

# ENGINEERS' ILLUSTRATED THESAURUS

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by  
Herbert Herkimer



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## FOREWORD

More than thirty years ago, the author began to follow the advice given by William Kent to his students:

“Every young engineer should compile his own pocket-data book, as he proceeds in study and practice, to suit his particular business.”

The author went a step farther and began his scrap-book collection of engineering drawings, sketches, diagrams and abstracts from various domestic and foreign patent-office gazettes and trade catalogs.

At the request of the publishers, he started the work of selecting from this accumulated material data pertaining to mechanical engineering and other engineering fields, and arranging them in a form suitable for publication.

The main object has been to present the maximum number of illustrations; this naturally limited descriptive text to a minimum, to keep the book from growing beyond all practical bounds. Engineering science and practice have developed to such an extent that a detailed analysis of the more than 8000 illustrations in this book would fill many volumes.

The graphic method of describing machine parts and their movement by means of diagrams, line drawings and photographs has been generally accepted as the quickest and most satisfactory. Since the purpose of the book is to emphasize underlying principles and not structural details, such as would appear in a textbook of machine design, the sketches and drawings will present a maximum of useful basic information without confusing irrelevant detail, since the practical engineer and inventor need only an outline of an idea for his inspiration and would probably resent elaborate explanations.

While it may be repeated that this work is not a textbook of machine design, nevertheless typical assembly drawings,

examples of American and foreign designs are given. It is a well-known fact that most complicated mechanisms consist merely of combinations of the six fundamental machines:

1. Pulley
2. Wheel and axle
3. Inclined plane
4. Wedge
5. Screw
6. Lever

Yet the field of mechanisms and structures seems almost unlimited, according to the patent-office records and the volume of trade catalogs published monthly.

One claim to originality by an author of a book of this type lies in the novel methods of arrangement and indexing for ready, rapid reference.

The author has adopted a classification similar to that of *Roget's Thesaurus of English Words and Phrases* in which a word is classed according to the idea it intends to convey. In addition, there is a detailed alphabetical index in the back of the book. In using the book, the classification should be consulted first and the index afterward.

As all bodies are either in a state of rest or in motion, accordingly two main divisions are used as follows:

#### PART I — STATICS

- Class I — Fasteners
- Class II — Adjusting Devices
- Class III — Supports and Structures

#### PART II — DYNAMICS

- Class IV — Basic Mechanical Movements
- Class V — Elevators, Derricks, Cranes, Conveyors
- Class VI — Transmission of Liquids and Gases
- Class VII — Combustion
- Class VIII — Prime Movers
- Class IX — Transportation
- Class X — Industrial Processes
- Class XI — Electrical Appliances
- Class XII — Comfort Heating Cooling and Air Conditioning

Each class is divided into sections and each section is further subdivided into topics. Each topic is illustrated by drawings or photographs.

Invention and engineering design constitute a peculiar art which cannot be acquired but by long and continued practice. There are some engineers more highly gifted than others, but to all there comes a time when ideas stagnate and the solution is far away. Like 'spirits from the vasty deep they come not when we call.'

To engineers struggling with difficulties, this book should prove of great help in solving their problems.

Although with some machine parts, the name of the manufacturer is given, this does not mean that the author recommends the said manufacturer's products. All illustrations are given as examples only and it is left to the reader to select equivalent products of other manufacturers, if he prefers.

The author extends his thanks to many manufacturers who have so courteously supplied drawings and catalogs. If there is any borrowed matter of importance, the source of which is unknown to the author, he will be grateful for pointing it out to him and he will acknowledge it in a later edition.

Grateful acknowledgment is also due to the author's son, Harold Herkimer, for his assistance in the preparation of the illustrations.



## TABLE OF CONTENTS

	<i>Page</i>
<b>CLASS I: FASTENERS</b>	<b>2</b>
<i>Sections</i>	
1a Marine and Masonry Anchors	4a Holders and Clamps
1b Expansion Shields and Anchors	4b Holders and Clamps
2a Screw and Nut Design Types	4c Holders and Chucks
2b Screw and Nut Design Types	4d Holders and Grips
2c Commercial Nuts	4e Holders and Grips
2d Miscellaneous Bolts and Screws	5a Keys and Cotters
2e Miscellaneous Screws, Bolts and Nuts	6a Manholes, Hand Holes, Covers, Doors
2f Commercial Bolts	7a Riveted Joints
2g Nails and Spikes	7b Boiler Flue Connections and Stays
3a Clamps and Locking Devices	8a Miscellaneous Joints
3b Clamps and Locking Devices	9a Welding
3c Clamps and Locking Devices	9b Fabricated Welded Shapes
3d Clamps and Locking Devices	9c Structural-Steel Fasteners
3e Clamps and Locking Devices	10a Screw and Welded Pipe Joints
3f Clamps and Locking Devices	10b Fabrication of Welded Piping
	10c Pipe Clamps and Hangers
	10d Pipe Clamps and Hangers
	10e Miscellaneous Pipe Joints
	10f Pipe Connections, Boiler Tubes and Ferrules
	11a Joints and Cuts for Wood-working
	11b Timber Splicing and Joiner Work
<b>CLASS II: ADJUSTING DEVICES</b>	<b>74</b>
<i>Sections</i>	
12a Miscellaneous Adjusting Devices	13a Differential Screw-Adjusting Devices
12b Miscellaneous Adjusting Devices	14a Valve Handles
12c Miscellaneous Adjusting Devices	14b Machine Handles
	14c Miscellaneous Handles

