ELECTRIC CURRENT IS DIRECTLY RELATED TO THE WEIGHT OF THAT PLATING METAL.

SCENE 16.
PS16A, tape 937, 05:22:30-05:23:00
electroplating operation

NARRATION (VO):

THIS RELATIONSHIP DETERMINES THE PLATING TIME AND ELECTRIC CURRENT REQUIRED TO DEPOSIT A SPECIFIC THICKNESS OF A METAL WITHIN AN ELECTROPLATING OPERATION.

SCENE 17.
PS17A, tape 949, 17:19:49-17:20:10
zoom out, copper coil going into electroplating operation
PS17B, CGS: Iron
Copper
Nickel
Zinc
Silver
Gold
Cadmium
Cobalt
PS17C, tape 935, 03:05:00-03:05:16
zoom out, parts racked for electroplating operation
PS17D, CGS: Stainless Steel
Aluminum
Beryllium
Magnesium
Chromium
Lead
Titanium
Zirconium

NARRATION (VO):

MOST METALS CAN BE ELECTROPLATED, WITH THE EASIEST BEING: IRON, COPPER, NICKEL, ZINC, SILVER, GOLD, CADMIUM AND COBALT. METALS DIFFICULT TO PLATE INCLUDE: STAINLESS STEEL, ALUMINUM, BERYLLIUM, MAGNESIUM, CHROMIUM, LEAD, TITANIUM AND ZIRCONIUM.

SCENE 18.
PS18A, tape 949, 17:02:10-17:02:38
zoom out, coil coming out of electroplating process
PS18B, CGS: Nickel
Copper
Chromium
Zinc
Various Alloys

NARRATION (VO):

MANY METALS ARE USED FOR ELECTROPLATING, WITH EACH IMPARTING SPECIFIC PROPERTIES TO IMPROVE THE MATERIAL BEING PLATED. SOME OF THE MOST

Precious Metals

COMMON ELECTROPLATING METALS ARE: NICKEL, COPPER, CHROMIUM, AND ZINC. VARIOUS ALLOYS AND PRECIOUS METALS CAN ALSO BE ELECTROPLATED.

SCENE 19.
PS19A, tape 936, 04:11:03-04:11:34
zoom out, electrolytic solution

NARRATION (VO):

NUMEROUS ELECTROLYTIC SOLUTIONS ARE USED IN ELECTROPLATING. THE SELECTION OF WHICH IS DEPENDENT UPON THE PLATING METAL AND THE METAL SUBSTRATE TO BE PLATED.

SCENE 20.
PS20A, tape 936, 04:17:58-04:18:31
pan electrolytic solution, parts coming out

NARRATION (VO):

ELECTROLYTIC SOLUTIONS OFTEN CONTAIN ADDITIVES USED TO BRIGHTEN, LEVEL OR ENHANCE THE UNIFORMITY OF THE PLATING METAL. THEY ALSO INFLUENCE PLATING METAL PROPERTIES SUCH AS HARDNESS AND CORROSION RESISTANCE.

SCENE 21.
PS21A, ANI: electric current concentrating at part edge, plating material building-up into thicker deposit
PS21B, tape 935, 03:09:18-03:09:31
parts pulled from rack after electroplating
PS21C, tape 937, 05:20:46-05:21:01
pan, part going through electrolytic solution

NARRATION (VO):

ELECTRIC CURRENT CONCENTRATES AT PART EDGES, POINTS AND AREAS CLOSEST TO THE ANODE, PRODUCING THICKER DEPOSITS IN THESE AREAS. THIS IS PROBLEMATIC FOR ELECTROPLATING OPERATIONS AND IS OFTEN ADDRESSED WITHIN THE DESIGN OF THE PLATED PART AND OR IN THE CHEMICAL COMPOSITION OF THE ELECTROLYTIC SOLUTION USED.

SCENE 22.
PS22A, tape 935, 03:15:18-03:15:35
parts going through cleaning

NARRATION (VO):

BEFORE ELECTROPLATING, CHEMICAL CLEANING, DEGREASING AND THOROUGH RINSING OF SUBSTRATE SURFACES IS ESSENTIAL.

SCENE 23.
PS23A, tape 937, 05:05:17-05:05:36
pan, barrel processing of electroplated parts
PS23B, tape 936, 04:09:22-04:09:34
rack going into electroplating operation
PS23C, tape 949, 17:06:54-17:07:10
zoom out, reel-to-reel processing of electroplated coil stock

NARRATION (VO):

PARTS ARE ELECTROPLATED USING BARREL...,

RACK...,

AND CONTINUOUS REEL-TO-REEL, OR STRIP,

PLATING.

SCENE 24.
PS24A, CGS: Barrel Plating
PS24B, tape 937, 05:01:08-05:01:23
pan, barrels processing of electroplated parts
PS24C, tape 937, 05:01:43-05:02:00
barrel in electrolytic solution
PS24D, tape 937, 05:07:20-05:07:42
parts dumped from barrel

NARRATION (VO):

BARREL PLATING IS USUALLY PERFORMED IN HORIZONTAL OR OBLIQUE BARRELS CONSTRUCTED OF POLYPROPYLENE OR OTHER SUITABLE PLASTIC. BARREL WALLS ARE PERFORATED AND THE BARREL IS ROTATED SO THAT ALL ENCLOSED PARTS HAVE CONTACT WITH THE PLATING SOLUTION. BARREL PLATING IS COMMONLY USED TO ELECTROPLATE SMALLER PARTS.

SCENE 25.
PS25A, CGS: Rack Plating
PS25B, tape 936, 04:08:03-04:08:22
pan, rack going into electrolytic solution

NARRATION (VO):

RACK PLATING IS USED FOR LARGER PARTS AND FOR CHROMIUM PLATING. RACKS ARE USUALLY MADE OF COPPER FOR HIGH CURRENT-CARRYING CAPACITY AND THEN COVERED WITH AN INSULATING MATERIAL TO PREVENT PLATE PICKUP.

SCENE 26.
PS26A, tape 935, 03:05:30-03:05:54
zoom out, parts being racked up

NARRATION (VO):

PARTS ARE POSITIONED ON THE RACK IN A MANNER TO ACHIEVE UNIFORM ELECTRIC CURRENT DISTRIBUTION AND TO PREVENT AIR OR GAS ENTRAPMENT IN HOLES OR RECESSES, WHICH RESTRICTS PLATE DEPOSITION.

