

FUNDAMENTAL MANUFACTURING PROCESSES

Welding

SCENE 1.
CG: FBI warning
white text centered on black to
blue gradient

WARNING
federal law provides severe civil and
criminal penalties for the unauthorized
reproduction, distribution or exhibition
of copyrighted videotapes.

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SCENE 2.
CG: disclaimer
white text centered on black to
blue gradient

Always read the operating manual and safety
information provided by the manufacturer before
operating any welding equipment.
Make sure all machine guards are in place, and
follow all safety procedures when working with or
near welding equipment.

--- TOUCH BLACK ---

SCENE 3.
tape 40, 01:00:00-01:00:12
SME logo, with music
CG, SUPER: www.sme.org

SCENE 4.
tape 25, 01:01:00-01:01:45
fundamental series open, with
music
tape 534, 01:00:00-01:28:24
peter carey narration

MUSIC UP AND UNDER

NARRATION (VO):

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

--- TOUCH BLACK ---

SCENE 5.
program title:
CG: Welding
white text centered on black

NARRATION (VO):

THIS PROGRAM EXPLORES THE FUNDAMENTALS OF WELDING.

--- TOUCH BLACK ---

SCENE 6.

tape 529, 15:15:51-15:16:05
fusion welding operation

NARRATION (VO) :

WELDING IS A COMMON METHOD OF JOINING METALS, AND
INCLUDES A WIDE VARIETY OF PROCESSES.

SCENE 7.

tape 518, 03:06:01-03:06:04
gas metal welding operation
tape 524, 11:22:22-11:22:26
resistance welding operation
tape 519, 05:11:31-05:11:33
gas metal welding operation
tape 525, 12:09:08-12:09:12
capacitor discharge welding
operation
tape 527, 03:32:24-03:32:28
ultrasonic welding operation
tape 532, 01:01:44-01:01:52
automobile being welded
tape 483, 11:04:09-11:04:30
aircraft taking off
tape 182, 02:03:56-02:04:02
pan of truck on bridge
tape 466, 05:17:15:00
still, agricultural equipment
tape 520, 08:01:10-08:01:20
still of ship
tape 232, 04:24:36-04:24:41
machine tool
tape 519, 05:02:30-05:02:34
tube welding
tape 273, 03:18:05-03:18:12
entire press tooling
tape 212, 01:01:39-01:01:51
tombstone with chucks
tape 531, 12:09:15-12:09:19
electronics
tape 535, 20:00:55-20:01:05
GRAPHIC: pacemaker

NARRATION (VO) :

THESE PROCESSES ARE USED FOR MANY INDUSTRIAL
APPLICATIONS, INCLUDING THE MANUFACTURING OF
AUTOMOBILES,
AIRCRAFT,
BRIDGES,
AGRICULTURAL EQUIPMENT,
SHIPS,
MACHINE TOOLS,
TUBE AND PIPE,
TOOLS AND DIES,
FIXTURES,
ELECTRONICS,
AND MEDICAL PRODUCTS.

SCENE 8.

tape 516, 01:12:21-01:012:32
joint ready to weld, being
welded
CG, SUPER: Butt Joint
tape 536, 00:00:40-00:00:50
GRAPHIC: butt joint
CG, SUPER: Corner Joint
tape 536, 00:01:08-00:01:18
GRAPHIC: corner joint
CG, SUPER: Edge Joint
tape 536, 00:01:28-00:01:38
GRAPHIC: edge joint
CG, SUPER: Lap Joint
tape 536, 00:01:47-00:01:57

NARRATION (VO) :

AN EXTREMELY IMPORTANT ASPECT OF WELDING IS JOINT
DESIGN. THE BASIC JOINT TYPES USED INCLUDE:
THE BUTT JOINT...,
THE CORNER JOINT...,
THE EDGE JOINT...,
THE LAP JOINT...,

GRAPHIC: lap joint
 CG, SUPER: Tee Joint
tape 536, 00:02:05-00:02:15
 GRAPHIC: tee joint
 CG, SUPER: Flanged Butt Joint
tape 536, 00:02:25-00:02:35
 GRAPHIC: flanged butt joint #1
tape 536, 00:02:45-00:02:55
 GRAPHIC: flanged butt joint #2
 CG, SUPER: Flanged Corner Joint
tape 536, 00:03:05-00:03:15
 GRAPHIC: flanged corner joint
 CG, SUPER: Flanged Edge Joint
tape 536, 00:03:25-00:03:35
 GRAPHIC: flanged edge joint #1
tape 536, 00:03:45-00:03:55
 GRAPHIC: flanged edge joint #2
 CG, SUPER: Flanged Lap Joint
tape 536, 00:04:05-00:04:15
 GRAPHIC: flanged lap joint #1
tape 536, 00:04:25-00:04:35
 GRAPHIC: flanged lap joint #2
 CG, SUPER: Flanged Tee Joint
tape 536, 00:04:45-00:04:55
 GRAPHIC: flanged tee joint

THE TEE JOINT.
 THE FLANGED BUTT JOINT...,
 THE FLANGED CORNER JOINT...,
 THE FLANGED EDGE JOINT...,
 THE FLANGED LAP JOINT...,
 AND THE FLANGED TEE JOINT.

SCENE 9.

tape 522, 09:20:38-09:20:56
 c.u. joint root set up to weld,
 welding beginning
 CG, SUPER: Closed Joint Root
tape 536, 00:05:05-00:05:15
 GRAPHIC: closed joint root
 CG, SUPER: Open Joint Root
tape 536, 00:05:26-00:05:36
 GRAPHIC: open joint root

NARRATION (VO) :

THE PORTION OF THE JOINT WHERE THE MEMBERS TO BE
 WELDED ARE CLOSEST TO EACH OTHER OR MEET IS THE
 JOINT ROOT. THIS MAY BE A POINT, A LINE OR AN
 AREA. DEPENDING ON THE WELDING PROCESS, THE JOINT
 ROOT MAY BE CLOSED...,
 OR OPEN, WITH A CONTROLLED WIDTH GAP TO ASSIST
 WELD PENETRATION.

SCENE 10.

tape 529, 15:22:37-15:22:50
 zoom out, joint with edge
 preparation
 CG, SUPER: Square
tape 536, 00:05:45-00:05:55
 GRAPHIC: square
 CG, SUPER: Single Bevel
tape 536, 00:06:05-00:06:15
 GRAPHIC: single bevel
 CG, SUPER: Double Bevel
tape 536, 00:06:25-00:06:35
 GRAPHIC: double bevel
 CG, SUPER: Single "J"
tape 536, 00:06:45-00:06:55

NARRATION (VO) :

JOINTS MAY ALSO REQUIRE SOME TYPE OF EDGE SHAPE TO
 ALLOW FOR COMPLETE JOINT PENETRATION DURING
 WELDING. THE BASIC EDGE SHAPES INCLUDE:
 SQUARE...,
 SINGLE BEVEL...,
 DOUBLE BEVEL...,

GRAPHIC: single "j"	SINGLE "J"....,
CG, SUPER: Double "J"	
tape 536, 00:07:05-00:07:15	DOUBLE "J"....,
GRAPHIC: double "j"	
CG, SUPER: Flanged	FLANGED....,
tape 536, 00:07:25-00:07:35	
GRAPHIC: flanged	AND ROUND.
CG, SUPER: Round	
tape 536, 00:07:45-00:07:55	DEPENDING ON THE WELDING OPERATION, EDGE SHAPES
GRAPHIC: round #1	
tape 536, 00:08:05-00:08:15	ARE COMBINED TO PRODUCE THE DESIRED WELD.
GRAPHIC: round #2	
tape 517, 02:01:27-02:01:32	
gas metal arc welding operation	--- TOUCH BLACK ---
tape 522, 09:09:20-09:09:24	
laser welding operation	
tape 524, 11:05:36-11:05:40	
resistance welding operation	
tape 528, 14:17:30-14:17:38	
flux core welding operation	

