Design for X

MCHE 201 – Spring 2019

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Design for X

How can the design be improved with respect to *X*?

Phases of Design

1. Problem Understanding
2. Specification Development
3. Conceptual Design

} Think about *X* throughout the design process

4. Detail Design
5. Production Specification
6. Manufacture
7. Disposal

} Don’t wait until here to think about *X*

Design for Manu. and Assembly

- Formalized methods developed by Geoffrey Boothroyd & Peter Dewhurst

- Won National Medal of Technology

- http://www.dfma.com/

Design for Assembly

- Methods consists of a design review by:
  - Design and development personnel
  - Production personnel

- The technique imposes:
  - Discipline
  - Objectiveness

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Like so much of what we've discussed, one objective is to make formerly-implicit requirements explicit.

Examine Assembly Operations

- Storing
- Handling
  - Identifying
  - Picking-Up
  - Moving
- Positioning
  - Orientating
  - Aligning
- Joining
- Adjusting
- Securing
- Inspecting

DFA Goals

- Standardization of assembly operations
- Use of existing assembly equipment and tools
- Use of standard assembly tools

DFA Evaluation Process

- Are there “favorable” sequences?
  - Preassemble parts
  - Parallel assembly
- Can it be automated?
- Can errors be reduced?
- Can component damage be reduced?
- Can we avoid special training?
- How can we improve assembly safety?
- How can we better enforce ergonomic/human factors standards?

DFA – Questions to Ask

- Can some part of the process be eliminated?
  - By a better material choice
  - By combination of the part with another

- What is the cost to:
  - Deliver parts to the assembly location
  - Give correct orientation and position information?

- What is the actual assembly cost of the part?

DFA – Questions to Ask

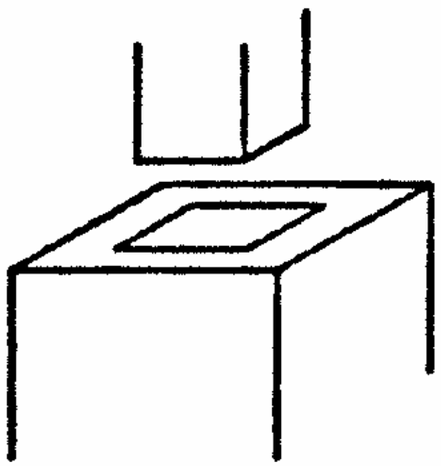
- During operation does the part move?
- If so, is the motion small enough such that an elastic hinge or similar can achieve that motion?
- Does the part need to be isolated or of different material than parts assembled before it?

Designing for Automated Assembly

- Layered Designs
- Self-alignment
- Combine detail parts
- Utilize symmetry
- Use common fasteners
- Minimize springs
- Minimize cables

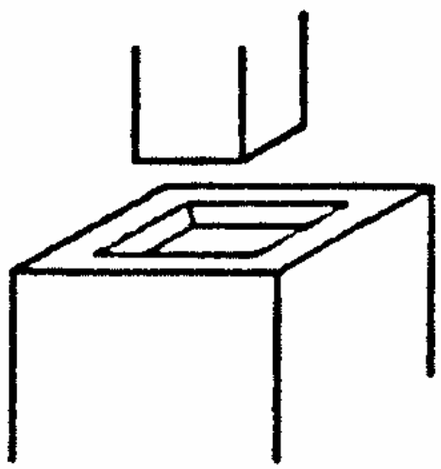
Self-Alignment

Avoid

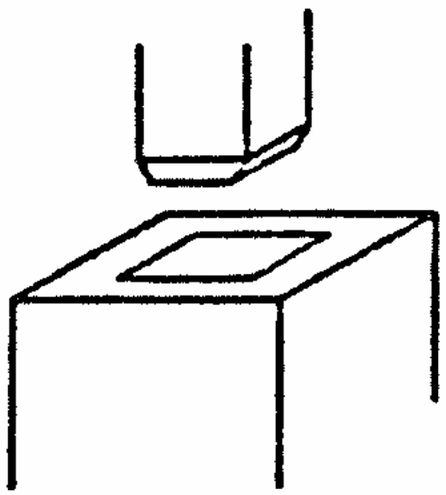


No Chamfers

Better

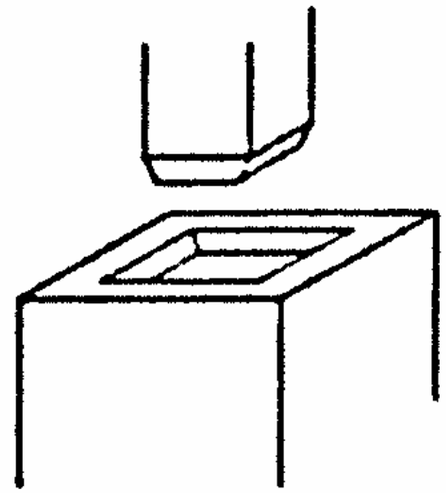


Bottom Part Chamfered



Top Part Chamfered

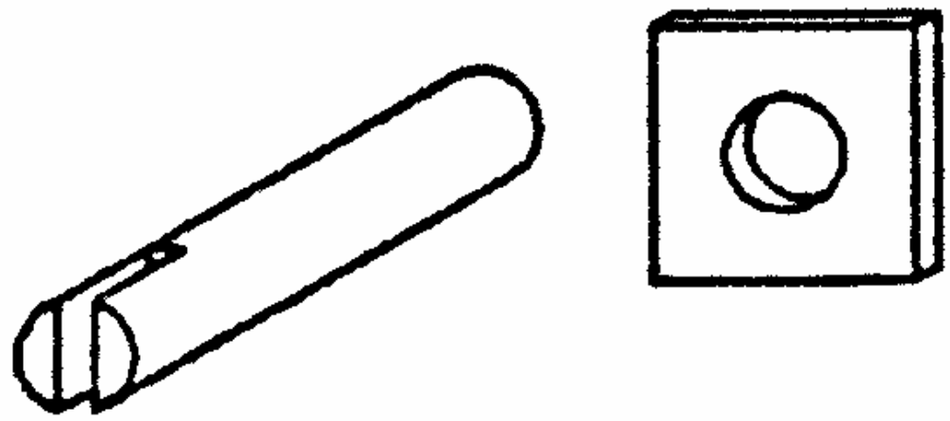
Best



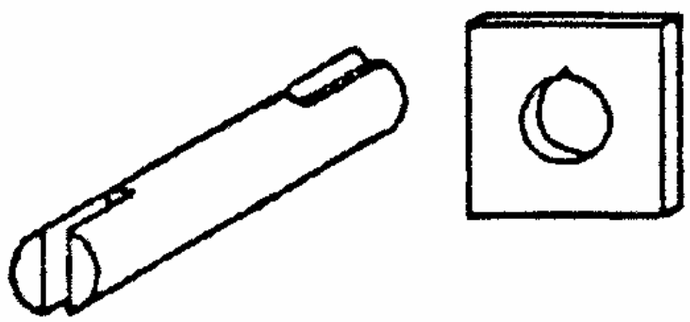
Both Parts Chamfered

Self-Alignment

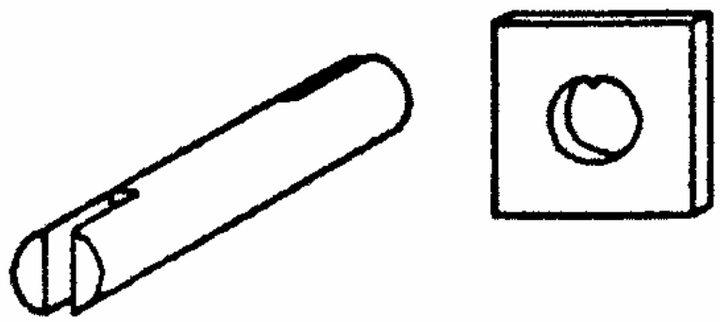
This part could be oriented in any direction



