

FUNDAMENTAL MANUFACTURING PROCESSES

Heat Treating

SCENE 1.

CG: Surface Hardening Processes
white text centered on black

SCENE 2.

tape 503, 15:09:41-15:09:46

pan c.u. of crankshaft

tape 502, 14:15:09-14:15:13

gears

tape 485, 11:22:30-11:22:44

zoom in to bearing loading into
furnace

NARRATION (VO) :

PARTS SUCH AS CRANKSHAFTS...,

GEARS...,

AND BEARINGS NEED TO BE HARDENED TO WITHSTAND

THOUSANDS OF HOURS OF USE WHILE BEING TOUGH ENOUGH

TO RESIST THE SUDDEN SHOCKS OF SPEED AND POWER

CHANGES.

SCENE 3.

tape 499, 08:04:01-08:04:13

pan from unprocessed part to
case hardened part

NARRATION (VO) :

THESE REQUIREMENTS ARE MET USING CASE HARDENING

PROCESSES WHICH PROVIDE A HARD, WEAR-RESISTANT

SURFACE, OR CASE, OVER A TOUGH, SHOCK-RESISTANT

INTERIOR.

SCENE 4.

tape 507, 21:14:10-21:14:29

flame hardening operation

CG, SUPER: Case Hardening

Methods

Differential Heat

Treating

Differential Metal

Structure

NARRATION (VO) :

THERE ARE TWO METHODS OF CASE HARDENING:

DIFFERENTIAL HEAT TREATING,

AND DIFFERENTIAL METAL STRUCTURE.

SCENE 5.

continue previous shot

CG, SUPER: Differential Heat
Treating

tape 504, 16:05:13-16:05:31

induction heating operation

NARRATION (VO) :

DIFFERENTIAL HEAT TREATING BRINGS ONLY THE SURFACE

OF A STEEL PART RAPIDLY UP TO ITS AUSTENITIZING

TEMPERATURE WHILE KEEPING THE INTERIOR WELL BELOW

THAT POINT. AS SOON AS THE SURFACE REACHES

TEMPERATURE, OFTEN WITHIN A FEW SECONDS, THE PART IS QUENCHED.

SCENE 6.

continue previous shot
tape 514, 00:00:50:00
freeze frame, blue background
CG: Differential Heat Treating Processes
Flame Hardening
Induction Hardening

NARRATION (VO) :

THE TWO PRIMARY TYPES OF DIFFERENTIAL HEAT TREATING ARE:
FLAME HARDENING,
AND INDUCTION HARDENING.

SCENE 7.

CG, SUPER: Flame Hardening
tape 507, 21:18:17-21:18:36
zoom out, flame hardening operation

NARRATION (VO) :

FLAME HARDENING USES AN OXYGEN-GAS TORCH OR TORCHES TO BRING THE PART SURFACE QUICKLY TO THE AUSTENITIZING TEMPERATURE. ONCE THAT TEMPERATURE IS REACHED, THE PART IS QUENCHED.

SCENE 8.

CG, SUPER: Induction Hardening
tape 498, 07:18:28-07:19:00
induction heating operation

NARRATION (VO) :

INDUCTION HARDENING PRODUCES THE SAME RESULTS ELECTRICALLY USING INDUCTION COILS. THESE COILS DEVELOP A STRONG MAGNETIC FIELD AROUND THE PART, CAUSING ELECTRIC CURRENT TO FLOW THROUGH IT. BECAUSE OF THE ELECTRICAL RESISTANCE OF STEEL, THE INDUCED CURRENT FLOW HEATS THE PART. ONCE UP TO TEMPERATURE THE PART IS QUENCHED.

--- TOUCH BLACK ---

SCENE 9.

CG, SUPER: Differential Metal Structure
tape 514, 00:27:54-00:27:57
ANI: part in furnace
tape 514, 00:28:01-00:28:11
ANI: cutaway of part in furnace
tape 514, 00:28:16-00:28:27
ANI: surface of cutaway highlights in furnace
tape 514, 00:28:30-00:28:40
GRAPHIC: cutaway cooled down,

NARRATION (VO) :

DIFFERENTIAL METAL STRUCTURE SURFACE HARDENING PROCESSES ALTER THE CHEMICAL COMPOSITION OF THE WORKPIECE SURFACE, BUT NOT ITS INTERIOR. THE ENTIRE WORKPIECE CAN THEN BE SUBJECTED TO THE SAME HEAT TREATING CYCLE. THE SURFACE RESPONDS MORE TO

surface altered

HEAT TREATING, BECOMING HARDER THAN THE INTERIOR.