SCENE 11.

tape 528, 14:01:22-14:02:10
fusion welding operation
CG, SUPER: The Materials To Be
 Joined
 The Thickness Of The
 Parts
 The Joint Design
 The Joint Location &
 Orientation
 Edge Preparation
 Weld Bead Quality
 Production
 Requirements
 Equipment Cost
 Equipment Portability
 Environmental
 Requirements
 Welder/Machine
 Operator Skills
 Safety Considerations

NARRATION (VO) :

WHEN SELECTING A WELDING PROCESS FOR SPECIFIC
APPLICATIONS, MANY FACTORS MUST BE CONSIDERED,
INCLUDING:
THE MATERIALS TO BE JOINED,
THE THICKNESS OF THE PARTS,
THE JOINT DESIGN,
THE JOINT LOCATION AND ORIENTATION,
EDGE PREPARATION,
WELD BEAD QUALITY,
PRODUCTION REQUIREMENTS,
EQUIPMENT COST,
EQUIPMENT PORTABILITY,
ENVIRONMENTAL REQUIREMENTS,
WELDER OR MACHINE OPERATOR SKILLS,
AND SAFETY CONSIDERATIONS.

SCENE 12.

tape 521, 08:03:49-08:04:15
zoom in, friction welding
operation

NARRATION (VO) :

THE NUMEROUS WELDING PROCESSES JOIN, OR COALESCE,

tape 518, 03:00:59-03:01:03
fusion welding operation
tape 528, 14:16:07-14:16:41
fusion welding operation
tape 533, 17:10:30-17:10:34
resistance welding
tape 522, 09:06:15-09:06:19
fusion welding operation
tape 520, 07:01:00-07:02:00
blue background
CG: Fusion Welding
Solid-State Welding

METALS TOGETHER BY EITHER FUSION WELDING,
OR SOLID-STATE WELDING.

--- FADE TO BLACK ---

SCENE 13.
CG: Fusion Welding Processes
white text centered on black

SCENE 14.
tape 528, 14:18:33-14:18:52
flux-core arc welding operation
using filler metal

NARRATION (VO) :

IN FUSION WELDING, METAL COALESCENCE IS CREATED BY
MELTING A BASE METAL AND FILLER METAL TOGETHER, OR
BY MELTING THE BASE METAL ALONE.

SCENE 15.
continue previous shot
tape 520, 07:01:00-07:02:00
blue background
CG: Fusion Welding Processes
Arc Welding
Resistance Welding
Laser Beam Welding
Electron Beam Welding

NARRATION (VO) :

THE PRINCIPAL FUSION WELDING PROCESSES ARE:
ARC WELDING,
RESISTANCE WELDING,
LASER BEAM WELDING,
AND ELECTRON BEAM WELDING.

--- TOUCH BLACK ---

SCENE 16.
tape 525, 12:07:32-12:07:52
arc welding operation
CG, SUPER: Arc Welding

NARRATION (VO) :

ARC WELDING PROCESSES USE AN ELECTRIC ARC AS THE
HEAT SOURCE TO MELT AND JOIN THE BASE METALS. THE
ARC IS STRUCK BETWEEN THE WORKPIECES AND THE TIP
OF AN ELECTRODE.

SCENE 17.
tape 519, 05:13:38-05:13:47
consumable arc welding operation
tape 525, 12:11:59-12:12:06

NARRATION (VO) :

ARC WELDING ELECTRODES ARE USUALLY CONSUMABLE...,

non-consumable arc welding
operation

BUT CAN BE NON-CONSUMABLE.

SCENE 18.

tape 517, 02:13:45-02:14:15
pan from consumable electrode
wire rolling off to arc welding
operation
tape 530, 16:03:35-16:03:44
slag covering being removed

NARRATION (VO) :

THE CONSUMABLE ELECTRODE IS USUALLY WIRE OR ROD,
AND THE CURRENT THAT SUSTAINS THE ARC ALSO MELTS
THE ELECTRODE SO THAT IT SUPPLIES FILLER METAL TO
THE JOINT. THE ELECTRODE MAY ALSO PRODUCE A SLAG
COVERING TO PROTECT THE HOT WELD METAL FROM
OXIDATION.

SCENE 19.

tape 525, 12:14:28-12:14:34
tungsten rod being placed in
welding gun
tape 525, 12:12:42-12:12:55
gas tungsten arc welding
operation, with filler metal
supplied to joint

NARRATION (VO) :

THE MOST COMMON NONCONSUMABLE ELECTRODE IS A
TUNGSTEN ROD, WHICH CARRIES THE ELECTRIC CURRENT.
IF A WELDING OPERATION USING A NONCONSUMABLE
ELECTRODE ALSO REQUIRES A FILLER METAL, IT IS
SUPPLIED BY A SEPARATE WIRE, ROD OR CONSUMABLE
INSERT.

SCENE 20.

tape 517, 02:03:55-02:04:04
electrode moved manually
tape 529, 15:02:53-15:03:12
electrode moved mechanically

NARRATION (VO) :

WHILE WELDING, THE ELECTRODE IS MOVED EITHER
MANUALLY...,
OR MECHANICALLY ALONG THE JOINT,
OR THE ELECTRODE IS HELD STATIONARY AND THE
WORKPIECE IS MOVED.

SCENE 21.

tape 528, 14:26:15-14:26:25
arc welding process
tape 520, 07:01:00-07:02:00
blue background
CG: Arc Welding Processes
Shielded Metal Arc Welding
(SMAW)
Submerged Arc Welding
(SAW)
Gas Metal Arc Welding
(GMAW, MIG)

NARRATION (VO) :

ARC WELDING ENCOMPASSES A VARIETY OF PROCESSES,
THE PRIMARY TYPES BEING:
SHIELDED METAL ARC WELDING,
SUBMERGED ARC WELDING,
GAS METAL ARC WELDING,

Flux-Cored Arc Welding (FCAW)	FLUX-CORED ARC WELDING,
Gas Tungsten Arc Welding (GTAW, TIG, Heliarc)	GAS TUNGSTEN ARC WELDING,
Plasma Arc Welding (PAW, Needle Arc)	AND PLASMA ARC WELDING.

--- TOUCH BLACK ---

SCENE 22.

CG, SUPER: Shielded Metal Arc
Welding

tape 529, 15:23:45-15:23:53

shielded metal arc welding
operation

tape 533, 18:00:40-18:01:10

GRAPHIC: stick

tape 533, 18:01:40-18:02:10

GRAPHIC: stick with enlarged
cross section

tape 529, 15:23:57-15:24:18

shielded metal arc welding
operation

CG, SUPER: Source Of Arc
Stabilizers
Fluxing Agents
Lubricants
Gases To Displace
Air
Metal & Slag To
Protect, Support &
Insulate The Hot
Weld Metal During
Welding

NARRATION (VO) :

SHIELDED METAL ARC WELDING USES A COVERED
ELECTRODE CONSISTING OF A CORE WIRE SURROUNDED BY
A CONCENTRIC COVERING WHICH IS A MIXTURE OF
SILICATE BINDERS AND POWDERS. THESE BINDERS AND
POWDERS SERVE AS A SOURCE OF ARC STABILIZERS,
FLUXING AGENTS, LUBRICANTS, GASES TO DISPLACE AIR,
AND METAL AND SLAG TO PROTECT, SUPPORT AND
INSULATE THE HOT WELD METAL DURING WELDING.