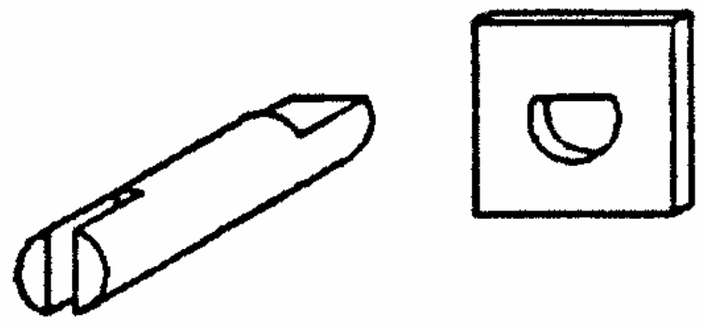
These parts can be oriented only one way



Hole to accept swaged part

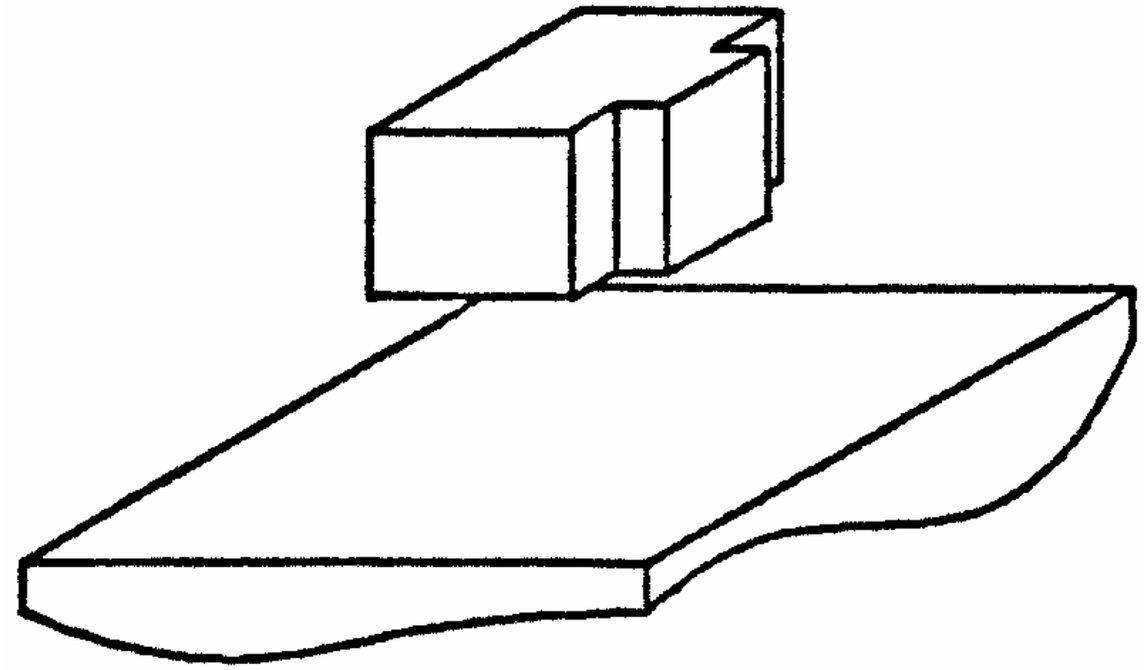


Hole to accept notched part

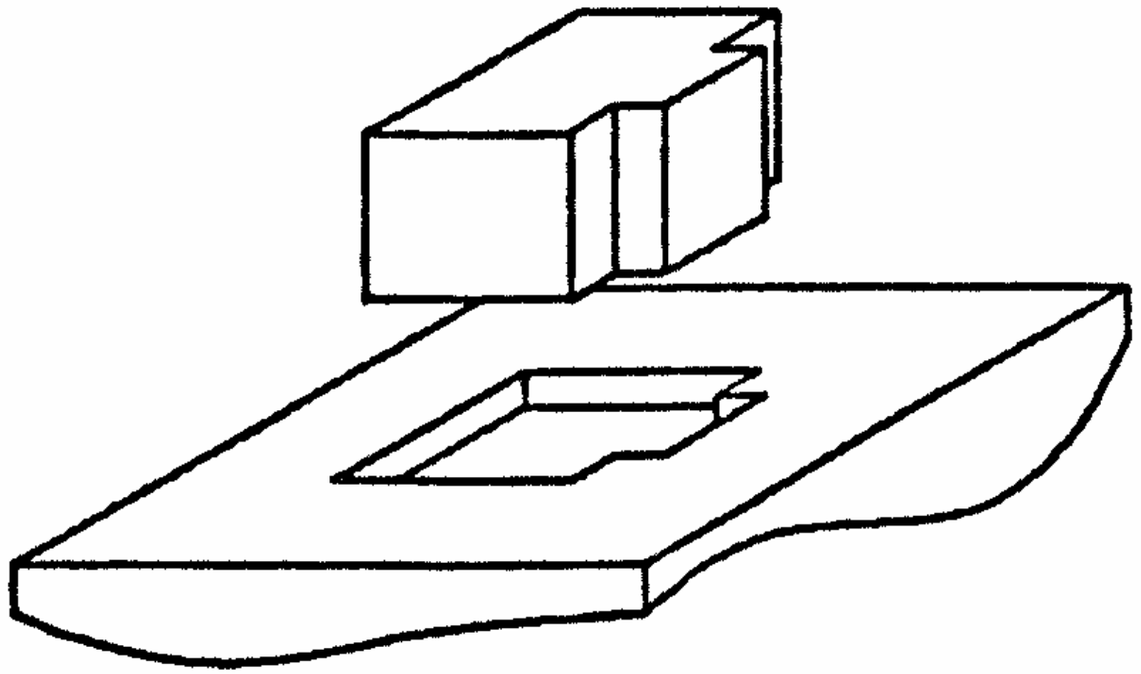


“D” shaped hole

Nest Parts

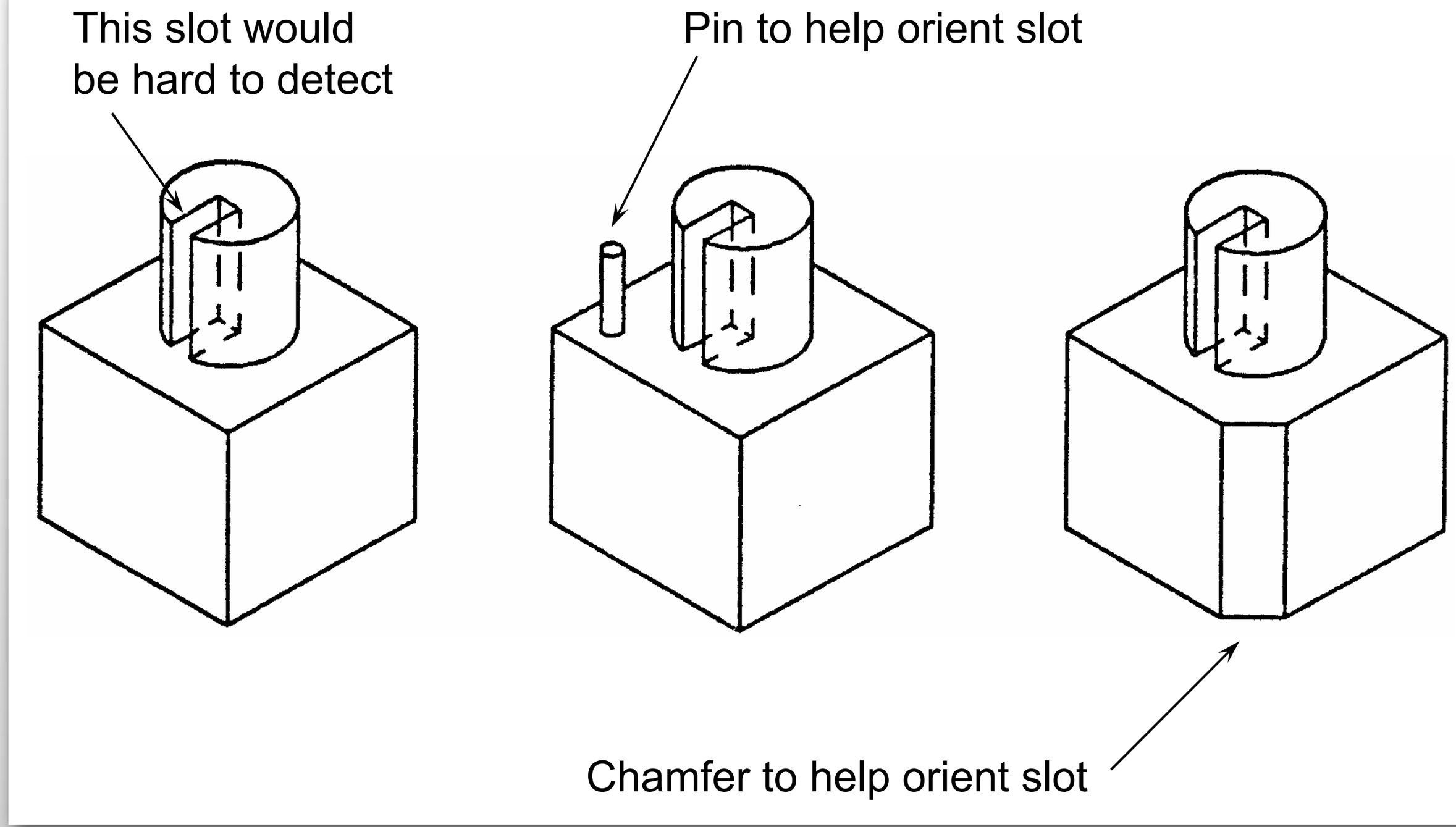


This part could be placed in any orientation and not be secured

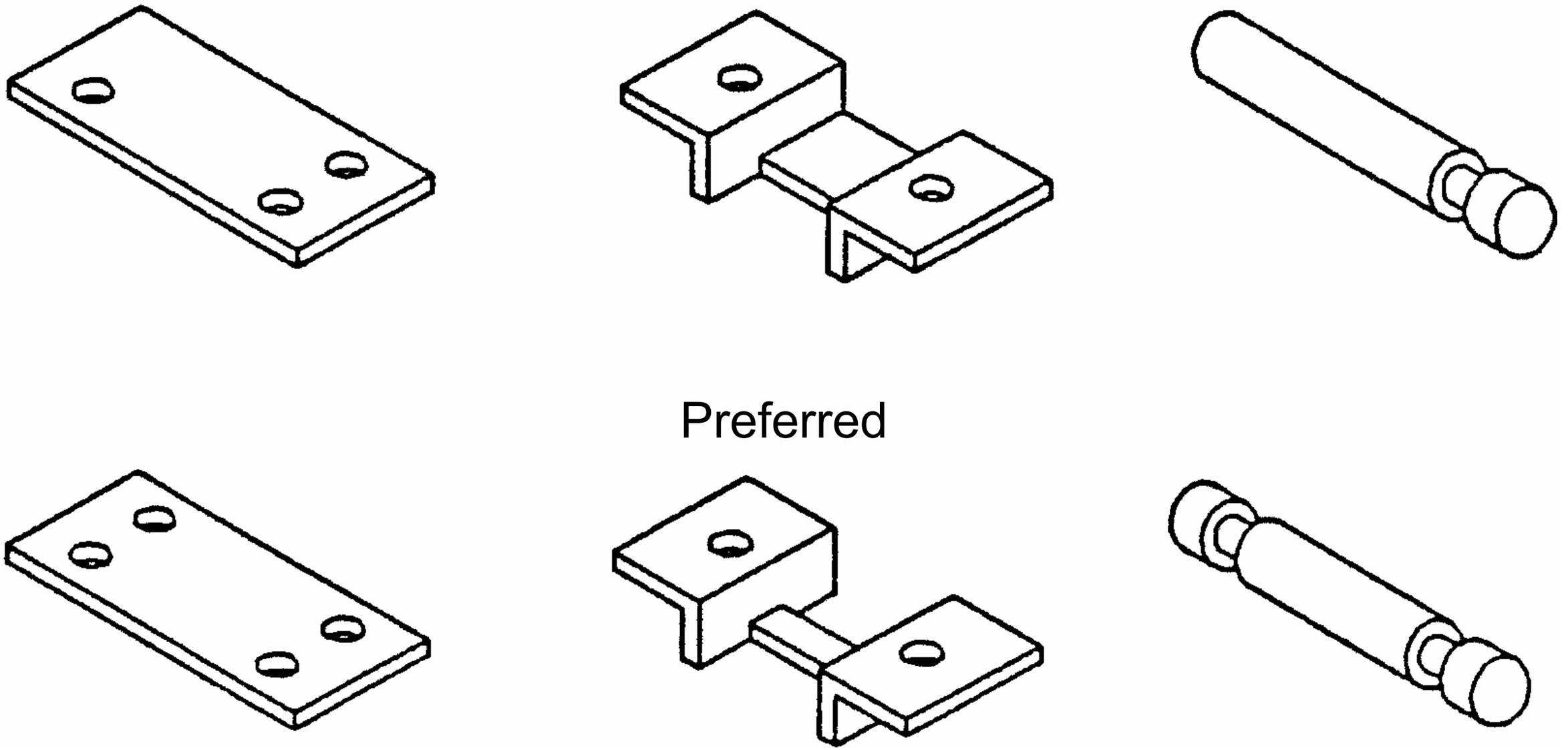


This part has a “nest” to orient and help it secure