SCENE 27.
PS27A, CGS: Reel-To-Reel Plating
PS27B, tape 949, 17:08:30-17:08:48
zoom in, coil stock going into electroplating tanks
PS27C, tape 949, 17:09:23-17:09:45
coil stock taken up on take-up reels
PS27D, tape 949, 17:04:18-17:04:32
zoom out, coil taken up on take-up reel

NARRATION (VO):

IN REEL-TO-REEL PLATING, THE UNPLATED WORK MATERIAL, TYPICALLY COIL STOCK OR PARTS STAMPED ONTO AND HELD BY THE COIL, IS CONTINUOUSLY PULLED BY TAKE-UP REELS THROUGH PROCESSING STATIONS OR TANKS FOR ELECTROPLATING. ONCE THE COIL STOCK IS PLATED, IT IS RECOILED ONTO THE TAKE-UP REELS.

SCENE 28.
PS28A, tape 949, 17:03:14-17:03:26
zoom out, multiple coils being plated simultaneously
PS28B, still, selectively plated stock

NARRATION (VO):

TO MAXIMIZE PRODUCTION, MULTIPLE COILS MAY BE PLATED SIMULTANEOUSLY. ADDITIONALLY, REEL-TO-REEL PLATING PROVIDES FOR SELECTIVE PLATING OF MULTIPLE METALS ONTO A SINGLE COIL.

--- FADE TO BLACK ---

SCENE 29.
PS29A, GRAPHIC: Electroless Plating
white text centered on black

SCENE 30.
PS30A, peter carey narration
PS30B, tape 947, 15:09:32-15:09:41
part placed in electroless plating solution
PS30C, ANI: plating metal in solution pulled to the part surface that has been made catalytic through chemical reactions

NARRATION (VO):

ELECTROLESS PLATING, ALSO CALLED AUTOCATALYTIC DEPOSITION, IS THE DEPOSITION OF A PLATING METAL FROM ITS IONIC STATE WITHIN A PLATING SOLUTION ONTO A SUBSTRATE SURFACE THAT HAS BEEN MADE CATALYTIC THROUGH CHEMICAL REACTIONS.

SCENE 31.
continue previous animation

NARRATION (VO):

ONCE A LAYER OF METAL FORMS ON THE SUBSTRATE, THAT LAYER AND THOSE FOLLOWING BECOME THE

CATALYST, CAUSING THE REACTION TO CONTINUE.

SCENE 32.
PS32A, tape 947, 15:12:12-15:12:32
zoom out, electroless plating solution
PS32B, tape 947, 15:19:22-15:19:33
parts pulled from catalytic pretreatment

NARRATION (VO):

ELECTROLESS PLATING SOLUTIONS ARE OFTEN VERY COMPLEX AND CONTAIN METAL SALTS, REDUCING AGENTS, COMPLEXING AGENTS, 'PH' ADJUSTERS AND STABILIZERS. TYPICALLY, PART SUBSTRATES BECOME CATALYTIC ONCE IN CONTACT WITH THE PLATING SOLUTION...,

OR THROUGH A CATALYTIC PRETREATMENT PROCESS.

SCENE 33.
PS33A, tape 947, 15:10:14-15:10:31
parts in electroless plating bath

NARRATION (VO):

MOST ELECTROLESS PLATING BATHS OPERATE AT ABOUT 200 DEGREES FAHRENHEIT, OR 90 DEGREES CENTIGRADE. COATING THICKNESS DEPENDS ON IMMERSION TIME IN THE SOLUTION.

SCENE 34.
PS34A, tape 633, 13:26:25-13:27:07
parts pulled from electroless plating solution
PS34B, tape 633, 13:21:06-13:21:24
electroless plating of plastic part

NARRATION (VO):

SINCE METAL DEPOSITION IS A CHEMICAL, INSTEAD OF AN ELECTRIC PROCESS, ELECTROLESS PLATING HAS SEVERAL ADVANTAGES OVER ELECTROPLATING. IT PRODUCES COATINGS UNIFORM IN THICKNESS, INDEPENDENT OF PART GEOMETRY, AND IT CAN BE USED TO PLATE NUMEROUS CONDUCTIVE, SEMI-CONDUCTIVE AND NON-CONDUCTIVE SUBSTRATES.

SCENE 35.
PS35A, tape 633, 13:25:13-13:25:28
wide, parts moving through electroless plating operation

NARRATION (VO):

THE PRIMARY DISADVANTAGE OF ELECTROLESS PLATING IS THAT THE RATE OF METAL DEPOSITION IS CONSIDERABLY SLOWER THAN THAT OF ELECTROPLATING.

SCENE 36.
PS36A, tape 633, 13:25:35-13:25:50
parts coming out of electroless plating operation
PS36B, CGS: Nickel
Nickel Alloys
Copper
Cobalt
Gold

NARRATION (VO):

THE MOST COMMON ELECTROLESS DEPOSITED METALS ARE NICKEL AND NICKEL ALLOYS, BUT COPPER, COBALT AND GOLD ARE ALSO OFTEN USED.

SCENE 37.
PS37A, tape 947, 15:23:50-15:24:11
zoom out, parts produced from electroless plating operation

NARRATION (VO):

CORROSION AND WEAR RESISTANCE ARE THE PRINCIPAL REASONS ELECTROLESS NICKEL PLATING IS USED, WITH TYPICAL PLATING THICKNESS BEING ONE THOUSANDTH OF AN INCH OR 25 MICROMETERS.

SCENE 38.
PS38A, tape 633, 13:26:04-13:26:28
electroless plating of plastic part
PS38B, tape 635, 15:09:15-15:09:30
electroplating of plastic part

NARRATION (VO):

ELECTROLESS PLATING IS COMMONLY USED TO PLATE NON-CONDUCTIVE PLASTIC PARTS IN PREPARATION FOR ELECTROPLATING OPERATIONS.

--- FADE TO BLACK ---

SCENE 39.
PS39A, GRAPHIC: Conversion Coating
white text centered on black

SCENE 40.
PS40A, peter carey narration
PS40B, tape 942, 10:02:09-10:02:28
zoom out, parts coming out of black oxide coating
PS40C, tape 938, 06:15:18-06:15:32
parts going into anodizing operation

NARRATION (VO):

IN CONVERSION COATING PROCESSES, STRONGLY ADHERENT COATINGS ARE FORMED ON METAL SURFACES BY THE CONTROLLED CHEMICAL...,
OR ELECTROCHEMICAL REACTION BETWEEN A SOLUTION AND THE IONS FORMED FROM THE METALLIC SURFACE IMMERSED IN THE SOLUTION.

--- TOUCH BLACK ---

SCENE 41.
PS41A, tape 951, 20:08:24-20:08:42
parts going into zinc phosphate bath
PS41B, CGS: Phosphate Conversion Coatings
PS41C, tape 936, 04:24:14-04:24:22
parts going into chromate bath
PS41D, CGS: Chromate Conversion Coatings
PS41E, tape 942, 10:17:47-10:17:55
black oxide parts lowered to ground
PS41F, CGS: Oxide Conversion Coatings

NARRATION (VO):

THE MOST COMMON CHEMICAL CONVERSION COATINGS ARE PHOSPHATE CONVERSION COATINGS..., CHROMATE CONVERSION COATINGS..., AND OXIDE CONVERSION COATINGS.