SCENE 23.

tape 530, 16:12:38-16:12:47

bare section of electrode
clamped in holder

tape 530, 16:16:02-16:16:12

workpiece connected to power
source

NARRATION (VO) :

THE BARE SECTION OF THE ELECTRODE IS CLAMPED IN A
HOLDER, WHICH IS CONNECTED BY A WELDING LEAD, OR
CABLE, TO A TERMINAL OF A CONSTANT CURRENT POWER
SOURCE. THE WORKPIECE IS CONNECTED TO THE OTHER
POWER-SOURCE TERMINAL.

SCENE 24.

tape 530, 16:05:38-16:06:09

touching the tip of the
electrode against the workpiece,
initiating arc, arcing electrode
moves out of shot, showing weld

NARRATION (VO) :

TOUCHING THE TIP OF THE ELECTRODE AGAINST THE
WORKPIECE AND WITHDRAWING IT SLIGHTLY INITIATES,
OR STRIKES, THE ARC. THE HEAT OF THE ARC MELTS THE

BASE METAL IN THE IMMEDIATE AREA AS WELL AS THE ELECTRODE CORE WIRE AND COVERING. THE MOLTEN BASE METAL, CORE WIRE AND METAL POWDERS IN THE COVERING COALESCE, OR FUSE, TO FORM THE WELD.

SCENE 25.

tape 530, 16:15:24-16:16:00

wide, arc welding process
CG, SUPER: Alternating-Current
Or "Ac"/Direct-Current Or "Dc"
Power Source
Welding Leads
Electrode Holder
Welding Helmet & Gloves
Protective Clothing

NARRATION (VO) :

THE EQUIPMENT REQUIRED FOR SHIELDED METAL ARC WELDING INCLUDES EITHER AN ALTERNATING-CURRENT OR "AC" OR DIRECT-CURRENT OR "DC" POWER SOURCE, WELDING LEADS, AN ELECTRODE HOLDER, WELDING HELMET AND GLOVES, AND PROTECTIVE CLOTHING.

SCENE 26.

tape 530, 16:19:00-16:19:17

shielded metal arc welding operation
CG, SUPER: Ferrous Metals
Cast Iron
Carbon Steels
Low-Alloy Steels
Stainless Steels
Tool Steels
Non-Ferrous Metals
Copper
Nickel
Aluminum

NARRATION (VO) :

THE PROCESS IS EFFECTIVE FOR WELDING FERROUS METALS SUCH AS CAST IRON, CARBON, LOW-ALLOY, STAINLESS AND TOOL STEELS; AND NON-FERROUS METALS INCLUDING COPPER, NICKEL, ALUMINUM AND THEIR ALLOYS.

--- TOUCH BLACK ---

SCENE 27.

CG, SUPER: Submerged Arc Welding

tape 528, 14:08:14-14:08:34

submerged arc welding operation

tape 528, 14:10:48-14:10:20

spark struck, starting submerged arc welding operation, hand held, zoom out

NARRATION (VO) :

IN SUBMERGED ARC WELDING, A BARE, CONTINUOUS, CONSUMABLE ELECTRODE WIRE, SHIELDED BY A LAYER OF GRANULAR FLUX PARTICLES, SUSTAINS THE ARC. WHEN THE ARC IS STRUCK, THE TIP OF THE ELECTRODE IS SUBMERGED IN THE FLUX AND THE ARC IS NOT VISIBLE. WELDING PROCEEDS WITHOUT THE INTENSE RADIATION THAT CHARACTERIZES OPEN-ARC PROCESSES, AND WITH

LITTLE FUMES.

SCENE 28.

tape 529, 15:03:38-15:03:48

wide, submerged arc welding operation

NARRATION (VO) :

THE SUBMERGED ARC WELDING PROCESS VARIES FROM SEMIAUTOMATIC, TO FULLY AUTOMATIC.

SCENE 29.

tape 529, 15:02:43-15:02:56

pan from wire feeding device to joint-tracking systems moving the welding head

NARRATION (VO) :

EQUIPMENT INCLUDES AUTOMATIC WIRE-FEED DEVICES..., AND JOINT-TRACKING SYSTEMS TO MOVE EITHER THE WELDING HEAD, OR THE WORKPIECE.

SCENE 30.

tape 528, 14:09:22-14:09:37

submerged arc welding operation
CG, SUPER: All Types Of Steel
Stainless Steels
Nickel Alloys

NARRATION (VO) :

SUBMERGED ARC WELDING IS COMMONLY USED TO JOIN ALL TYPES OF STEEL, STAINLESS STEELS, AND NICKEL ALLOYS.

--- TOUCH BLACK ---

SCENE 31.

CG, SUPER: Gas Metal Arc Welding

tape 525, 12:05:51-12:06:12

zoom in, robotic gas metal arc welding operation

NARRATION (VO) :

GAS METAL ARC WELDING USES A CONTINUOUS, SOLID, WIRE ELECTRODE FOR THE FILLER METAL AND A SHIELDING GAS TO PROVIDE THE DESIRED ARC CHARACTERISTICS AND PROTECT THE MOLTEN WELD METAL FROM AIR.

SCENE 32.

tape 519, 05:10:22-05:10:34

gas metal arc welding operation

NARRATION (VO) :

GAS METAL ARC WELDING IS SUITABLE FOR WELDING MANY TYPES OF JOINTS OF MOST ANY METAL IN ALL WELDING POSITIONS.

SCENE 33.

tape 517, 02:09:36-02:09:53

gas metal arc welding operation

tape 517, 02:25:56-02:26:22

gas metal arc welding operation

CG, SUPER: Short-Circuiting
Transfer

NARRATION (VO) :

THE CHARACTERISTICS OF THE GAS METAL ARC WELDING PROCESS ARE BEST DESCRIBED IN TERMS OF THE THREE

Globular Transfer
Spray Transfer

BASIC MODES BY WHICH METAL IS TRANSFERRED FROM THE
ELECTRODE TO THE WORK:

THE SHORT CIRCUITING TRANSFER,
THE GLOBULAR TRANSFER,
AND THE SPRAY TRANSFER.

SCENE 34.

continue previous shot &
previous CG, SUPER
tape 517, 02:10:52-02:11:13
c.u. gas metal arc welding
operation

CG, SUPER: The Magnitude & Type
Of Welding Current
Electrode Diameter
Composition Of The
Electrode
Electrode
Extension/Length
The Type Of Shielding
Gas

NARRATION (VO) :

THE TYPE OF TRANSFER IS DETERMINED BY A NUMBER OF
FACTORS, THE MOST SIGNIFICANT INCLUDING:

THE MAGNITUDE AND TYPE OF WELDING CURRENT,
THE ELECTRODE DIAMETER,
THE COMPOSITION OF THE ELECTRODE,
THE ELECTRODE EXTENSION OR LENGTH,
AND THE TYPE OF SHIELDING GAS.

SCENE 35.