Features for Orientation



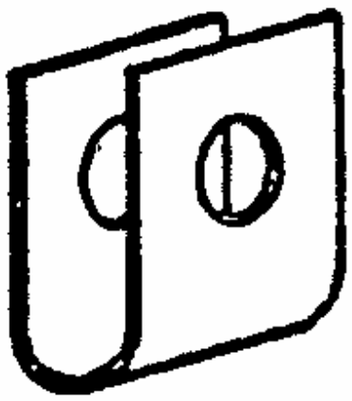
Symmetry

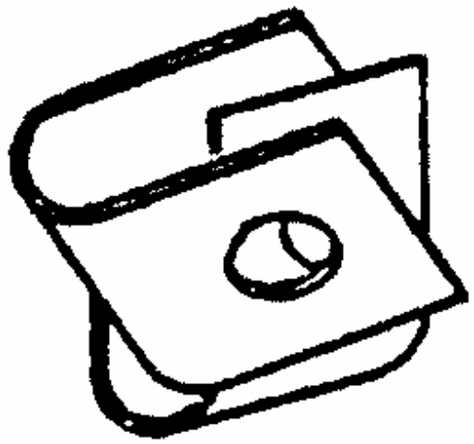


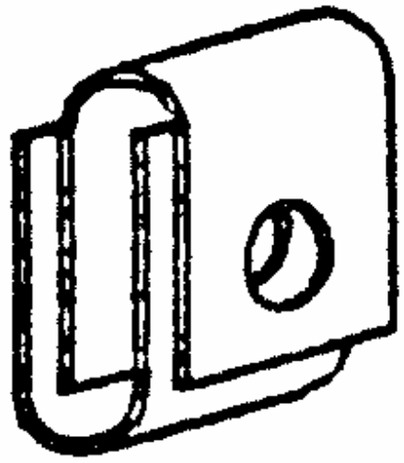
Preferred

Tangling

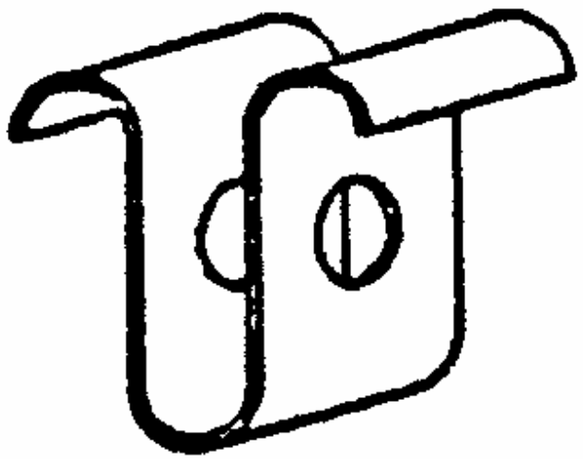
These parts can tangle easily

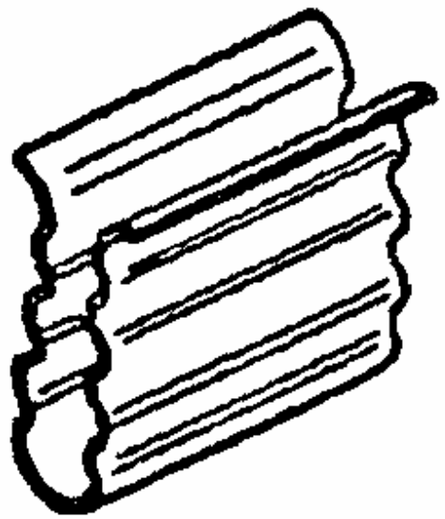






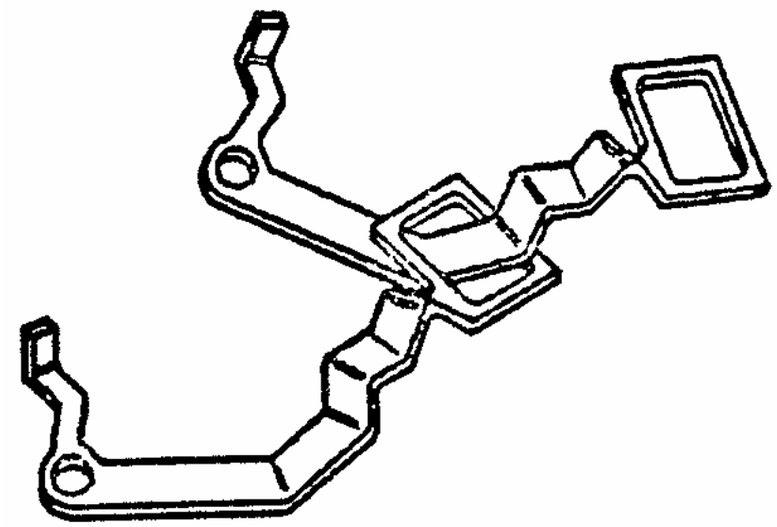
The same parts redesigned, will not tangle



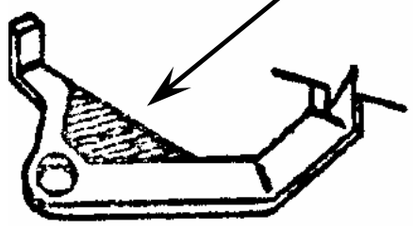


Tangling (cont.)