--- TOUCH BLACK ---

SCENE 42.
PS42A, CGS: Phosphate Conversion Coatings
PS42B, tape 951, 20:16:58-20:17:21
parts placed in zinc phosphating tank

NARRATION (VO):

PHOSPHATE CONVERSION COATINGS ARE PRODUCED BY IMMERSING METAL PARTS, USUALLY STEEL OR ZINC, IN BATHS CONTAINING METAL PHOSPHATES DISSOLVED IN PHOSPHORIC ACID SOLUTIONS.

SCENE 43.
PS43A, tape 951, 20:13:02-20:13:25
parts placed in zinc phosphating tank
PS43B, CGS: Zinc Phosphates
Iron Phosphates
Manganese Phosphates

NARRATION (VO):

COMMON METAL PHOSPHATES USED IN SOLUTION FOR PHOSPHATE CONVERSION COATINGS INCLUDE ZINC PHOSPHATES, IRON PHOSPHATES, AND MANGANESE PHOSPHATES.

SCENE 44.
PS44A, tape 951, 20:19:53-20:20:08
zoom out, parts in phosphating solution
PS44B, tape 952, 22:05:15-22:05:22
pre-phosphated part
PS44C, tape 952, 22:05:03-22:05:12
post-phosphated part
PS44C, tape 952, 22:04:20-22:04:29
zoom out, phosphated part

NARRATION (VO):

THESE METAL PHOSPHATE SOLUTIONS COAT AND TRANSFORM THE METAL SUBSTRATES INTO NEW SURFACES HAVING NON-METALLIC, NON-CONDUCTING, AND WATER-INSOLUBLE PROPERTIES.

SCENE 45.
PS45A, tape 952, 21:06:37-21:07:00
zoom out, parts being painted

NARRATION (VO):

PHOSPHATE CONVERSION COATINGS ARE USED EXTENSIVELY TO PRECONDITION PART SURFACES FOR PAINTING AND BONDING OPERATIONS. ADDITIONALLY,

PHOSPHATE COATINGS ARE TYPICALLY ROUGH AND PROVIDE EXCEPTIONAL SURFACES FOR RETAINING LUBRICANTS.

--- TOUCH BLACK ---

SCENE 46.
PS46A, CGS: Chromate Conversion Coatings
PS46B, tape 937, 05:24:45-05:25:20
parts coming out of chromate bath, indexed over, new parts lowered into chromate bath

NARRATION (VO):

CHROMATE CONVERSION COATINGS ARE PRODUCED FROM COMPOUNDS OF CHROMIUM COMBINED WITH OTHER WATER-SOLUBLE INORGANIC MATERIALS. DURING CONVERSION, THE OUTSIDE SURFACE OF THE METAL PARTS TRANSFORMS INTO A LAYER OF COMPLEX CHROMIUM COMPOUNDS.

SCENE 47.
continue previous shot
PS47A, CGS: Aluminum
Magnesium
Zinc
Cadmium
Silver

NARRATION (VO):

TYPICAL METALS TREATED THROUGH CHROMATE CONVERSION INCLUDE ALUMINUM, MAGNESIUM, ZINC, AND IN SOME CASES, CADMIUM AND SILVER.

SCENE 48.
PS48A, tape 936, 05:24:45-05:25:00
parts coming out of chromate bath
PS48B, tape 936, 04:27:49-04:28:00
dry chromated parts on rack
PS48C, tape 937, 05:27:36-05:27:56
yellow chromated parts pulled from racks
PS48D, CGS: Clear
Bright Clear Yellow
Bronze
Green
Olive Drab
Black

NARRATION (VO):

CHROMATE COATINGS ARE AMORPHOUS, GELATINOUS, AND NON-POROUS WHEN APPLIED, BUT HARDEN AND BECOME MOISTURE AND ABRASION RESISTANT WHEN DRIED. CHROMATE CONVERSION COATINGS CAN RANGE IN COLOR FROM CLEAR TO BRIGHT CLEAR YELLOW, BRONZE, GREEN, OLIVE DRAB, AND BLACK.

SCENE 49.
PS49A, tape 937, 05:23:52-05:24:26
parts coming out of chromate bath

NARRATION (VO):

CHROMATE COATINGS IMPART SUPERIOR CORROSION RESISTANCE AND, LIKE PHOSPHATE COATINGS, ARE USED AS A BONDING LAYER FOR PAINTS, LACQUERS

AND OTHER ORGANIC FINISHES.

--- TOUCH BLACK ---

SCENE 50.
PS50A, CGS: Oxide Conversion Coatings
PS50B, CGS: Black Oxide Coatings
PS50C, tape 941, 09:10:56-09:11:05 zoom out, parts in bucket
PS50D, tape 941, 09:15:22-09:15:42 parts lowered in black oxide bath

NARRATION (VO):

OXIDE CONVERSION COATINGS, SPECIFICALLY BLACK OXIDE COATINGS, ARE COMMONLY FORMED BY IMMERSING METAL PARTS, USUALLY FERROUS ALLOYS, IN HIGH-TEMPERATURE SOLUTIONS CONTAINING SODIUM HYDROXIDE, SODIUM NITRITE, SODIUM NITRATE, AND OTHER COMPOUNDS.

SCENE 51.
PS51A, tape 941, 09:18:14-09:18:36 parts pulled from black oxide bath

NARRATION (VO):

IN THE BATH, THE IRON ON THE SURFACE OF THE FERROUS ALLOYS REACTS WITH THE OXIDIZING SALTS TO FORM A PROTECTIVE LAYER OF MAGNETITE, WHICH IS A BLACK OXIDE OF IRON.

SCENE 52.
PS52A, tape 942, 10:05:13-10:05:30 files placed into black oxide bath

NARRATION (VO):

SIMILAR OXIDE CONVERSION COATINGS CAN BE OBTAINED ON NON-FERROUS PARTS USING SPECIAL ACIDIC SOLUTIONS. ADDITIONALLY, OTHER OXIDE COATINGS CAN BE FORMED AT ROOM TEMPERATURE.

SCENE 53.
PS53A, tape 942, 10:14:57-10:15:15 files pulled from black oxide bath

NARRATION (VO):

BLACK OXIDE COATINGS ARE GENERALLY USED FOR THEIR DECORATIVE APPEARANCE AND WEAR RESISTANCE, AND THEY PROVIDE A GOOD PAINT BASE.

SCENE 54.
PS54A, tape 942, 10:17:02-10:17:21 files placed into lubricant bath

NARRATION (VO):

BLACK OXIDE COATINGS ARE POROUS AND TYPICALLY

POST TREATED WITH A SEALING LUBRICANT, SUCH AS OIL OR WAX. THIS AIDS IN CORROSION RESISTANCE AND IMPROVES LUBRICITY.