CG, SUPER: Short Circuiting
Transfer
High Speed Video
Micrography

GRAPHIC: add mask to accentuate
the actual deposition of weld
metal

tape 535, 19:27:52-19:28:25
c.u. slow motion, short-
circuiting gas metal arc welding
operation
tape 535, 19:21:40-19:22:12
c.u. slow motion, short-
circuiting gas metal arc welding
operation

NARRATION (VO) :

THE SHORT CIRCUITING TRANSFER MODE ENCOMPASSES THE
LOWEST RANGE OF WELDING CURRENTS AND ELECTRODE
DIAMETERS ASSOCIATED WITH GAS METAL ARC WELDING.
METAL IS TRANSFERRED FROM THE ELECTRODE TO THE
WORK ONLY DURING INTERVALS OF CONTROLLED SHORT
CIRCUITS. THE SHORT CIRCUITING TRANSFER MODE IS
GENERALLY SUITED FOR JOINING THIN SECTIONS,
BRIDGING LARGE ROOT OPENINGS, AND FOR WELDING IN
ALL POSITIONS.

SCENE 36.

CG, SUPER: Globular Transfer
High Speed Video
Micrography

GRAPHIC: add mask to accentuate
the actual deposition of weld
metal

tape 535, 19:22:48-19:23:15
c.u. slow motion, globular-
transfer gas metal arc welding

NARRATION (VO) :

THE GLOBULAR-TRANSFER MODE IS CHARACTERIZED BY
DROP SIZES WITH A DIAMETER LARGER THAN THAT OF THE
ELECTRODE. THESE MOLTEN DROPS ARE EASILY ACTED ON
BY GRAVITY, USUALLY LIMITING SUCCESSFUL TRANSFER

operation

TO THE FLAT POSITION.

SCENE 37.

CG, SUPER: Spray Transfer
High Speed Video
Micrography

GRAPHIC: add mask to accentuate
the actual deposition of weld
metal

tape 535, 19:13:24-19:14:00

c.u. slow motion, spray transfer
gas metal arc welding operation

NARRATION (VO) :

THE SPRAY TRANSFER MODE DEPOSITS SMALL DROPLETS OF
METAL AT RATES OF SEVERAL HUNDRED PER SECOND.
SPRAY TRANSFER REQUIRES HIGH ELECTRIC CURRENT, AND
ARGON OR ARGON-RICH GAS MIXTURES TO SHIELD THE
ARC. METAL TRANSFER IS STABLE, DIRECTIONAL AND
VIRTUALLY SPATTER-FREE.

--- TOUCH BLACK ---

SCENE 38.

CG, SUPER: Flux-Cored Arc
Welding

tape 528, 14:17:54-14:18:08

flux-cored arc welding
operation, pan up to wire
spooling

CG, SUPER: Carbon Steels
Low Alloy Steels
Stainless Steels
Cast Iron

NARRATION (VO) :

FLUX-CORED ARC WELDING USES A FILLER METAL MADE UP
OF A TUBULAR ELECTRODE WITH A FLUX CORE AND WITH
OR WITHOUT ADDITIONAL GAS SHIELDING TO JOIN CARBON
STEELS, LOW ALLOY STEELS, STAINLESS STEELS, AND
CAST IRON.

SCENE 39.

tape 520, 08:01:40-08:02:20

GRAPHIC: flux core wire

CG, SUPER: Minerals
Ferroalloys
Ingredients That
Provide Shielding
Gases, Deoxidizers,
& Slag-Forming
Materials

tape 528, 14:22:48-14:23:00

flux core welding
CG, SUPER: Arc Stability
Enhance Weld-Metal
Properties
Improve Weld Bead
Contour

NARRATION (VO) :

THE CORE MAY CONTAIN MINERALS, FERROALLOYS AND
INGREDIENTS THAT PROVIDE SHIELDING GASES,
DEOXIDIZERS, AND SLAG-FORMING MATERIALS. THESE
INGREDIENTS PROMOTE ARC STABILITY, ENHANCE WELD-
METAL PROPERTIES AND IMPROVE WELD BEAD CONTOUR.

--- TOUCH BLACK ---

SCENE 40.

CG, SUPER: Gas Tungsten Arc
Welding

tape 529, 15:17:21-15:17:50

zoom out, gas tungsten arc
welding operation

NARRATION (VO) :

GAS TUNGSTEN ARC WELDING USES A NONCONSUMABLE
TUNGSTEN ELECTRODE AND EXTERNALLY SUPPLIED INERT-

GAS SHIELDING.

SCENE 41.

continue previous shot
CG, SUPER: Argon
Helium
Mixtures Of The Two

NARRATION (VO) :

THE MOST COMMON SHIELDING GASES USED ARE ARGON AND
HELIUM AND MIXTURES OF THE TWO GASES.

SCENE 42.

continue previous shot

NARRATION (VO) :

ALL TYPES OF STEELS AND MOST NONFERROUS METALS CAN
BE WELDED IN ALL KINDS OF JOINTS AND POSITIONS.

SCENE 43.

tape 529, 15:20:34-15:20:44
zoom out, gas tungsten arc
welding operation
tape 525, 12:17:48-12:17:55
gas tungsten arc welding
operation, with filler metal
supplied to joint

NARRATION (VO) :

DEPENDING ON THE APPLICATION, WORKPIECES CAN BE
WELDED WITHOUT A FILLER METAL...,
OR WELDED WITH A FILLER METAL SUPPLIED SEPARATELY
TO THE JOINT.

SCENE 44.

tape 525, 12:16:12-12:16:29
zoom out, power source to gas
tungsten arc welding operation

NARRATION (VO) :

THE GAS TUNGSTEN ARC WELDING PROCESS EMPLOYS
EITHER AN ALTERNATING-CURRENT OR DIRECT-CURRENT
POWER SOURCE, DEPENDING ON THE TYPE OF METAL TO BE
JOINED AND IT'S THICKNESS.

SCENE 45.

tape 529, 15:16:39-15:17:08
gas tungsten arc welding
operation

NARRATION (VO) :

SOME POWER SOURCES PROVIDE PULSATING DIRECT
CURRENT WITH VARIABLE FREQUENCY. THESE ADJUSTMENTS
ALLOW BETTER CONTROL OF THE MOLTEN WELD METAL WHEN
WELDING THIN SECTIONS AND WHEN WELDING IN OTHER
THAN THE FLAT POSITION.

--- TOUCH BLACK ---

SCENE 46.

CG, SUPER: Plasma Arc Welding
tape 526, 13:19:11-13:19:26
zoom out, plasma arc welding

NARRATION (VO) :

IN PLASMA ARC WELDING, METAL COALESCENCE IS

operation

tape 536, 00:08:30-00:09:30

ANI: cut away of plasma arc welding head, gas surrounding the tungsten electrode within the orifice body, forming the plasma jet, with auxiliary shielding gas

CG, SUPER: add arrow showing gas flowing down inside torch chamber

CG, SUPER: add arrow showing gas flowing through constricted orifice

PRODUCED BY A CONSTRICTED ARC MADE UP OF A HIGH-VELOCITY STREAM OF IONIZED GAS, CALLED A PLASMA. IN MOST PLASMA ARC WELDING OPERATIONS THE PLASMA JET IS GENERATED BY HEATING THE ORIFICE GAS IN THE TORCH PLENUM CHAMBER TO A PLASMA AND FORCING THE PLASMA TO EXIT THROUGH A CONSTRICTING NOZZLE OR ORIFICE.

SCENE 47.

continue previous animation
CG, SUPER: add arrows showing auxiliary gas

CG, SUPER: Argon
Helium
Argon/Hydrogen
Argon/Helium

NARRATION (VO) :

PARTIAL SHIELDING IS OBTAINED FROM THE PLASMA AND IS SUPPLEMENTED BY AN AUXILIARY SHIELDING GAS. AUXILIARY SHIELDING GASES USED INCLUDE ARGON, HELIUM OR MIXTURES OF ARGON WITH HYDROGEN OR HELIUM.