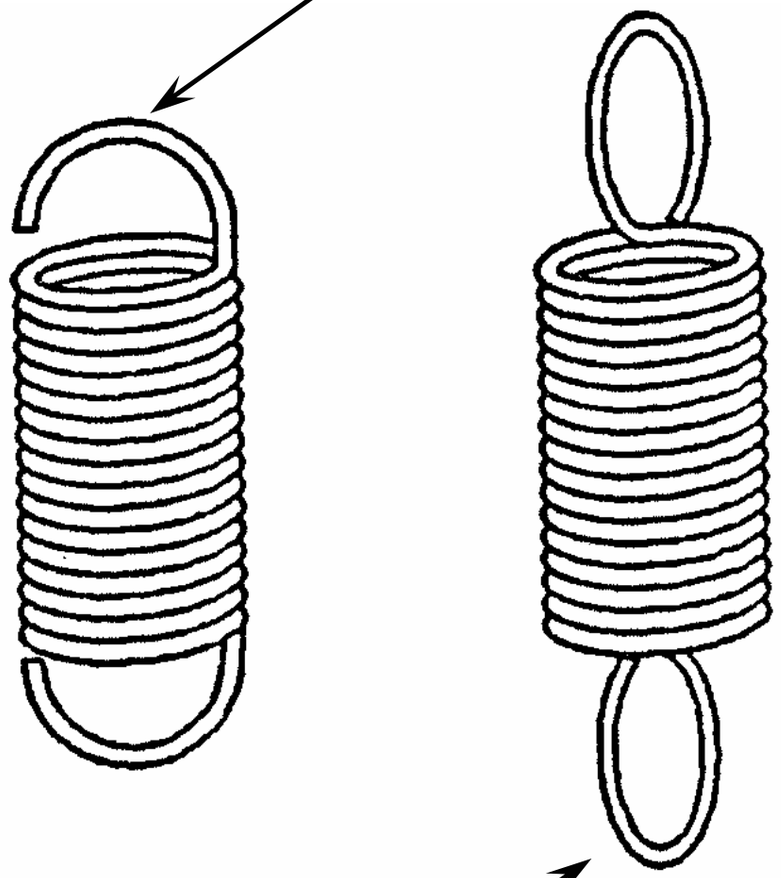
Parts that interconnect will not feed



A fillet will keep the parts from interconnecting

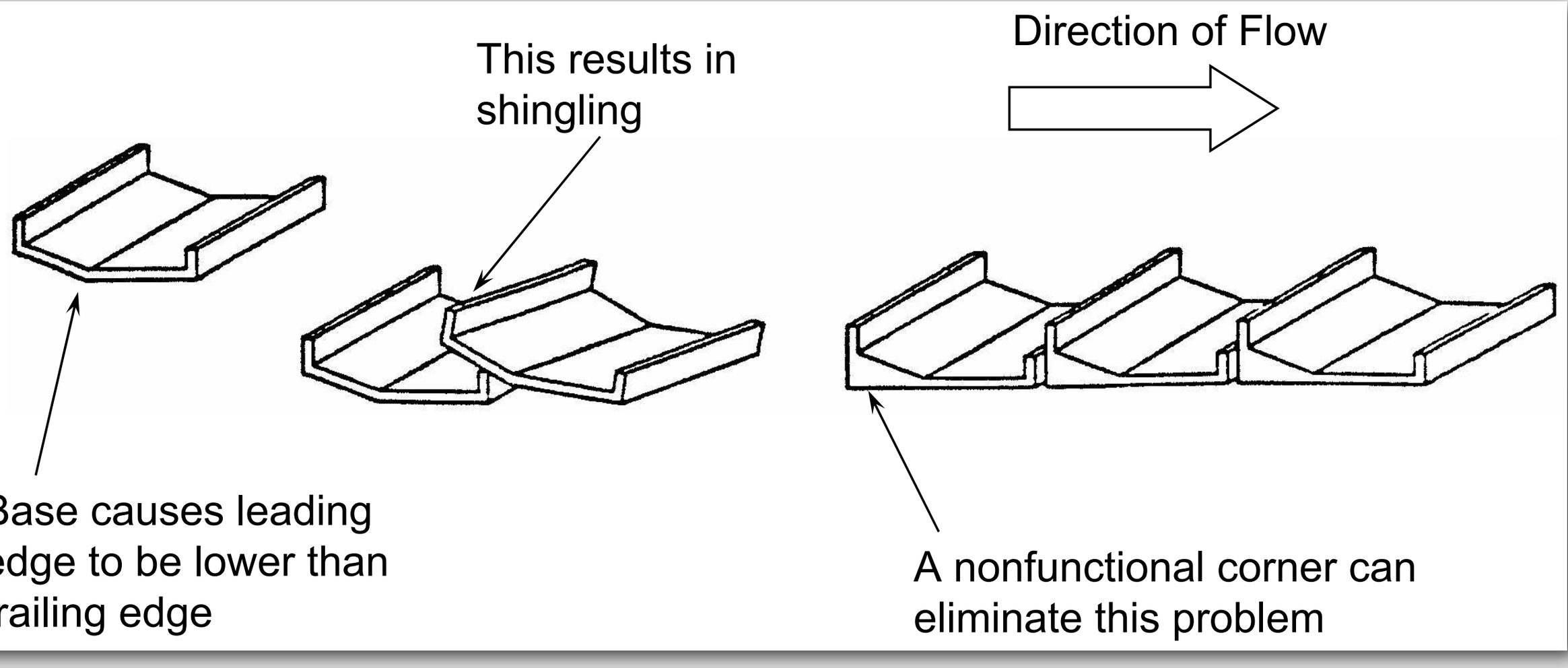


Springs with open loops will tangle

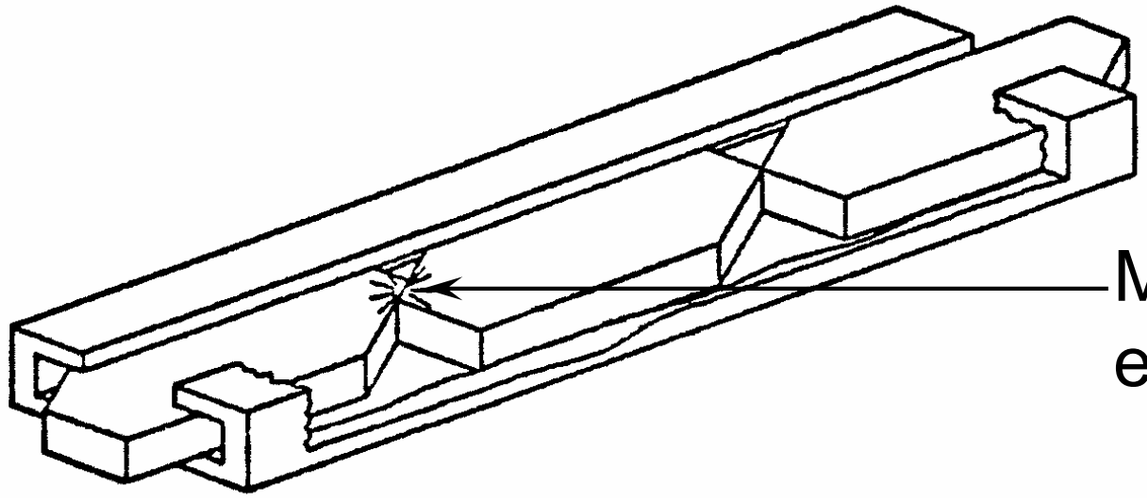


Springs with closed loops will not tangle

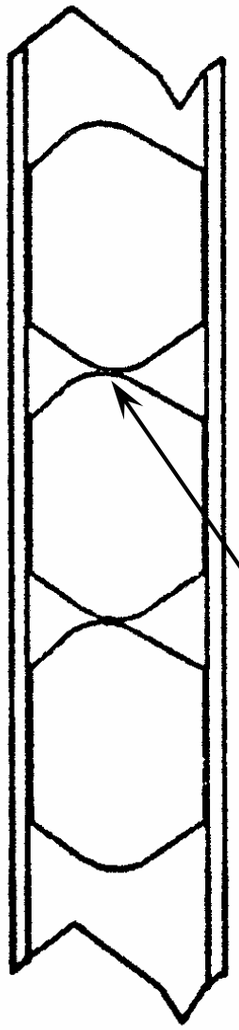
Jamming


Direction of Flow
This results in shingling
Base causes leading edge to be lower than trailing edge
A nonfunctional corner can eliminate this problem

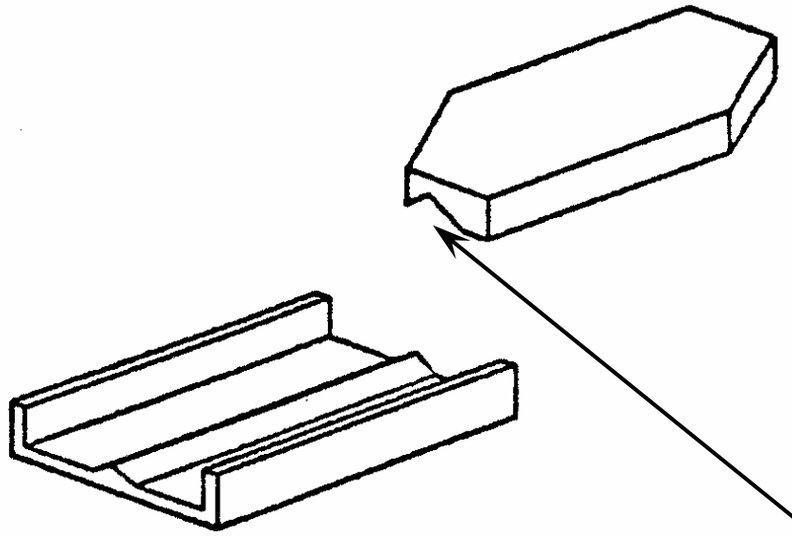
Jamming (cont.)