--- TOUCH BLACK ---

SCENE 55.
PS55A, CGS: Anodizing
PS55B, tape 939, 07:19:28-07:19:48 aluminum parts being placed in anodizing tank
PS55C, ANI: part in anodizing operation, part indicated as anode
PS55D, GRAPHIC: positive symbol
PS55E, CGS: Anode

NARRATION (VO):

ELECTROCHEMICAL CONVERSION COATINGS ARE PRODUCED BY ANODIZING. THE TERM 'ANODIZING' STEMS FROM THE FACT THAT THE PART TO BE ANODIZED IS THE ANODE IN THE ELECTROLYTIC CELL RATHER THAN THE CATHODE AS IN ELECTROPLATING.

SCENE 56.
PS56A, tape 939, 07:23:27-07:24:01 zoom out, parts in solution, parts coming out of anodizing, rinsed
PS56B, tape 952, 22:03:22-22:03:37 zoom in, anodized tube surface

NARRATION (VO):

UNLIKE ELECTROPLATING WHERE THE METAL PLATING IONS TRAVEL FROM THE BATH TO THE PART AND BUILD UP THE PLATED LAYER BY ADDING MORE AND MORE PLATING IONS, ANODIZING PRODUCES A CONSTANTLY FORMED OXIDE LAYER INTEGRAL WITH THE UNDERLYING METAL SUBSTRATE SURFACE.

SCENE 57.
PS58A, tape 938, 06:26:59-06:27:19 parts pulled from sealer
PS58B, CGS: Abrasion Resistance
Decorative Appeal
Paint & Adhesive Adherence
Electrical Insulation

NARRATION (VO):

THIS OXIDE COATING WHEN SEALED IMPROVES CORROSION PROTECTION, AND ALSO INCREASES ABRASION RESISTANCE, DECORATIVE APPEAL, PAINT AND ADHESIVE ADHERENCE, AND ELECTRICAL INSULATION.

SCENE 58.
PS59A, tape 938, 06:03:42-06:03:58 zoom out, aluminum parts fixtured for anodizing
PS59B, tape 940, 08:07:44-08:08:03 zoom out, anodizing operation
PS59C, CGS: Titanium
Zinc

NARRATION (VO):

ALUMINUM PARTS ARE THE MOST COMMONLY ANODIZED, ALTHOUGH THE PROCESS IS ALSO FREQUENTLY APPLIED TO MAGNESIUM PARTS. OTHER METALS THAT

Beryllium
Zirconium
Thorium

CAN BE ANODIZED ARE TITANIUM, ZINC, BERYLLIUM, ZIRCONIUM AND THORIUM.

SCENE 59.
PS60A, tape 938, 06:06:50-06:07:01
zoom in, parts going into cleaning tank
PS60B, tape 938, 06:13:21-06:13:34
zoom in, parts going into pickling tank
PS60C, tape 938, 06:22:35-06:22:44
parts coming out of anodizing tank
PS60D, tape 938, 06:26:59-06:27:19
zoom out, parts coming out of sealing tank

NARRATION (VO):

A COMPLETE ANODIZING CYCLE TYPICALLY INVOLVES CLEANING...,

ETCHING OR PICKLING...,

ANODIZING...,

AND COLORING AND OR SEALING, WITH A THOROUGH RINSING IN WATER AFTER EACH STAGE IN THE CYCLE.

SCENE 60.
PS61A, tape 938, 06:17:47-06:18:06
zoom out, racks in agitated solution
PS61B, CGS: Sulfuric
Chromic
Oxalic
Phosphoric

NARRATION (VO):

THE PRINCIPAL ALUMINUM ANODIZING ELECTROLYTES ARE SULFURIC, CHROMIC, OXALIC AND PHOSPHORIC ACID SOLUTIONS, WITH SULFURIC ACID BEING THE MOST COMMON.

SCENE 61.
PS62A, tape 939, 07:04:36-07:04:58
zoom out, racks in agitated solution

NARRATION (VO):

THE RATE AT WHICH THE OXIDE COATING DEVELOPS IN ANODIZING IS DETERMINED BY SPECIFIC CONDITIONS WITHIN THE PROCESS, INCLUDING VOLTAGE, CURRENT DENSITY, ELECTROLYTE SOLUTION USED, ITS TEMPERATURE AND OTHER OPERATING CONDITIONS.

SCENE 62.
PS63A, tape 939, 07:11:44-07:12:12
parts pulled from anodizing tank

NARRATION (VO):

ANODIC COATINGS MADE BY SULFURIC-ACID ANODIZING ARE GENERALLY TRANSPARENT, WITH OXIDE THICKNESS RANGING FROM ONE TEN-THOUSANDTH OF AN INCH OR 2.5 MICROMETERS TO

THREE THOUSANDTHS OF AN INCH OR 75 MICROMETERS.

SCENE 63.
PS64A, tape 948, 16:06:54-16:06:59
sulfuric-acid hard anodizing bath
PS64B, tape 948, 16:07:50-16:08:36
parts coming out of hard anodizing bath

NARRATION (VO):

SULFURIC-ACID IS ALSO USED FOR HARD ANODIZING. HARD ANODIZING IS SIMILAR TO CONVENTIONAL SULFURIC-ACID ANODIZING BUT USES LOWER SOLUTION TEMPERATURES, HIGHER ELECTRIC CURRENT, AND HIGHER FINAL VOLTAGE.

SCENE 64.
PS65A, tape 948, 16:02:26-16:02:39
parts drying after coming out of hard anodizing bath
PS65B, tape 938, 06:01:19-06:01:35
zoom out, masked hard anodized parts

NARRATION (VO):

HARD ANODIZING OXIDE COATINGS ARE COMMONLY DARKER IN COLOR AND HAVE HIGH RESISTANCE TO ABRASION, EROSION, AND CORROSION. ADDITIONALLY, SINCE REDUCED SOLUTION TEMPERATURES ARE USED FOR HARD ANODIZING, IT IS EASIER TO MASK AND SELECTIVELY HARD COAT PARTS.

SCENE 65.
PS66A, tape 948, 16:01:20-16:01:30
zoom out, hard anodized parts
PS66B, tape 948, 16:02:44-16:03:06
zoom out, anodized parts on racks

NARRATION (VO):

HARD ANODIZED COATING THICKNESS RANGES FROM ONE THOUSANDTH OF AN INCH OR 25 MICROMETERS TO TWELVE HUNDREDS OF AN INCH OR 300 MICROMETERS.