SCENE 48.

tape 526, 13:20:40-13:20:54

plasma arc welding operation

tape 520, 07:01:00-07:02:00

blue background

CG: Permits Deep Penetration
Narrow Welds

Rapid Welding Speeds

Good Arc Stability

tape 526, 13:06:15-13:06:28

plasma arc welding operation

NARRATION (VO) :

BECAUSE OF THE CONSTRICTED ARC, THE HEAT ENERGY OF THE PLASMA STREAM IS CONCENTRATED AND EXTREMELY INTENSE. THIS PERMITS DEEP PENETRATION, NARROW WELDS AND RAPID WELDING SPEEDS WITH GOOD ARC STABILITY. WORKPIECES CAN BE JOINED WITH OR WITHOUT FILLER METAL.

SCENE 49.

tape 526, 13:04:44-13:05:05

wide, plasma arc welding operation

NARRATION (VO) :

PLASMA ARC WELDING CAN BE USED TO JOIN MOST FERROUS AND NONFERROUS METALS, INCLUDING EXTREMELY THIN MATERIALS, SUCH AS FOILS.

SCENE 50.

continue previous shot

NARRATION (VO) :

PLASMA ARC WELDING EQUIPMENT COST IS HIGH, HOWEVER, SO THE PROCESS IS OFTEN LIMITED IN ITS

APPLICATION.

--- TOUCH BLACK ---

SCENE 51.
CG, SUPER: Resistance Welding
tape 524, 11:20:02-11:20:21
resistance welding operation of
sheet metal stock

NARRATION (VO) :

RESISTANCE WELDING PROCESSES PRODUCE COALESCENCE
OF OVERLAPPING WORKPIECES WITH HEAT GENERATED BY
THE RESISTANCE OF THE WORKPIECES TO THE FLOW OF
ELECTRIC WELDING CURRENT, AND THE APPLICATION OF
PRESSURE.

SCENE 52.
tape 533, 17:03:50-17:04:09
zoom out, resistance welding
operation

NARRATION (VO) :

RESISTANCE WELDING IS PRIMARILY USED TO JOIN SHEET
METAL STOCK, BUT IS SOMETIMES USED TO JOIN THIN
PLATE. ALL METALS WHICH CAN BE FUSION WELDED ARE
WELDABLE BY RESISTANCE WELDING.

SCENE 53.
tape 524, 11:26:47-11:27:35
zoom out, copper electrodes as
workpiece is secured, and then
welded
CG, SUPER: Electrodes Conduct
Welding Current To
The Work/Fix The
Current Density In
The Weld Zone
Electrodes Transmit
A Force To The
Workpieces
Electrodes Dissipate
Some Heat From The
Weld Zone
Electrodes Maintain
Relative Alignment
& position Of The
Workpieces

NARRATION (VO) :

RESISTANCE WELDING PROCESSES USE COPPER
ELECTRODES. THESE ELECTRODES PERFORM FOUR
FUNCTIONS:
THEY CONDUCT THE WELDING CURRENT TO THE WORK, AND
IN SOME CASES, FIX THE CURRENT DENSITY IN THE WELD
ZONE,
THEY TRANSMIT A FORCE TO THE WORKPIECES,
THEY DISSIPATE SOME HEAT FROM THE WELD ZONE,
AND THEY MAINTAIN RELATIVE ALIGNMENT AND POSITION
OF THE WORKPIECES IN SOME RESISTANCE WELDING
OPERATIONS.

SCENE 54.
tape 533, 17:01:03-17:01:18
c.u. seam welding operation

NARRATION (VO) :

VERY HIGH ELECTRIC CURRENTS ARE USED TO QUICKLY

PRODUCE THE RESISTANCE HEAT NECESSARY FOR FUSION.

SCENE 55.

continue previous shot
tape 520, 07:01:00-07:02:00
blue background
CG: Resistance Welding
Spot Welding
Projection Welding
Seam Welding

NARRATION (VO) :

THE THREE PRINCIPAL TYPES OF RESISTANCE WELDING
ARE:
SPOT WELDING,
SEAM WELDING,
AND PROJECTION WELDING.

SCENE 56.

CG, SUPER: Spot Welding
tape 524, 11:17:59-11:18:15
c.u. spot welding operation,
multiple welds performed
tape 532, 01:03:58-01:04:13
robotic spot welding of
automotive component

NARRATION (VO) :

SPOT WELDING REFERS TO MAKING WELDS ONE AT A TIME
BETWEEN THE ELECTRODES. ONE, SEVERAL OR MANY
INDIVIDUAL SPOT WELDS MAY BE REQUIRED, DEPENDING
ON THE APPLICATION. SPOT WELDING, WITH THE
ELECTRODES MANEUVERED BY ARTICULATED-ARM ROBOTS,
IS COMMONLY USED TO JOIN SHEET COMPONENTS OF
AUTOMOBILES.

SCENE 57.

CG, SUPER: Seam Welding
tape 533, 17:05:41-17:05:59
seam welding operation, forming
leak proof weld

NARRATION (VO) :

IN SEAM WELDING, COORDINATED PULSES OF ELECTRIC
CURRENT FROM ROTATING WHEEL ELECTRODES PRODUCE A
SERIES OF OVERLAPPING SPOT WELDS, RESULTING IN A
LEAK-TIGHT WELDED JOINT.

SCENE 58.

CG, SUPER: Projection Welding
tape 524, 11:06:38-11:06:48
c.u. projection welding
operation
tape 518, 03:25:09-03:25:14
projections on workpiece,
multiple welds performed

NARRATION (VO) :

IN PROJECTION WELDING, THE WELDS ARE LOCALIZED AT
PREDETERMINED POINTS BY PROJECTIONS, EMBOSSEMENTS,
OR INTERSECTIONS. SEVERAL POINTS MAY BE WELDED
SIMULTANEOUSLY.

SCENE 59.

tape 524, 11:25:03-11:25:10
wide, semiautomatic resistance
welding operation

NARRATION (VO) :

ALL RESISTANCE WELDING METHODS USE EITHER

tape 532, 01:00:34-01:00:39
wide, automated resistance
welding operation

SEMIAUTOMATIC...,
OR AUTOMATIC SYSTEMS.

SCENE 60.

tape 524, 11:19:13-11:19:23
semiautomatic resistance welding
operation, operator positioning
workpiece

tape 519, 05:07:03-05:07:09
wide, semiautomatic resistance
welding operation, operator
positioning portable welding
gun, starting welding sequence

tape 519, 05:02:06-05:02:12
c.u. same semiautomatic
resistance welding operation,
operator positioning portable
welding gun, starting welding
sequence

NARRATION (VO) :

WITH SEMIAUTOMATIC MACHINES, THE OPERATOR EITHER
POSITIONS THE WORKPIECES BETWEEN THE
ELECTRODES...,
OR POSITIONS A PORTABLE WELDING GUN AROUND THEM
AND PUSHES A SWITCH TO INITIATE THE WELD. WELDING
THEN PROCEEDS ACCORDING TO A PREPROGRAMMED
SEQUENCE.

SCENE 61.

tape 533, 17:07:38-17:07:59
zoom in, automated resistance
welding operation

NARRATION (VO) :

AUTOMATIC MACHINES FEED WORKPIECES INTO THE
MACHINE, WHERE THEY ARE WELDED AND THEN EJECTED
WITHOUT OPERATOR ASSISTANCE.