Mating surfaces with sharp edges can cause jams

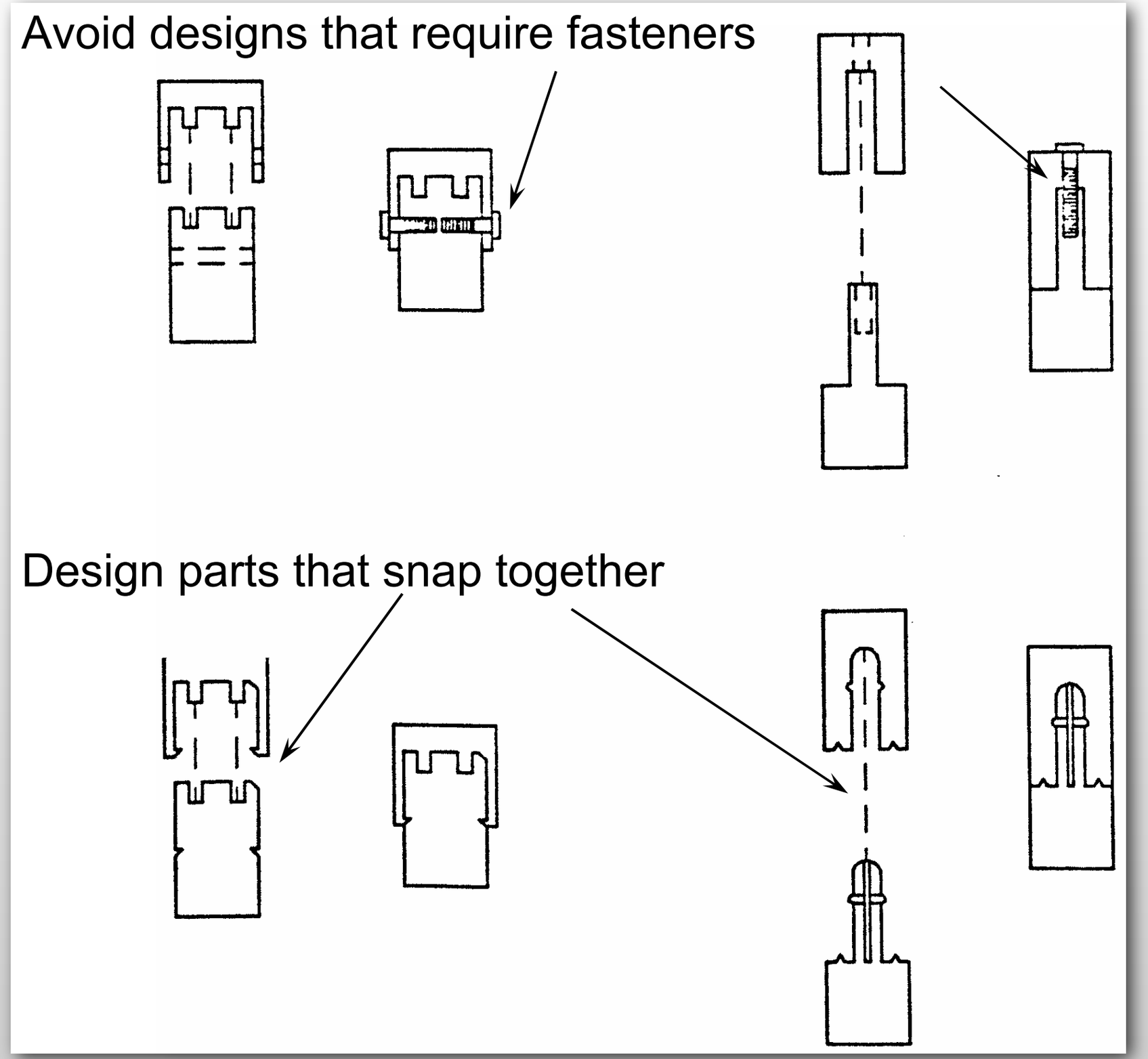


Rounded corners can prevent jams

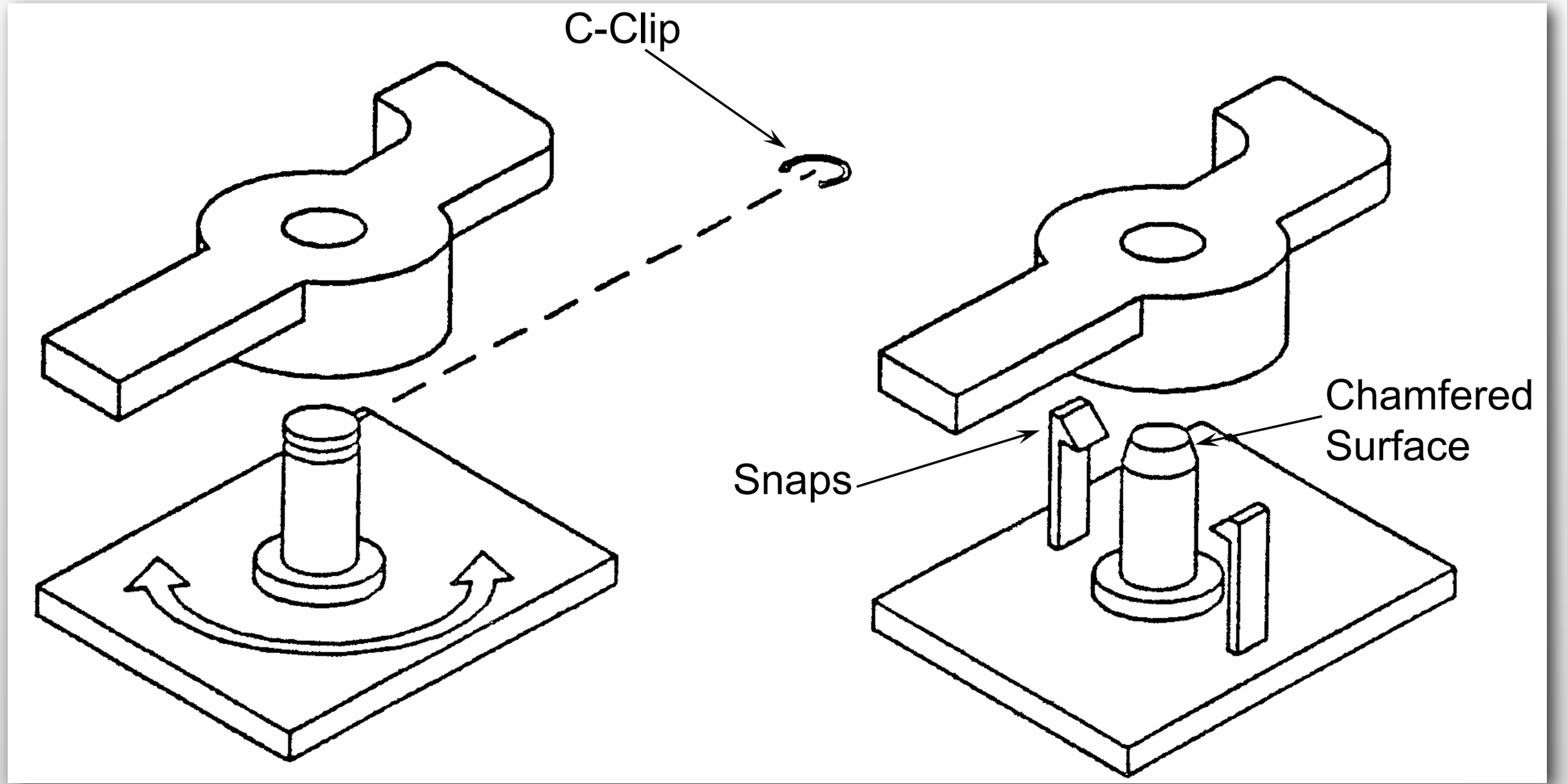


A groove can prevent jams by centering the part

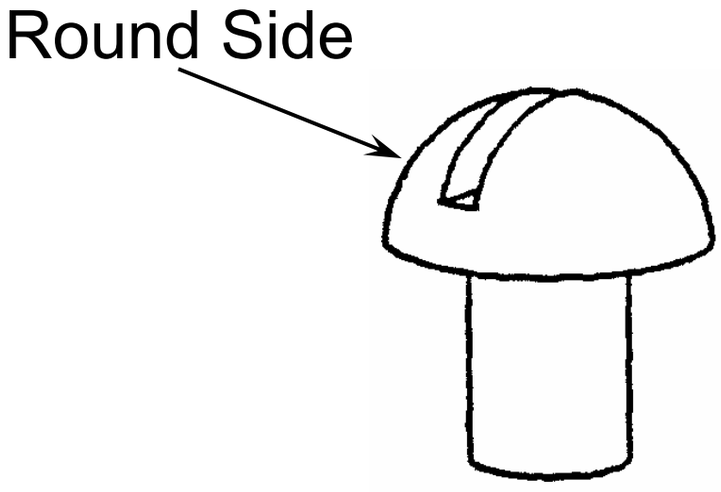
Avoid Fasteners, If Possible