SCENE 66.
PS67A, tape 939, 07:01:50-07:02:11
zoom out, racks of parts being dried
PS67B, tape 939, 07:02:58-07:03:26
zoom in, racks going into agitated solution

NARRATION (VO):

PART FIXTURING IS AN IMPORTANT ASPECT OF ANODIZING, WITH RACKS BEING THE MOST FREQUENTLY USED. FIXTURING RACKS SERVE TO CONDUCT THE ELECTRIC CURRENT TO THE PARTS FOR ANODIZING AND ALSO HOLD THE PARTS SECURELY UNDER THE AGITATED ELECTROLYTE SOLUTION.

SCENE 67.
PS68A, tape 939, 07:18:16-07:18:26
zoom out, pan, racking up parts for anodizing
PS68B, tape 938, 06:10:42-06:10:59
zoom in, racking up parts for anodizing

NARRATION (VO):

RACKS ARE CUSTOM BUILT OUT OF TITANIUM OR ALUMINUM FOR SPECIFIC PARTS AND PART FAMILIES. RACKS COMMONLY INCORPORATE FINGERS, TAPERED POINTS, OR CLIPS TO SECURE PARTS, WHICH MUST BE INDIVIDUALLY RACKED.

--- FADE TO BLACK ---

SCENE 68.
PS69A, GRAPHIC: Hot Dipping
white text centered on black

SCENE 69.
PS70A, peter carey narration
PS70B, tape 943, 11:28:57-11:29:20
zoom out, hot dip galvanizing

NARRATION (VO):

HOT DIPPING PROCESSES COAT WORKPIECE SUBSTRATES, TYPICALLY STEEL OR IRON, BY IMMERSION IN A BATH OF MOLTEN METAL.

SCENE 70.
PS71A, tape 946, 14:10:52-14:11:14
zoom out, continuous galvanizing operation

NARRATION (VO):

CORROSION PROTECTION IS THE PRINCIPAL REASON HOT DIP COATINGS ARE USED. THESE COATINGS MAY PROVIDE BARRIER PROTECTION OR SACRIFICIAL PROTECTION, OR A COMBINATION OF THE TWO.

SCENE 71.
PS72A, tape 945, 13:03:59-13:04:27
zoom out, batch galvanizing operation
PS72B, tape 950, 19:01:17-19:01:35
zoom out, part with barrier coating compromised

NARRATION (VO):

WITH BARRIER PROTECTION, THE COATING ISOLATES THE SUBSTRATE FROM A CORROSIVE ENVIRONMENT. A MAJOR LIMITATION OF BARRIER PROTECTION IS THAT THE PROTECTION CEASES THE INSTANT THE BARRIER IS BROKEN. BARRIER DAMAGE CAN BE CAUSED BY A SCRATCH, ABRASION, IMPACT OR MECHANICAL REMOVAL.

SCENE 72.
PS73A, tape 948, 16:13:20-16:14:00
zoom out, part with sacrificial coating worn off

NARRATION (VO):

WITH SACRIFICIAL PROTECTION, THE COATING CORRODES PREFERENTIALLY TO THE SUBSTRATE METAL, PROTECTING THE SUBSTRATE. THIS DETERIORATION CONTINUES UNTIL SO MUCH OF THE COATING IS REMOVED THAT IT CAN NO LONGER PROTECT THE SUBSTRATE FROM CORROSION.

SCENE 73.
PS74A, tape 946, 14:02:15-14:02:34
tilt up, continuous galvanizing operation

NARRATION (VO):

SOME METALLIC COATINGS FOR STEEL PROVIDE BOTH BARRIER AND SACRIFICIAL PROTECTION. THE MOST POPULAR DUAL-PROTECTION METALLIC COATINGS ARE ZINC AND ALUMINUM.

SCENE 74.
PS75A, tape 943, 11:27:53-11:28:30
batch galvanizing operation
PS75B, CGS: Galvanizing
Aluminizing
Tinning
Terne Coating

NARRATION (VO):

THERE ARE A VARIETY OF HOT DIPPING PROCESSES INCLUDING:
GALVANIZING,
ALUMINIZING,
TINNING,
AND TERNE COATING, WITH THE MOST COMMON OF THESE PROCESSES BEING GALVANIZING.

--- TOUCH BLACK ---

SCENE 75.
PS76A, CGS: Galvanizing
PS76B, tape 946, 14:08:25-14:09:00
zoom out, continuous galvanizing
PS76C, tape 943, 11:20:04-11:20:23
zoom out, batch galvanizing operation
PS76D, photomicrograph of galvanized steel with arrow

NARRATION (VO):

GALVANIZING INVOLVES COATING THE SURFACE OF STEEL OR IRON PRODUCTS WITHIN A TANK OF MOLTEN ZINC HAVING A TEMPERATURE THAT IS MAINTAINED BETWEEN 835 AND 855 DEGREES FAHRENHEIT, OR 445 AND 460 DEGREES CENTIGRADE. THE MOLTEN ZINC

AND SUBSTRATE STEEL OR IRON REACT
METALLURGICALLY, PRODUCING A COATING
CONSISTING OF A SERIES OF ZINC-IRON ALLOYS...,
AND A SURFACE LAYER OF VIRTUALLY PURE ZINC.

SCENE 76.
PS77A, tape 943, 11:19:21-11:19:31
zoom out, batch galvanizing operation
PS77B, tape 946, 14:03:07-14:03:17
continuous galvanizing operation

NARRATION (VO):

GALVANIZING IS MOST COMMONLY PERFORMED USING
BATCH GALVANIZING...,
AND CONTINUOUS GALVANIZING.

--- TOUCH BLACK ---

SCENE 77.
PS78A, CGS: Batch Galvanizing
PS78B, tape 944, 12:24:04-12:24:31
zoom out, batch galvanizing operation

NARRATION (VO):

BATCH GALVANIZING IS APPLIED PRIMARILY TO
FABRICATED OR SEMI-FABRICATED PARTS. THE
ADVANTAGE TO GALVANIZING AFTER FABRICATION IS
THAT THE ZINC COMPLETELY SEALS EDGES,
OVERLAPS, RIVETS AND WELDS, AS WELL AS,
INTERNAL SURFACES OF HOLLOW PARTS.

SCENE 78.
PS79A, tape 943, 11:18:56-11:19:12
zoom out, dipped parts cooling
PS79B, tape 945, 13:11:33-13:11:43
zoom out, dipped parts cooling

NARRATION (VO):

THE PROCESS IS SIMPLE AND VERSATILE, AND IS
USED TO PROVIDE PROTECTION FOR PARTS RANGING
FROM VERY SMALL TO EXTREMELY LARGE.

SCENE 79.
PS80A, tape 945, 13:06:26-13:07:26
part pulled from batch galvanizing process
PS80B, tape 944, 12:01:13-12:01:39
parts coming out of cleaning solution for batch galvanizing
PS80C, CGS: Caustic Cleaning
Pickling
Fluxing

NARRATION (VO):

SURFACE PREPARATION IS EXTREMELY IMPORTANT TO
ENSURE PARTS AND ASSEMBLIES ARE GALVANIZED
PROPERLY. SURFACE PREPARATION STEPS TYPICALLY
INCLUDE:
CAUSTIC CLEANING,
PICKLING,

AND FLUXING.