SCENE 10.

tape 485, 11:24:18-11:24:26

bearings falling out other side
of furnace

tape 514, 00:00:50:00

freeze frame, blue background

CG: Differential Metal Structure

Processes

Carburizing

Nitriding

Carbonitriding

NARRATION (VO) :

DIFFERENTIAL METAL STRUCTURE PROCESSES INCLUDE:

CARBURIZING,

NITRIDING,

AND CARBONITRIDING.

SCENE 11.

CG, SUPER: Carburizing

tape 499, 09:06:30-09:06:52

carburizing operation, parts
loaded in

tape 499, 09:07:18-09:07:27

door closing

NARRATION (VO) :

IN CARBURIZING, THE WORKPIECE IS PLACED IN A

CARBON-RICH GAS, LIQUID OR SOLID AND THEN HEATED

TO A TEMPERATURE AT LEAST 100°F HIGHER THAN ITS

UPPER TRANSFORMATION TEMPERATURE. CARBON IS

ABSORBED FROM THE CARBON-RICH SOURCE INTO THE

STEEL AND SLOWLY DIFFUSES INTO THE SURFACE LAYERS.

SCENE 12.

continue previous shot

NARRATION (VO) :

CARBURIZING BUILDS HIGH CARBON CONCENTRATIONS

CLOSE TO THE SURFACE OF LOW CARBON STEELS.

SCENE 13.

tape 499, 09:03:43-09:03:58

carburized load is quenched
within unit

tape 508, 23:03:36-23:03:46

zoom in, cutaway, casing and
tough interior of bearing

NARRATION (VO) :

BECAUSE THE STEEL IS AUSTENITIZED WHILE IT'S BEING

CARBURIZED, IT'S USUALLY QUENCHED DIRECTLY OUT OF

THE CARBURIZING FURNACE IN A TANK CONTAINED IN THE

HEAT TREATING UNIT. ONCE TEMPERED, WORKPIECES

EXHIBIT A HARD, STRONG, HIGH CARBON STEEL CASE

OVER A TOUGHER, MORE DUCTILE, LOWER CARBON

INTERIOR.

SCENE 14.

CG, SUPER: Nitriding

tape 507, 20:02:16-20:02:35

nitriding operation

NARRATION (VO) :

NITRIDING DIFFUSES NITROGEN INSTEAD OF CARBON INTO

THE SURFACE OF STEEL. THIS FORMS EXTREMELY HARD ALLOYS CALLED NITRIDES.

SCENE 15.

tape 508, 23:18:10-23:18:20

GRAPHIC: cutaway of nitrided part

tape 508, 23:18:40-23:18:50

GRAPHIC: cutaway of nitrided part, arrow appears showing case depth

tape 507, 20:06:20-20:06:29

nitriding operation

NARRATION (VO) :

ALTHOUGH ITS CASE DEPTH IS MUCH SHALLOWER, NITRIDING CAN BE DONE AT LOWER TEMPERATURES THAN CARBURIZING. THIS REDUCES DIMENSIONAL GROWTH AND DISTORTION.

SCENE 16.

tape 507, 20:05:25-20:05:41

zoom out parts in nitriding operation

NARRATION (VO) :

THE STEEL SURFACE REMAINS BRIGHT AND SCALE-FREE, MAKING NITRIDING IDEAL FOR SURFACE HARDENING OF TOOLS, DIES, CYLINDER LININGS AND OTHER FINISH-MACHINED OR GROUND PARTS.

SCENE 17.

CG, SUPER: Carbonitriding

tape 495, 02:06:21-02:06:45

parts going into carbonitriding operation

tape 495, 02:22:52-02:23:15

coming out of carbonitriding operation

NARRATION (VO) :

CARBONITRIDING IS A COMBINATION OF CARBURIZING AND NITRIDING. THE PROCESS IS SIMILAR TO CARBURIZING, BUT NITROGEN IS ADDED TO THE CARBURIZING GAS, PRODUCING A CASE HARDER THAN CARBURIZING ALONE. CARBONITRIDING CAN IMPROVE PRODUCTIVITY BY PRODUCING A CASE OF A GIVEN HARDNESS WITH A SHORTER FURNACE CYCLE.

--- FADE TO BLACK ---