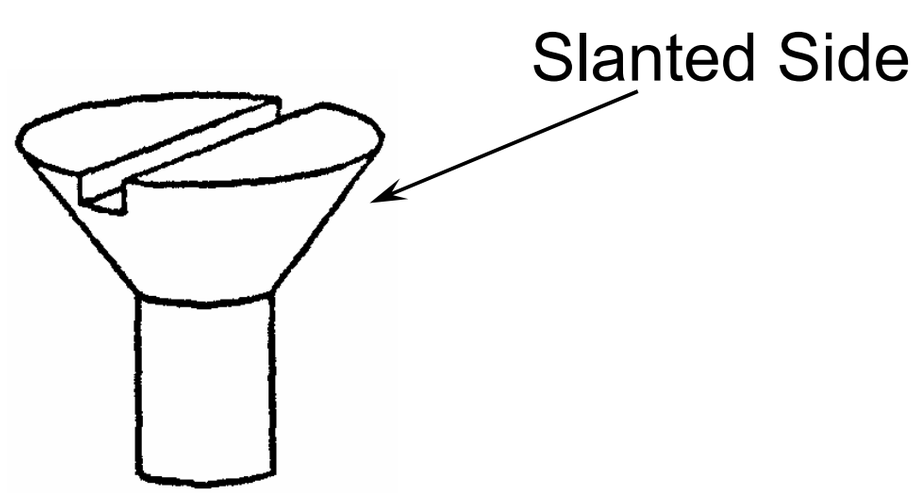
Avoid Fasteners – Moving Parts



If you have to use fasteners…

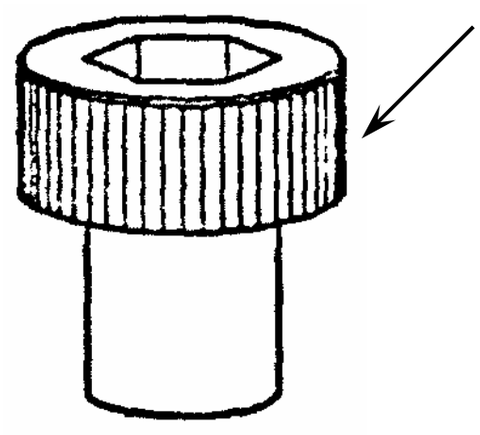


Round Head

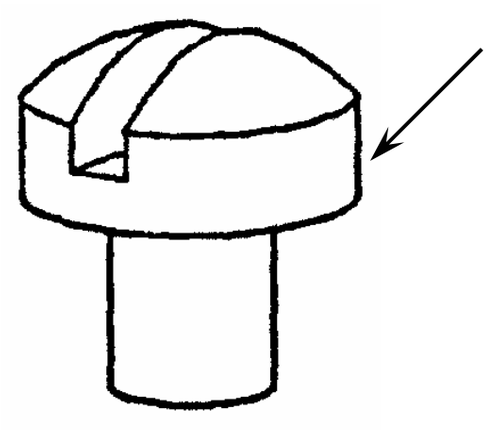


Flat Head

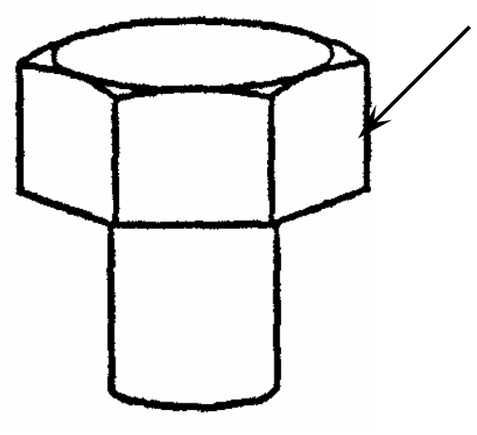
Preferred: Have flat vertical sides for vacuum pickup



