CONNECTICUT STATE DEPARTMENT OF EDUCATION

Division of Instruction

Hartford

SHOP THEORY FOR THE MACHINE TRADES

SUBJECT: Metallurgy of Iron and Steel

SESSION 4.

OBJECT: Methods of manufacturing - Shaping and Forming

REFERENCES: Johnson, Metallurgy. Palmer, Tool Steel Simplified.

METHOD: Reading lesson, followed by questions and discussion

I. Steel Ingot Preparation (Johnson, pp.139-42. Palmer, pp.27-33)

1. Imperfections in steel ingots are not removed by subsequent regular mill operations

2. Common imperfections
   a. Pipes, hollows in ingot caused by shrinkage
   b. Blow holes, caused by gas bubbles, either deep seated or on the surface of the ingot
   c. Dendritic structure, abnormal crystallization near the surface of the ingot that results in long radial crystals (dendritic means "finger like") that weaken the steel
   d. Segregation, separation of different constituents of the steel in the ingot, caused by differential cooling
   e. Slag inclusions
   f. Surface checks, cracks, and scabs
   g. Internal stresses

3. Methods of controlling and removing imperfections in ingots
   a. Pipes are partially controlled by use of "hot tops" and removed by cutting off the top portion of the ingot (cropping)
   b. Blow holes are controlled by deoxidizing the steel before casting and surface blow holes are removed by chipping, grinding, or rough turning
   c. Dendritic structure is removed by rough turning
   d. Segregation; cropping to remove pipes also removes most of the segregated structure

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e. Slag inclusions. Prevention is the only remedy

f. Surface checks, etc. Remove by grinding or rough turning

g. Internal stresses; removed by reheating and soaking

II. Hot Rolling (Johnson, pp.143-7)

1. Reduces thickness and increases length of ingot or billet by successive "passes" between rolls at a temperature above the annealing point

2. Effects on Product (Johnson, pp.149-51)
   a. Obtains the desired shape or size

   b. Improves mechanical properties
      refines grain
      distributes constituents better
      develops fibrous structure
      improves soundness

III. Forging (Johnson, pp.148-9)

1. A method of hot working by
   a. drop hammer

   b. hydraulic presses

2. Effects on product - same as II,2, above

IV. Extruding
1. Pressing through an opening

2. Steel is not extruded

V. Cold Rolling (Johnson, pp.151-2)

1. Rolled without pre-heating

2. Effects on product
   a. Finishes surfaces

   b. Insures accuracy of size

   c. Increases tensile strength

   d. Too much continued cold working produces brittleness, controlled by annealling between passes.

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VI. Pressing (Johnson, p.152)

1. Cold forming by means of punches and dies
   a. Bending
   b. Drawing
   c. Flanging
   d. Up-setting
   e. Punching
   f. Blanking
   g. Spinning

2. Effects on product
   a. Same, in general as V,2.
   b. Speeds up production

VII. Drawing (Johnson, pp.153-4)

1. Used to form wire, tubing, and bars
2. May be hot or cold drawing
3. Cross section reduced very little in one pass
4. Annealing between passes often necessary

VIII. Welding (Johnson, p.156)

1. Crystallizing of two metal surfaces into union
   a. Accomplished by heat, fusion, and pressure
   b. Surfaces must be chemically clean
   c. Dissimilar metals may be welded
   d. Method is comparatively new and has an extensive future

STUDENT ASSIGNMENT

I. Follow this outline carefully and read indicated references

II. Answer the questions for Session 4.

III. Discussion and grading of papers.

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Name of Student_____Date_____

Instructor_____Grade_____

Questions - Metallurgy of Iron and Steel
Session 4, Methods of Manufacturing, - Shaping and Forming

1. How is the forming of "Pipes" in steel ingots controlled?

2. What is the cause of segregation as applied to the constituents of steel ingots?

3. What are the main beneficial effects of hot rolling on the quality of steel?

4. Explain how extruding is done.

5. What bad effect can result from cold working?

6. What are the good effects that result from cold working?

7. What is meant by pickling?

8. What materials, other than steel, are used to make wire drawing dies?

9. Can two dissimilar metals be welded? What are the limitations?

10. What becomes of the oxides that form when fusion welding is done?