SCENE 80.
PS81A, CGS: Caustic Cleaning
PS81B, tape 944, 12:09:15-12:09:40
parts placed in caustic cleaning tank

NARRATION (VO):

CAUSTIC CLEANING INVOLVES DIPPING PARTS IN A HOT ALKALI SOLUTION TO REMOVE CONTAMINATES SUCH AS DIRT, GREASE, OIL AND PAINT.

SCENE 81.
PS82A, CGS: Pickling
PS82B, tape 944, 12:13:04-12:13:25
parts pulled from pickling tank

NARRATION (VO):

PICKLING USES A DILUTED SOLUTION OF HOT SULFURIC ACID OR ROOM TEMPERATURE HYDROCHLORIC ACID TO REMOVE SCALE AND RUST FROM PART SURFACES.

SCENE 82.
PS83A, CGS: Fluxing
PS83B, tape 944, 12:19:20-12:19:48
parts pulled from flux tank

NARRATION (VO):

FLUXING REMOVES AND SUBSEQUENTLY PREVENTS THE FORMATION OF OXIDES ON THE SURFACE OF THE PARTS PRIOR TO GALVANIZING. FLUXING ALSO PROMOTES BONDING OF THE MOLTEN ZINC TO PART SURFACES DURING GALVANIZING.

SCENE 83.
PS84A, tape 944, 12:26:16-12:26:48
parts lowered into zinc tank
PS84B, tape 945, 13:04:54-13:05:17
parts pulled from zinc tank

NARRATION (VO):

ONCE THE PARTS ARE THOROUGHLY CLEANED AND FLUXED, THEY ARE IMMERSED IN THE MOLTEN ZINC BATH. THIS BATH CONSISTS OF A MINIMUM OF 98 PERCENT PURE ZINC FOR GALVANIZING...,
THE PARTS ARE LEFT IMMERSED UNTIL THEY REACH BATH TEMPERATURE, AND THEN ARE SLOWLY WITHDRAWN...,
AS THEY ARE WITHDRAWN, ANY EXCESS ZINC IS REMOVED.

SCENE 84.
PS85A, tape 945, 13:17:12-13:17:28

NARRATION (VO):

zoom out, finishing batch galvanized part

PS85B, tape 945, 13:16:00-13:16:13
zoom out, finishing batch galvanized part, alternate shot

ONCE SUFFICIENTLY COOLED, BATCH GALVANIZED PARTS ARE INSPECTED FOR IMPERFECTIONS, AND ANY SHARP EDGES AND SOLIDIFIED DRIPS ARE REMOVED.

--- TOUCH BLACK ---

SCENE 85.

PS86A, CGS: Continuous Galvanizing

PS86B, tape 946, 14:01:34-14:01:57
zoom out, continuous galvanizing operation

PS86C, tape 654, 05:19:35-05:19:58
zoom out, ductwork being produced

PS86D, CGS: Ductwork
Roofing & Siding Panels
Guardrails
Appliance Housings
Automotive Body Parts

NARRATION (VO):

CONTINUOUS GALVANIZING IS A HIGH PRODUCTION METHOD OF ZINC-COATING SHEET METAL COIL STOCK. TYPICAL APPLICATIONS USING GALVANIZED COIL INCLUDE DUCTWORK, ROOFING AND SIDING PANELS, GUARDRAILS, APPLIANCE HOUSINGS, AND AUTOMOTIVE BODY PARTS.

SCENE 86.

PS87A, tape 950, 18:08:55-18:09:09
pan down from furnace to galvanizing operation

PS87B, tape 946, 14:04:30-14:04:48
tilt up, galvanizing operation

NARRATION (VO):

COIL STOCK FOR CONTINUOUS GALVANIZING IS FIRST CLEANED AND THEN HEATED TO GALVANIZING TEMPERATURE IN A CONTINUOUS, CONTROLLED-ATMOSPHERE FURNACE. THE COIL STOCK IS THEN PULLED THROUGH THE MOLTEN ZINC.

SCENE 87.
continue previous shot

PS88A, tape 950, 18:06:24-18:06:38
zoom out, side view, air knife blowing molten zinc off the coil stock

NARRATION (VO):

THICKNESS OF THE ZINC COATING IS CONTROLLED BY THE WIPING ACTION FROM A STREAM OF AIR OR STEAM, CALLED AN AIR KNIFE, AS THE GALVANIZED COIL IS PULLED UPWARD THROUGH THE MOLTEN ZINC AND COOLED.

SCENE 88.

PS89A, tape 946, 14:18:44-14:19:00
zoom out, coil being inspected

PS89B, tape 950, 18:02:00-18:02:18
zoom out, coil taken up on recoiler

NARRATION (VO):

ONCE COOLED, THE GALVANIZED COIL STOCK IS FINISHED AND INSPECTED...,

AND THEN TAKEN UP ON A RECOILER REEL FOR

FURTHER PROCESSING.

--- FADE TO BLACK ---

SCENE 89.
PS90A, GRAPHIC: Porcelain Enameling
white text centered on black

SCENE 90.
PS91A, peter carey narration
PS91B, tape 933, 01:25:42-01:25:53
powder coating of porcelain enameled parts
PS91C, tape 933, 01:06:42-01:07:12
zoom in, porcelain enameled parts being fired

NARRATION (VO):

PORCELAIN ENAMELING IS THE DEPOSITION..., AND FUSION BONDING OF ALKALIBOROSILICATE GLASS, COMMONLY KNOWN AS FRIT, ON METAL SUBSTRATES AT TEMPERATURES TYPICALLY BETWEEN 800 TO 1400 DEGREES FAHRENHEIT OR 425 TO 760 DEGREES CENTIGRADE.

SCENE 91.
continue previous shot
PS92A, tape 934, 02:07:03-02:07:18
zoom out, parts after inspection

NARRATION (VO):

AS IT MELTS, THE FRIT BONDS CHEMICALLY WITH THE METAL SUBSTRATE TO PRODUCE A UNIQUE COATING THAT IMPARTS HIGH HEAT, CORROSION, CHEMICAL, AND ELECTRICAL RESISTANCE, AS WELL AS DECORATIVE COLOR.

SCENE 92.
PS93A, tape 933, 01:02:13-01:02:41
zoom out, pan, parts placed on racks for processing
PS93B, CGS: Steel
Cast Iron
Aluminum

NARRATION (VO):

PORCELAIN ENAMELING IS WIDELY USED FOR MANY INDUSTRIAL, HOUSEHOLD, AND ARCHITECTURAL APPLICATIONS. THE METALS THAT ARE TYPICALLY PORCELAIN ENAMELED INCLUDE STEEL, CAST IRON AND ALUMINUM.