Socket Head

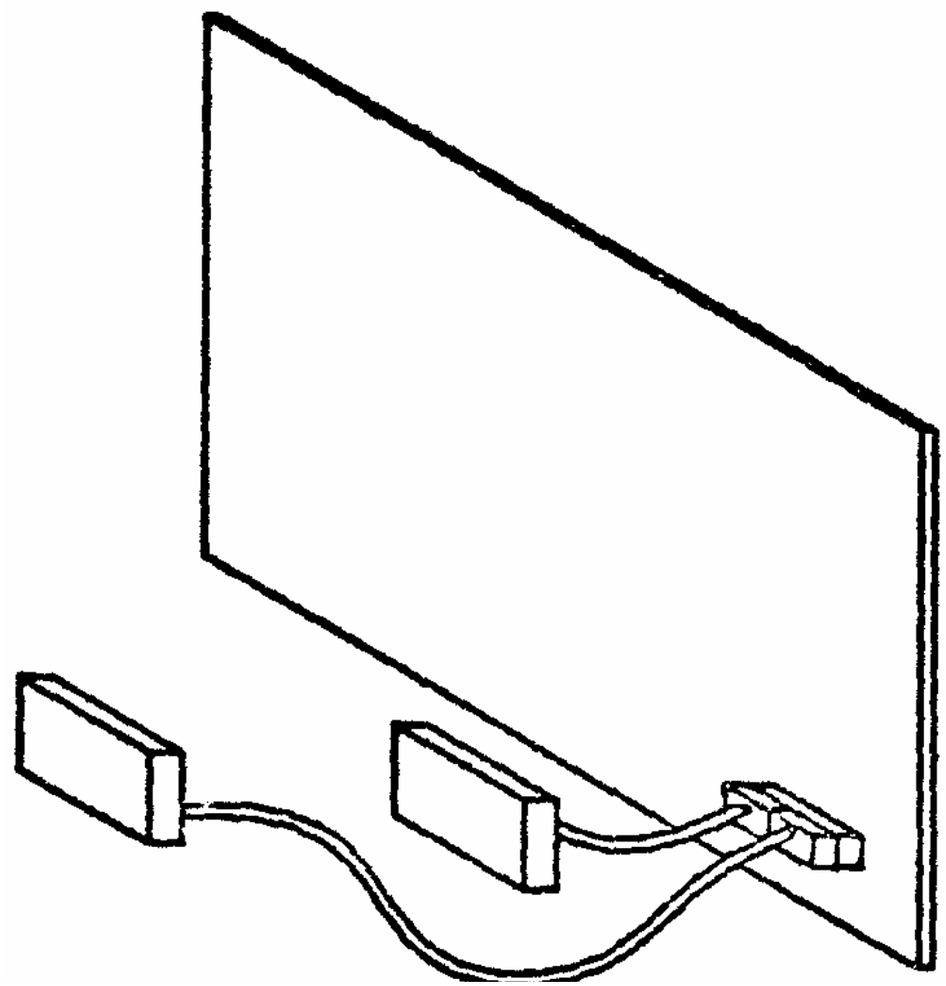


Fillister Head

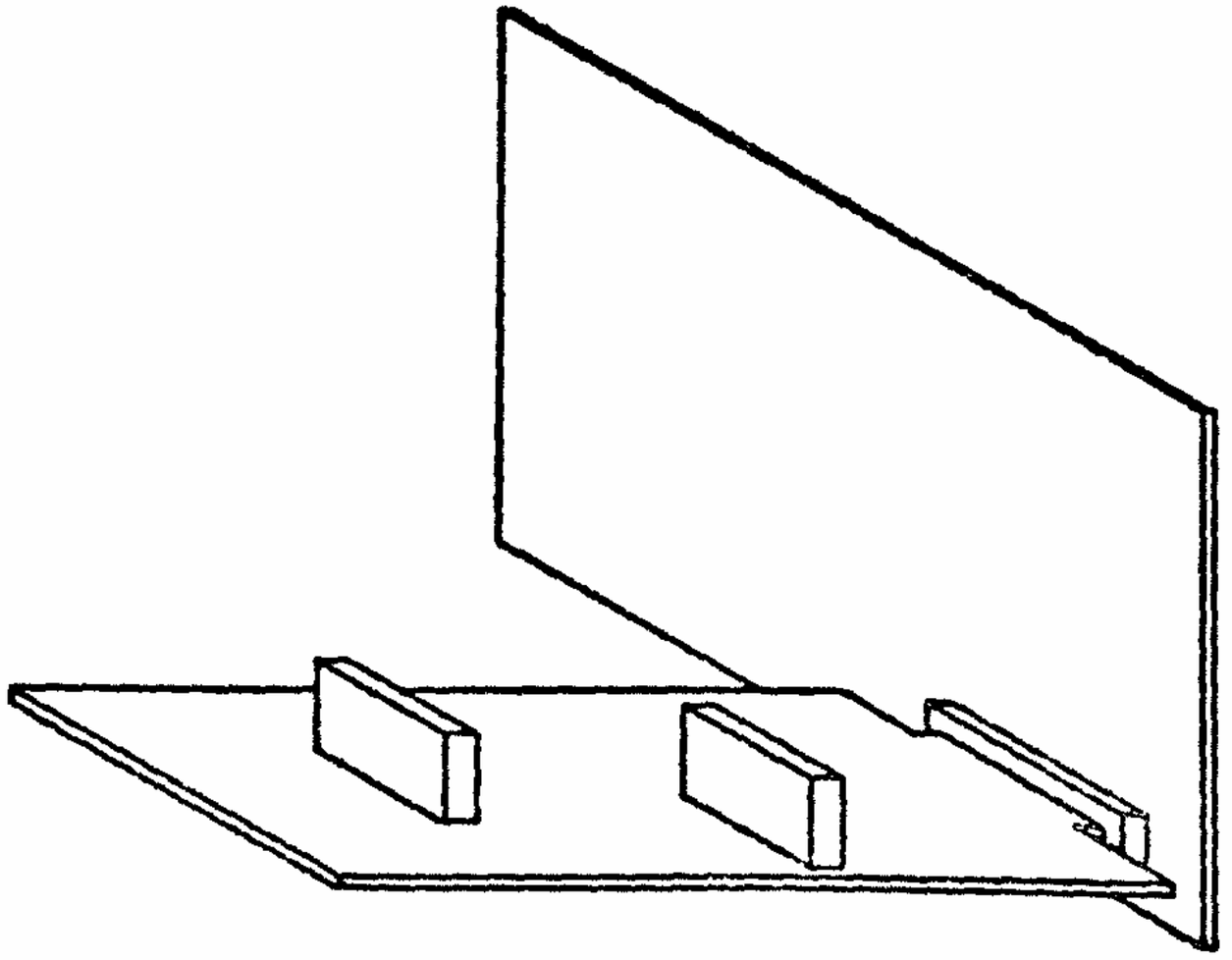


Hex Head

Cables and Connectors

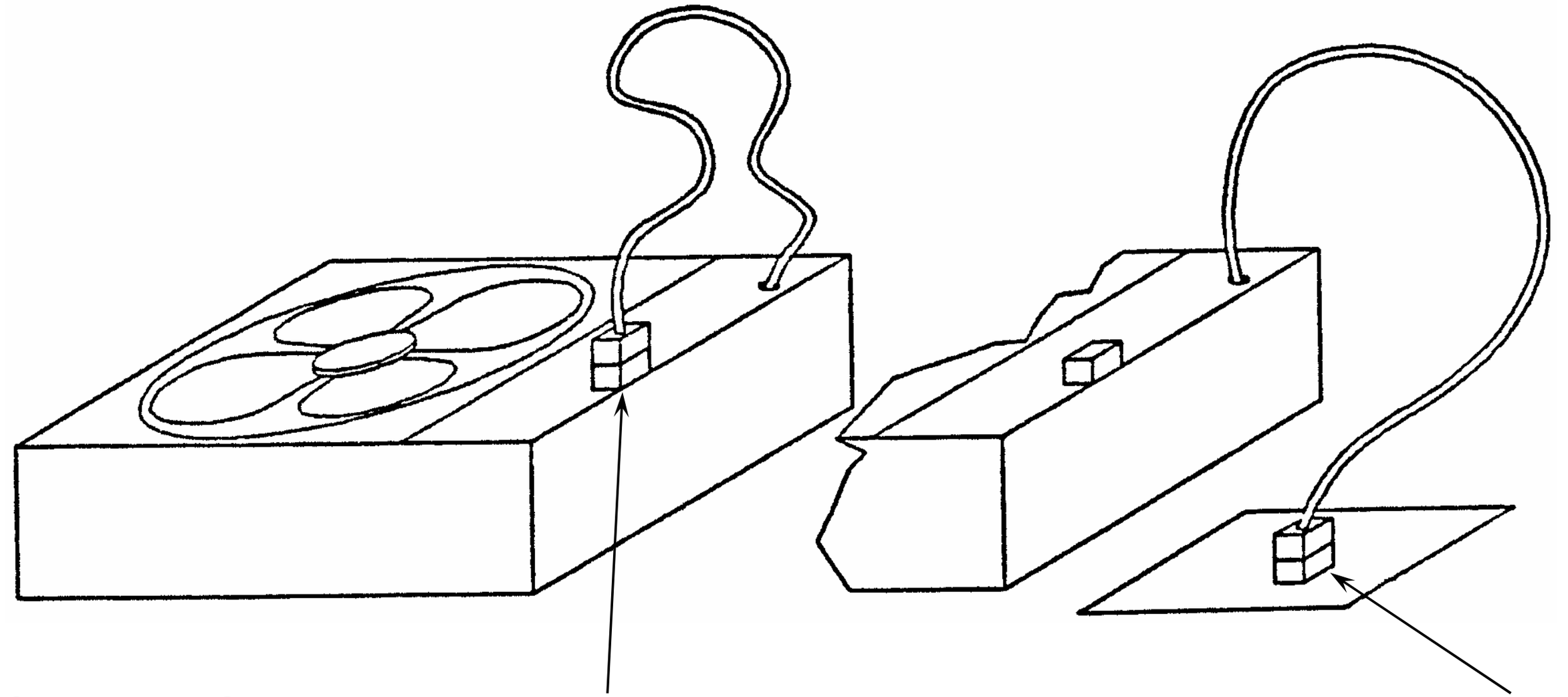


Avoid:
Components that are connected with cables to circuit board



Preferred:
Components that are plugged on a slave circuit board