SCENE 62.

continue previous shot
tape 524, 11:09:57-11:10:35
wide, resistance welding system,
zoom into welding

CG, SUPER: Control Panel
Welding Machine With
A Rigid Frame
Low-Voltage/High-
Current Transformer
Electrodes
Leads Connecting
Electrodes With The
Welding Transformer
Controls To Regulate
Electric Current
Pneumatic Cylinder/
Other Means Of
Exerting Force To
The Upper Electrode
Arm

NARRATION (VO) :

THE TYPICAL RESISTANCE WELDING SYSTEM CONSISTS OF:
A CONTROL PANEL, A WELDING MACHINE WITH A RIGID
FRAME, A LOW-VOLTAGE, HIGH-CURRENT WELDING
TRANSFORMER, ELECTRODES, LEADS CONNECTING THE
ELECTRODES WITH THE WELDING TRANSFORMER, CONTROLS
TO REGULATE ELECTRIC CURRENT, AND A PNEUMATIC
CYLINDER OR OTHER MEANS OF EXERTING FORCE TO THE
UPPER ELECTRODE ARM.

--- TOUCH BLACK ---

SCENE 63.

CG, SUPER: Laser Beam Welding
tape 516, 01:04:24-01:05:10
zoom out, gas laser beam welding

NARRATION (VO) :

IN LASER BEAM WELDING, THE HEAT FOR COALESCENCE IS

operation

GENERATED BY A FOCUSED BEAM FROM A GAS OR SOLID-
STATE LASER.

SCENE 64.

continue previous shot
CG, SUPER: CO₂ Laser
tape 521, 08:23:59-08:24:19
zoom in, solid-state laser
welding operation
CG, SUPER: YAG Laser

NARRATION (VO) :

THE MOST COMMONLY USED GAS LASER IS THE CARBON-
DIOXIDE, OR "CO₂" LASER, WHICH IS ACTUALLY A
MIXTURE OF CARBON DIOXIDE, NITROGEN AND HELIUM
GASES. THE MOST COMMONLY USED SOLID-STATE LASER IS
THE NEODYMIUM-DOPED YTTRIUM-ALUMINUM GARNET, OR
"YAG" LASER.

SCENE 65.

tape 522, 09:14:47-09:15:09
gas laser beam welding operation
tape 521, 08:28:19-08:28:35
c.u. solid-state laser welding
operation

NARRATION (VO) :

"CO₂" LASERS CAN GENERATE GREATER CONTINUOUS BEAM
POWER, AND ARE SUITABLE FOR WELDING THIN OR THICK
WORKPIECES. "YAG" LASERS GENERATE LESS CONTINUOUS
BEAM POWER, AND ARE GENERALLY USED TO WELD THIN
WORKPIECES.

SCENE 66.

tape 516, 01:10:00-01:10:20
laser welding operation using
gas shielding

NARRATION (VO) :

MOST LASER WELDS REQUIRE NO FILLER METAL, ALTHOUGH
FILLER METALS CAN BE USED IF DESIRED. INERT
SHIELDING GASES ARE NORMALLY EMPLOYED, USUALLY
ARGON, HELIUM OR A MIXTURE OF THE TWO.

SCENE 67.

tape 522, 09:01:19-09:01:56
zoom in, rapid laser welding
operation

NARRATION (VO) :

WELDING SPEEDS ARE USUALLY MUCH HIGHER THAN OTHER
WELDING PROCESSES, THUS LIMITING HEAT-AFFECTED
ZONE SIZE AND WORKPIECE DISTORTION. IN ADDITION,
BECAUSE OF THE INTENSE, PRECISELY FOCUSED HEAT,
WELDS CAN BE QUITE DEEP. ALSO, WELDS CAN BE MADE
IN CONFINED REGIONS AND BETWEEN DISSIMILAR METALS.

SCENE 68.

tape 516, 01:11:13-01:11:23

laser beam welding operation

tape 516, 01:21:35-01:21:57

pan, automated laser beam
welding system

CG, SUPER: Laser

Power Supply

Beam-Delivery System

Workstation

Motion Control System

NARRATION (VO) :

LASER BEAM WELDING SYSTEMS ARE USED IN MANY

INDUSTRIES, AND ARE TYPICALLY FULLY AUTOMATED AND

COMPUTER-CONTROLLED. TYPICAL EQUIPMENT INCLUDES

THE LASER AND ITS POWER SUPPLY, A BEAM-DELIVERY

SYSTEM WITH MIRRORS AND FOCUSING OPTICS, A

WORKSTATION, AND A MOTION CONTROL SYSTEM TO MOVE

EITHER THE LASER BEAM OR THE WORKPIECE.

SCENE 69.

tape 522, 09:06:41-09:07:19

c.u. laser welding operation

CG, SUPER: Carbon Steels

Alloy Steels

Stainless Steels

Aluminum Alloys

Copper Alloys

Magnesium Alloys

Nickel Alloys

Titanium Alloys

Refractory Metals

NARRATION (VO) :

MANY FERROUS AND NONFERROUS METALS CAN BE JOINED

USING LASER BEAM WELDING, INCLUDING CARBON, ALLOY

AND STAINLESS STEELS, ALUMINUM ALLOYS, COPPER

ALLOYS, MAGNESIUM ALLOYS, NICKEL ALLOYS, TITANIUM

ALLOYS AND REFRACTORY METALS.

--- TOUCH BLACK ---

SCENE 70.

CG, SUPER: Electron Beam Welding

tape 522, 09:23:32-09:23:48

c.u. electron beam welding
operation

NARRATION (VO) :

IN ELECTRON BEAM WELDING, THE COALESCENCE HEAT IS

GENERATED BY THE KINETIC ENERGY OF A FOCUSED

STREAM OF ELECTRONS DIRECTED UPON THE JOINT.

SCENE 71.

tape 522, 09:22:24-09:22:50

pan down of electron beam system

NARRATION (VO) :

THE ELECTRONS ARE PRODUCED BY AN ELECTRON GUN,

ACCELERATED TO HIGH VELOCITY, SHAPED INTO A BEAM

BY ELECTRICAL FIELDS, AND THEN FURTHER COLLIMATED,

OR MADE PARALLEL, AND FOCUSED BY AN

ELECTROMAGNETIC LENS.

SCENE 72.

continue previous shot

tape 523, 10:23:58-10:24:15

NARRATION (VO) :

zoom in, electron beam welding operation

THIS ELECTRON STREAM IS DEVELOPED IN HIGH VACUUM, BUT ACTUAL WELDING CAN BE PERFORMED IN EITHER HIGH VACUUM, PARTIAL VACUUM OR STANDARD ATMOSPHERIC PRESSURE.

SCENE 73.
continue previous shot
tape 520, 07:02:40-07:02:50
GRAPHIC: thick part welded with electron beam, add arrow
tape 523, 10:05:52-10:06:00
electron beam welding operation, part with inaccessible joint

NARRATION (VO) :
BECAUSE OF THE INTENSE AND CONCENTRATED HEAT GENERATED, TOTAL HEAT INPUT IS LOW, MINIMIZING HEAT-AFFECTED ZONE SIZE AND PART DISTORTION. THIS ALSO ALLOWS FOR THE CREATION OF EXTREMELY DEEP AND NARROW WELDS. ADDITIONALLY, JOINTS INACCESSIBLE BY OTHER WELDING PROCESSES CAN BE WELDED.