SCENE 93.
PS94A, tape 933, 01:13:56-01:14:18
parts being washed for porcelain enameling
PS94B, tape 933, 01:18:40-01:18:51
zoom out, parts coming out of washer

NARRATION (VO):

ENAMEL ADHESION AND APPEARANCE DEPENDS ON CLOSE CONTROL OF CLEANING TO REMOVE DIRT, OILS

AND OTHER CONTAMINANTS FROM THE SUBSTRATE SURFACE. CLEANING IS TYPICALLY ACHIEVED USING CHEMICAL AND OR MECHANICAL METHODS.

SCENE 94.
PS95A, tape 934, 02:29:36-02:29:48
zoom out, liquid porcelain enamel coating being mixed
PS95B, CGS: Clay
Bentonite
Electrolytes
Coloring Oxides
PS95C, tape 934, 02:17:03-02:17:25
porcelain enamel applied with robotic sprayer
PS95D, tape 933, 01:27:14-01:27:30
zoom out, powder coating of porcelain enameled parts

NARRATION (VO):

PORCELAIN ENAMEL COATINGS CONSIST MAINLY OF FRIT AND OTHER MATERIALS SUCH AS CLAY, BENTONITE, ELECTROLYTES, AND COLORING OXIDES. THESE COATINGS ARE COMMONLY APPLIED SUSPENDED IN WATER EITHER BY DIPPING OR SPRAYING..., OR AS A DRY POWDER THAT IS ELECTROSTATICALLY APPLIED.

SCENE 95.
PS96A, tape 933, 01:28:51-01:29:10
parts coming out of porcelain enamel powder coating

NARRATION (VO):

REGARDLESS OF THE APPLICATION METHOD, UNIFORM COVERAGE OF THE PORCELAIN ENAMEL COATING IS ESSENTIAL.

SCENE 96.
PS97A, tape 934, 02:21:16-02:21:28
zoom out, sprayed parts going through drying furnace
PS97B, tape 934, 02:01:55-02:02:16
zoom out, parts being powder coated

NARRATION (VO):

ONCE APPLIED, WATER-BORNE PORCELAIN ENAMEL COATINGS MAY BE AIR-DRIED, OR DRIED USING RADIANT HEAT PRIOR TO FIRING. DRY POWDER PORCELAIN ENAMEL COATINGS REQUIRE NO DRY TIME AND MAY BE IMMEDIATELY FIRED.

SCENE 97.
PS98A, tape 933, 01:09:50-01:10:20
zoom out, parts in furnace
PS98B, CGS: Oil
Natural Gas
Propane Gas
Electricity

NARRATION (VO):

FIRING, OR CONTROLLED HEAT TREATMENT OF PORCELAIN ENAMEL PARTS, IS TYPICALLY PERFORMED IN CONTINUOUS, INTERMITTENT, OR BATCH FURNACES. THESE FURNACES ARE HEATED USING EITHER OIL, NATURAL GAS, PROPANE GAS OR

ELECTRICITY.

--- FADE TO BLACK ---

SCENE 98.
PS99A, GRAPHIC: Review white text on black
PS99B, peter carey narration

MUSIC UP AND UNDER

NARRATION (VO):

LET'S REVIEW THE MATERIAL CONTAINED IN THIS PROGRAM.

SCENE 99.
PS100A, tape 936, 04:07:46-04:07:58 plating operation
PS100B, tape 933, 01:23:30-01:23:51 zoom out, porcelain enameling operation
PS100C, review music

NARRATION (VO):

THE USE OF PLATING...,

AND OTHER SURFACE COATING TECHNOLOGIES ARE PRIMARY FUNCTIONS THROUGHOUT MANUFACTURING.

SCENE 100.
PS101A, tape 945, 13:03:30-13:03:48 zoom out, hot dipping operation
PS101B, tape 936, 04:08:51-04:09:01 rack going into electroplating operation
PS101C, tape 633, 13:25:13-13:25:28 wide, parts moving through electroless plating operation
PS101D, tape 948, 16:05:43-16:06:00 parts going into anodizing bath
PS101E, tape 944, 12:26:44-12:26:53 zoom out, hot dipping operation
PS101F, tape 933, 01:27:09-01:27:16 zoom out, porcelain enameling operation

NARRATION (VO):

THESE COATINGS ARE DEPOSITED AS THIN FILMS TO PART SURFACES FOR PROTECTION, DURABILITY OR DECORATION, AND INCLUDE:

ELECTROPLATING...,

ELECTROLESS PLATING...,

CONVERSION COATING...,

HOT DIPPING...,

AND PORCELAIN ENAMELING.

--- TOUCH BLACK ---

SCENE 101.
PS102A, CGS: Electroplating
PS102B, tape 936, 04:15:53-04:16:09 zoom in, parts coming out of electroplating tank
PS102C, tape 635, 15:11:43-15:11:58 electroplating of plastic
PS102D, tape 937, 05:02:28-05:02:54 zoom out, barrel electroplating of metal

NARRATION (VO):

ELECTROPLATING IS THE ELECTROLYTIC PROCESS OF CATHODICALLY DEPOSITING A THIN METAL LAYER ONTO ANOTHER METAL...,

PLASTIC,

OR OTHER SUBSTRATE MATERIAL THAT IS OR HAS

BEEN MADE ELECTRICALLY CONDUCTIVE.

SCENE 102.
continue previous shot
PS103A, ANI: positively charged plating metal ions an electrolytic solution being drawn to the negatively charged part surface, coating it
PS103B, GRAPHIC: positive symbol
PS103C, GRAPHIC: negative symbol
PS103D, CGS: Anode
PS103E, CGS: Cathode

NARRATION (VO):

USING DIRECT ELECTRIC CURRENT, POSITIVELY CHARGED PLATING METAL IONS IN THE ELECTROLYTIC SOLUTION ARE DRAWN, OR PRECIPITATED, OUT OF THE SOLUTION TO COAT THE NEGATIVELY CHARGED CONDUCTIVE PART SURFACE. THE POSITIVELY CHARGED PLATING METAL IS REFERRED TO AS THE 'ANODE', AND THE NEGATIVELY CHARGED PART OR PARTS, THE 'CATHODE'.

SCENE 103.
continue previous animation, circle appears with close up view of plating surface

NARRATION (VO):

AS THE ELECTRIC CURRENT FLOWS, THE METAL IONS GAIN ELECTRONS AT THE PART SURFACE AND TRANSFORM INTO A COATING OF METAL.