Cables and Connectors (cont.)

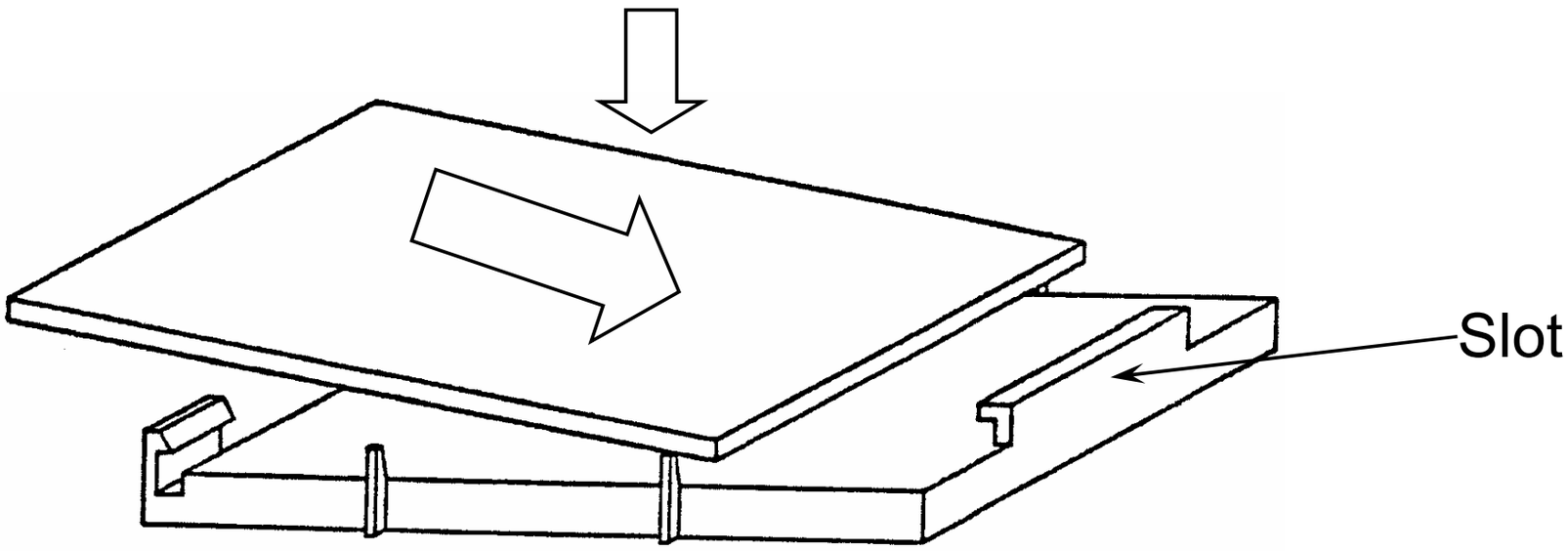


If the use of a cable cannot be avoided. Have the cable plugged into a dummy connector to locate the cable end.

Then a robot can locate the connector and plug it in.

Assembly Motion Design

Avoid: Three motions required for insertion



Preferred: Only one motion required