SCENE 74.
tape 523, 10:07:44-10:08:00
electron beam welding operation

NARRATION (VO) :
VIRTUALLY ALL FERROUS AND NONFERROUS METALS, THIN OR THICK, CAN BE JOINED. WELDING SPEEDS ARE FAST, AND FILLER METAL IS NOT GENERALLY REQUIRED.

SCENE 75.
tape 523, 10:17:33-10:17:45
wide, electron beam welding operation
tape 523, 10:10:45-10:10:55
c.u. joint being welded

NARRATION (VO) :
EQUIPMENT COST FOR ELECTRON BEAM WELDING IS TYPICALLY HIGH AND WELDING IS GENERALLY LIMITED TO MACHINED PARTS ASSEMBLED IN PRIMARILY BUTT, CORNER AND LAP JOINTS.

--- FADE TO BLACK ---

SCENE 76.
CG: Solid-State Welding Processes
white text centered on black

SCENE 77.
tape 521, 08:01:44-08:01:57
friction welding operation with pressure

NARRATION (VO) :
IN SOLID-STATE WELDING, COALESCENCE IS CREATED AT TEMPERATURES LESS THAN THE MELTING TEMPERATURE OF

THE BASE METALS WITH PRESSURE.

SCENE 78.

tape 527, 03:41:45-03:41:52
ultrasonic welding operation
tape 520, 07:01:00-07:02:00
blue background
CG: Solid-State Welding
Processes
Friction Welding
Ultrasonic Welding

NARRATION (VO) :

THE TWO MOST USED SOLID-STATE WELDING PROCESSES
ARE:
FRICTION WELDING,
AND ULTRASONIC WELDING.

--- TOUCH BLACK ---

SCENE 79.

CG, SUPER: Friction Welding
tape 521, 08:06:21-08:06:35
c.u. friction welding operation

NARRATION (VO) :

FRICTION WELDING IS AN EXTREMELY RAPID METHOD OF
WELDING WORKPIECES, TYPICALLY IN BUTT JOINTS, BY
FRICTIONAL HEAT AND AXIAL FORCE.

SCENE 80.

tape 521, 08:11:26-08:11:47
zoom in, friction welding
operation
tape 521, 08:02:11-08:02:21
c.u. friction welding operation

NARRATION (VO) :

FRICTIONAL HEAT IS GENERATED BY RAPIDLY ROTATING A
WORKPIECE AGAINST A STATIONARY WORKPIECE, UNTIL
THE INTERFACING, OR FAYING SURFACES REACH THE
PROPER TEMPERATURE. THE WELD IS COMPLETED BY AN
UPSETTING OPERATION WHICH CONSISTS OF THE RAPID
APPLICATION OF ADDITIONAL AXIAL FORCE AS, OR JUST
AFTER THE ROTATION STOPS. THIS UPSETTING OPERATION
FORCES HOT METAL, OXIDES AND IMPURITIES OUT OF THE
JOINT.

SCENE 81.

tape 521, 08:08:01-08:08:38
zoom in to workpiece, friction
welding operation
CG, SUPER: Bar To Bar
Bar To Tube
Tube To Tube
Bar/Tube To
Plate/Disk
continue previous image
CG, SUPER: Most Metals/Alloys
Some Metal Matrix

NARRATION (VO) :

IN GENERAL, ONE WORKPIECE MUST HAVE AN AXIS OF
SYMMETRY AND BE CAPABLE OF BEING ROTATED ABOUT
THAT AXIS. WORKPIECES ARE USUALLY EITHER IN BUTT
OR T- JOINTS WITH THE PIECES BEING BAR TO BAR, BAR
TO TUBE, TUBE TO TUBE AND BAR OR TUBE TO PLATE OR

Composites
Ceramics
Plastics

DISK. ADDITIONALLY, FRICTION WELDING CAN BE USED TO JOIN A WIDE RANGE OF SIMILAR AND DISSIMILAR MATERIALS, INCLUDING MOST METALS AND ALLOYS, SOME METAL MATRIX COMPOSITES, CERAMICS, AND PLASTICS.

--- TOUCH BLACK ---

SCENE 82.
CG, SUPER: Ultrasonic Welding
tape 527, 03:46:12-03:46:25
zoom out, ultrasonic welding,
thin workpiece being welded
tape 527, 03:37:51:00
still of interatomic bond
tape 527, 03:32:08-03:32:12
ultrasonic welding operation

NARRATION (VO) :

ULTRASONIC WELDING IS A METHOD OF PRODUCING LAP JOINTS BY HIGH-FREQUENCY VIBRATORY ENERGY AND MODERATE FORCE. THIS INDUCES INTERATOMIC ATTRACTION AND METALLURGICAL BONDING AT THE WELD INTERFACE SURFACES WITH RELATIVELY LITTLE HEAT.

SCENE 83.
tape 527, 03:37:26-03:37:38
animation of ultrasonic process,
loop

NARRATION (VO) :

THE WORKPIECES ARE CLAMPED BETWEEN TWO WELDING TIPS, CALLED SONOTRODES, OR JAWS. VIBRATORY ENERGY IS CONDUCTED THROUGH ONE OR BOTH TIPS, WHICH OSCILLATE Laterally AS A PERPENDICULAR FORCE ENSURES CONTACT OF THE WORKPIECES.

SCENE 84.
continue previous shot
tape 527, 03:48:12-03:48:24
three shots, ultrasonic welding
operation

NARRATION (VO) :

THE OSCILLATING ACTION DISRUPTS THE INTERFACE SURFACE FILMS AND PERMITS METAL-TO-METAL CONTACT. THIS CREATES PLASTIC DEFORMATION AT THE INTERFACE, RESULTING IN A SOLID METALLURGICAL BOND. UNDER PROPER CONDITIONS INTERFACE TEMPERATURES REACH ONLY 35 TO 50 PERCENT OF THE WORKPIECE MELTING TEMPERATURE.

SCENE 85.
tape 527, 03:45:19-03:45:46
four shots, ultrasonic welding
operation, grey image back, loop

NARRATION (VO) :

BASIC EQUIPMENT INCLUDES A ELECTRIC POWER SUPPLY,

last shot if necessary
 CG, SUPER: Electric Power Supply
 Frequency Converter
 To Increase
 Frequency, Generally
 To 15,000 To 75,000
 Hertz
 One Or More
 Transducers To
 Convert Power Into
 Acoustical Power Of
 Same Frequency
 Coupling System To
 Transmit Acoustical
 Power To Welding Tip
 & Into Workpieces
 Workpiece Support
 System
 Force Application
 System

A FREQUENCY CONVERTER TO INCREASE LINE FREQUENCY
 TO GENERALLY 15,000 TO 75,000 HERTZ, ONE OR MORE
 TRANSDUCERS TO CONVERT THAT POWER INTO ACOUSTICAL
 POWER OF THE SAME FREQUENCY, A COUPLING SYSTEM TO
 TRANSMIT THE ACOUSTICAL POWER TO THE WELDING TIP
 AND INTO THE WORKPIECES, A WORKPIECE SUPPORT
 SYSTEM, AND A FORCE APPLICATION SYSTEM.

SCENE 86.

tape 527, 03:34:19-03:34:26
 two shots, ultrasonic welding
tape 527, 03:46:12-03:46:25
 flip image, zoom out, ultrasonic
 welding, thin workpiece being
 welded

NARRATION (VO) :

ULTRASONIC WELDING TYPICALLY REQUIRES AT LEAST ONE
 OF THE WORKPIECES TO BE THIN. THE USUAL WELDS ARE
 SPOT WELDS AND STRAIGHT OR CIRCULAR SEAM WELDS.
 WORKPIECE DISTORTION IS LIMITED.