--- TOUCH BLACK ---

SCENE 104.
PS105A, CGS: Electroless Plating
PS105B, tape 947, 15:09:32-15:09:41 part placed in electroless plating solution
PS105C, ANI: plating metal in solution pulled to the part surface that has been made catalytic through chemical reactions

NARRATION (VO):

ELECTROLESS PLATING, ALSO CALLED AUTOCATALYTIC DEPOSITION, IS THE DEPOSITION OF A PLATING METAL FROM ITS IONIC STATE WITHIN A PLATING SOLUTION ONTO A SUBSTRATE SURFACE THAT HAS BEEN MADE CATALYTIC THROUGH CHEMICAL REACTIONS.

SCENE 105.
continue previous animation

NARRATION (VO):

ONCE A LAYER OF METAL FORMS ON THE SUBSTRATE, THAT LAYER AND THOSE FOLLOWING BECOME THE CATALYST, CAUSING THE REACTION TO CONTINUE.

SCENE 106.
PS107A, tape 633, 13:26:04-13:26:28
electroless plating of plastic part
PS107B, tape 635, 15:09:15-15:09:30
electroplating of plastic part

NARRATION (VO):

ELECTROLESS PLATING IS COMMONLY USED TO PLATE NON-CONDUCTIVE PLASTIC PARTS IN PREPARATION FOR ELECTROPLATING OPERATIONS.

--- TOUCH BLACK ---

SCENE 107.
PS108A, CGS: Conversion Coating
PS108B, tape 942, 10:02:09-10:02:28
zoom out, parts coming out of black oxide coating
PS108C, tape 938, 06:15:18-06:15:32
parts going into anodizing operation

NARRATION (VO):

IN CONVERSION COATING PROCESSES, STRONGLY ADHERENT COATINGS ARE FORMED ON METAL SURFACES BY THE CONTROLLED CHEMICAL...,
OR ELECTROCHEMICAL REACTION BETWEEN A SOLUTION AND THE IONS FORMED FROM THE METALLIC SURFACE IMMERSED IN THE SOLUTION.

SCENE 108.
PS109A, tape 951, 20:08:24-20:08:42
parts going into zinc phosphate bath
PS109B, CGS: Phosphate Conversion Coatings
PS109C, tape 936, 04:24:14-04:24:22
parts going into chromate bath
PS109D, CGS: Chromate Conversion Coatings
PS109E, tape 942, 10:17:47-10:17:55
black oxide parts lowered to ground
PS109F, CGS: Oxide Conversion Coatings

NARRATION (VO):

THE MOST COMMON CHEMICAL CONVERSION COATINGS ARE PHOSPHATE CONVERSION COATINGS...,
CHROMATE CONVERSION COATINGS...,
AND OXIDE CONVERSION COATINGS.

SCENE 109.
PS110A, CGS: Anodizing
PS110B, tape 939, 07:19:28-07:19:48
aluminum parts being placed in anodizing tank
PS110C, ANI: part in anodizing operation, part indicated as anode
PS110D, GRAPHIC: positive symbol
PS110E, CGS: Anode

NARRATION (VO):

ELECTROCHEMICAL CONVERSION COATINGS ARE PRODUCED BY ANODIZING. THE TERM 'ANODIZING' STEMS FROM THE FACT THAT THE PART TO BE ANODIZED IS THE ANODE IN THE ELECTROLYTIC CELL RATHER THAN THE CATHODE AS IN ELECTROPLATING.

SCENE 110.
PS111A, tape 939, 07:23:27-07:24:01
zoom out, parts in solution, parts

NARRATION (VO):

coming out of anodizing, rinsed
PS111B, tape 952, 22:03:22-22:03:37
zoom in, anodized tube surface

UNLIKE ELECTROPLATING WHERE THE METAL PLATING IONS TRAVEL FROM THE BATH TO THE PART AND BUILD UP THE PLATED LAYER BY ADDING MORE AND MORE PLATING IONS, ANODIZING PRODUCES A CONSTANTLY FORMED OXIDE LAYER INTEGRAL WITH THE UNDERLYING METAL SUBSTRATE SURFACE.

--- TOUCH BLACK ---

SCENE 111.
PS112A, CGS: Galvanizing
PS112B, tape 946, 14:08:25-14:09:00
zoom out, continuous galvanizing
PS112C, tape 945, 13:03:59-13:04:27
zoom out, batch galvanizing operation
PS112D, photomicrograph of galvanized steel with arrow

NARRATION (VO):

GALVANIZING IS THE MOST COMMON HOT DIPPING PROCESS, AND INVOLVES COATING THE SURFACE OF STEEL OR IRON PRODUCTS WITHIN A TANK OF MOLTEN ZINC. THE MOLTEN ZINC AND SUBSTRATE STEEL OR IRON REACT METALLURGICALLY, PRODUCING A COATING CONSISTING OF A SERIES OF ZINC-IRON ALLOYS...,
AND A SURFACE LAYER OF VIRTUALLY PURE ZINC.

SCENE 112.
PS113A, tape 943, 11:19:21-11:19:31
zoom out, batch galvanizing operation
PS113B, tape 946, 14:03:07-14:03:17
continuous galvanizing operation

NARRATION (VO):

GALVANIZING IS MOST COMMONLY PERFORMED USING BATCH GALVANIZING...,
AND CONTINUOUS GALVANIZING.

--- TOUCH BLACK ---

SCENE 113.
PS114A, CGS: Porcelain Enameling
PS114B, tape 933, 01:25:42-01:25:53
powder coating of porcelain enameled parts
PS114C, tape 933, 01:06:42-01:07:12
zoom in, porcelain enameled parts being fired

NARRATION (VO):

PORCELAIN ENAMELING IS THE DEPOSITION...,
AND HIGH TEMPERATURE FUSION BONDING OF ALKALIBOROSILICATE GLASS, COMMONLY KNOWN AS FRIT, ON METAL SUBSTRATES.

SCENE 114.
continue previous shot
PS115A, tape 934, 02:07:03-02:07:18
zoom out, parts after inspection

NARRATION (VO):

AS IT MELTS, THE FRIT BONDS CHEMICALLY WITH THE METAL SUBSTRATE TO PRODUCE A UNIQUE COATING THAT IMPARTS HIGH HEAT, CORROSION, CHEMICAL, AND ELECTRICAL RESISTANCE, AS WELL AS DECORATIVE COLOR.

--- FADE TO BLACK ---

SCENE 115.
PS116A, CG, ROLL: credits
white text on black, fade up mid-screen

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Anodizing Specialists, Inc.
Cleveland Black Oxide
Electro-Spec, Inc.
Microfinish Company Incorporated
Nimet Industries, Inc.

Parts Finishing Group, Inc.
Roesch, Inc.
Spartan Steel Coating
Sumco Inc.
Witt Galvanizing

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SCENE 116.
PS117A, GRAPHIC: disclaimer white text centered on black

Some machinery in this program had safety equipment removed to allow better recording of certain processes.
Always read the safety information provided in the manufacturers' manual before machine operation.

SCENE 117.
PS118A, SME logo animation, with music