SCENE 87.

tape 527, 03:47:21-03:47:28
 zoom out, ultrasonic welding of
 dissimilar
tape 527, 03:46:57-03:47:12
 three shots, ultrasonic welding
 of dissimilar

NARRATION (VO) :

DUCTILE METALS, IN SIMILAR OR DISSIMILAR
 COMBINATIONS, ARE IDEAL WORKPIECES, ALTHOUGH HARD
 METALS ALSO CAN BE WELDED. FILLER METALS ARE NOT
 NORMALLY REQUIRED, ALTHOUGH THEY CAN ASSIST IN
 JOINING DIFFICULT TO WELD DISSIMILAR METALS.

SCENE 88.

tape 527, 03:37:55-03:38:00
 wires being ultrasonically
 welded
tape 527, 03:33:34-03:33:46
 pan of ultrasonically welded
 parts

NARRATION (VO) :

THE ELECTRICAL AND ELECTRONICS INDUSTRIES ARE THE
 PRINCIPAL USERS OF ULTRASONIC WELDING. LIMITED
 APPLICATIONS ARE ALSO FOUND IN THE AUTOMOBILE,
 NUCLEAR AND AEROSPACE INDUSTRIES.

SCENE 89.

CG: Review

white text on black

tape 63, 12:00:15-12:03:49

review music

MUSIC UP AND UNDER

NARRATION (VO):

LET'S REVIEW THE MATERIAL CONTAINED IN THIS
VIDEOTAPE.

SCENE 90.

tape 529, 15:15:51-15:16:05

fusion welding operation

NARRATION (VO):

WELDING IS A COMMON METHOD OF JOINING METALS, AND
INCLUDES A WIDE VARIETY OF PROCESSES.

SCENE 91.

tape 521, 08:03:49-08:04:15

zoom in, friction welding
operation

tape 518, 03:00:59-03:01:03

fusion welding operation

tape 528, 14:25:30-14:25:35

fusion welding operation

tape 533, 17:09:20-17:09:24

resistance welding

tape 522, 09:06:50-09:07:03

fusion welding operation

tape 520, 07:01:00-07:02:00

blue background

CG: Fusion Welding

Solid-State Welding

NARRATION (VO):

THESE WELDING PROCESSES JOIN METALS TOGETHER BY
EITHER FUSION WELDING,
OR SOLID-STATE WELDING.

SCENE 92.

tape 528, 14:18:33-14:18:52

flux-core arc welding operation
using filler metal

NARRATION (VO):

IN FUSION WELDING, METAL COALESCENCE IS CREATED BY
MELTING A BASE METAL AND FILLER METAL TOGETHER, OR
BY MELTING THE BASE METAL ALONE.

SCENE 93.

tape 519, 05:10:22-05:10:34

arc welding operation

CG, SUPER: Arc Welding

tape 533, 17:03:50-17:04:09

zoom out, resistance welding
operation

CG, SUPER: Resistance Welding

tape 516, 01:04:24-01:05:10

zoom out, gas laser beam welding
operation

CG, SUPER: Laser Beam Welding

tape 522, 09:23:32-09:23:48

c.u. electron beam welding
operation

NARRATION (VO):

THE PRINCIPAL FUSION WELDING PROCESSES ARE:
ARC WELDING...,
RESISTANCE WELDING...,
LASER BEAM WELDING...,
AND ELECTRON BEAM WELDING.

CG, SUPER: Electron Beam Welding

SCENE 94.

tape 525, 12:07:32-12:07:52

arc welding operation

CG, SUPER: Arc Welding

NARRATION (VO) :

ARC WELDING PROCESSES USE AN ELECTRIC ARC AS THE HEAT SOURCE TO MELT AND JOIN THE BASE METALS. THE ARC IS STRUCK BETWEEN THE WORKPIECES AND THE TIP OF AN ELECTRODE.

SCENE 95.

continue previous shot

CG, SUPER: Shielded Metal Arc
Welding

tape 529, 15:23:45-15:23:53

shielded metal arc welding
operation

CG, SUPER: Submerged Arc Welding

tape 528, 14:08:14-14:08:34

submerged arc welding operation

CG, SUPER: Gas Metal Arc Welding

tape 520, 06:02:03-06:02:1-

gas metal arc welding operation

CG, SUPER: Flux-Cored Arc
Welding

tape 528, 14:22:48-14:23:00

flux core welding

CG, SUPER: Gas Tungsten Arc
Welding

tape 529, 15:17:21-15:17:50

zoom out, gas tungsten arc
welding operation

CG, SUPER: Plasma Arc Welding

tape 526, 13:19:11-13:19:26

zoom out, plasma arc welding
operation

NARRATION (VO) :

ARC WELDING ENCOMPASSES A VARIETY OF PROCESSES,

INCLUDING:

SHIELDED METAL ARC WELDING...,

SUBMERGED ARC WELDING...,

GAS METAL ARC WELDING...,

FLUX-CORED ARC WELDING...,

GAS TUNGSTEN ARC WELDING...,

AND PLASMA ARC WELDING.

SCENE 96.

CG, SUPER: Resistance Welding

tape 524, 11:20:02-11:20:21

resistance welding operation of
sheet metal stock

NARRATION (VO) :

RESISTANCE WELDING PROCESSES PRODUCE COALESCENCE OF OVERLAPPING WORKPIECES WITH HEAT GENERATED BY THE RESISTANCE OF THE WORKPIECES TO THE FLOW OF ELECTRIC WELDING CURRENT, AND THE APPLICATION OF PRESSURE.

SCENE 97.

continue previous shot

NARRATION (VO) :

tape 524, 11:26:48-11:26:52

c.u. spot welding operation,
multiple welds performed

CG, SUPER: Spot Welding

CG, SUPER: Seam Welding

tape 533, 17:05:41-17:05:59

seam welding operation, forming
leak proof weld

CG, SUPER: Projection Welding

tape 518, 03:25:09-03:25:14

projections on workpiece,
multiple welds performed

THE THREE PRINCIPAL TYPES OF RESISTANCE WELDING

ARE:

SPOT WELDING...,

SEAM WELDING...,

AND PROJECTION WELDING.

SCENE 98.

tape 521, 08:01:44-08:01:57

solid-state welding operation
with pressure

NARRATION (VO):

IN SOLID-STATE WELDING, COALESCENCE IS CREATED AT

TEMPERATURES LESS THAN THE MELTING TEMPERATURE OF

THE BASE METALS WITH PRESSURE.

SCENE 99.

tape 527, 03:41:45-03:41:52

ultrasonic welding operation

CG, SUPER: Friction Welding

tape 521, 08:06:21-08:06:35

c.u. friction welding operation

CG, SUPER: Ultrasonic Welding

tape 527, 03:46:12-03:46:25

zoom out, ultrasonic welding,
thin workpiece being welded

NARRATION (VO):

THE TWO MOST USED SOLID-STATE WELDING PROCESSES

ARE:

FRICTION WELDING...,

AND ULTRASONIC WELDING.

--- FADE TO BLACK ---

SCENE 100.

CG, ROLL: credits

white text on black, fade up

mid-screen

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--- TOUCH BLACK ---

SCENE 101.
CG: 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.

--- TOUCH BLACK ---

SCENE 102.

tape 40, 01:00:00-01:00:12

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