## Contents

---

Page

### **CLASS III: SUPPORTS AND STRUCTURES**

**88**

#### **Sections**

15a	Machine Frames and Bed-plates	17d	Bearings, Journals and Hangers
15b	Machine Frames and Bed-plates	17e	Ball-Bearing Contacts
15c	Frames of Welded Design	17f	Commercial Ball Bearings
16a	Girders, Columns and Struts	17g	Early-Type Roller Bearings
16b	Bridge Trusses	17h	Commercial Roller Bearings
17a	Miscellaneous Bearings	17j	Miscellaneous Supports
17b	Plain Bearings, Adjusting Brasses and Linings	17k	I-Beam Supports and Tracks
17c	Bearings, Journals and Hangers	17l	Masonry and Concrete

### **CLASS IV: BASIC MECHANICAL MOVEMENTS**

**120**

#### **Sections**

18a	Kinematic Chains	24b	Cams, Tappets and Wipers
18b	Kinematic Chains	24c	Cams, Tappets and Wipers
19a	Application of Energy to Machines	24d	Cams, Tappets and Wipers
20a	Levers	24e	Built-Up Gear Wheels
20b	Levers	25a	Toothed Gearing
20c	Levers	25b	Rack and Pinion
21a	Parallel and Straight-Line Motions	25c	Toothed Gearing
21b	Parallel and Straight-Line Motions	25d	Toothed Gearing
21c	Parallel and Straight-Line Motions	25e	Toothed Gearing
22a	Links and Connecting Rods	25f	Toothed Gearing
22b	Connecting Rods	25g	Toothed Gearing
22c	Guides and Slides	25h	Epicyclic Gearing
22d	Guides and Slides	26a	Rolling Contact and Friction Gearing
23a	Blocks and Tackles	26b	Rolling Contact and Friction Gearing
23b	Differential Pulleys and Winches	26c	Friction-Gear Details
23c	Chains, Crane Hooks and Fittings	27a	Pawls and Ratchets
23d	Hooks and Swivels	27b	Pawls and Ratchets
24a	Cams, Tappets and Wipers	27c	Pawls and Ratchets
		28a	Clock and Watch Movements
		28b	Clock and Watch Movements



## Contents

---

Page

### **CLASS IV: BASIC MECHANICAL MOVEMENTS (Cont'd)**

#### **Sections**

29a	Throwing in and out of Gear	34j	Textile-Rope Drives
29b	Miscellaneous Shifting and Reversing Gears	34k	Pitch-Chain Drives
29c	Hinges	35a	Commercial Wire Ropes
29d	Centers and Spindles	35b	Wire-Rope Pulleys
29e	Transmission of Motion	35c	Long-Distance Wire-Rope Transmission
30a	Circular and Reciprocating Motion	36a	Rudimentary Clutches
30b	Circular and Reciprocating Motion	36b	Friction Clutches
30c	Circular and Reciprocating Motion	36c	Commercial Friction Clutches and Couplings
31a	Variable Motion, Speed and Power	36d	Rigid-type Shaft Couplings
31b	Variable Motion, Speed and Power	36e	Flexible Shaft Couplings
32a	Differential Gearing	36f	Shaft Couplings and Friction Clutches
33a	Augmentation of Power	36g	Commercial Flexible Couplings
34a	Transmission of Motion	36h	Commercial Universal Joints
34b	Flat-Belt Transmission	36j	Rudimentary Angular Couplings
34c	Belt Tighteners and Pulleys	36k	Commercial Angular Shaft Transmission
34d	Solid and Split Pulleys	36l	Rudimentary Brakes
34e	Belt Joints and Fasteners	36m	Contracting and Expanding Mechanisms
34f	Belt Joints and Fasteners	36n	Contracting and Expanding Mechanisms
34g	Texrope and Leather-Rope Drives	36o	Springs
34h	Textile-Rope Drives		

### **CLASS V: ELEVATORS, DERRICKS, CRANES, CONVEYORS**

274

#### **Sections**

37a	Gantry Cranes	37g	Commercial Wire-Rope Slings
37b	Cranes	37h	Fundamental Lifting Grabs and Clamps
37c	Cranes and Derricks	37j	Rope Knots and End Fittings
37d	Cranes and Derricks	37k	Knots, Hitches and Whipping
37e	Commercial Cranes and Unloaders		
37f	Commercial Wire-Rope Slings		

## Contents

---

Page

### **CLASS V: ELEVATORS, DERRICKS, CRANES, CONVEYORS (Cont'd)**

#### *Sections*

- |  |  |
|--|--|
| 37l Rudimentary Feeders                  | 37o Bucket Elevators and Gravity-Discharge Conveyors |
| 37m Commercial Feeders                   | 38a Hydraulic Elevators and Jacks                    |
| 37n Bucket Elevators and Apron Conveyors | 38b Balance Weights                                  |

### **CLASS VI: TRANSMISSION OF LIQUIDS AND GASES**

**306**

#### *Sections*

- |   |   |
|---|---|
| 39a Primitive Water Lifts                 | 42a Early-Type Air Blowers                |
| 39b Rudimentary Pumps                     | 42b Commercial Blowers and Compressors    |
| 39c Commercial Reciprocating Pump Classes | 42c Small Refrigerating-Compressor Valves |
| 39d Reciprocating-Pump Valves             | 42d Refrigerating Compressors and Valves  |
| 39e Modern Commercial Pump Valves         | 42e Blowing Engine and Valves             |
| 40a Leather Packings                      | 43a Refrigeration-Fluid Control           |
| 40b Metallic Packings                     | 43b General-Purpose Shut-Off Valves       |
| 40c Pistons                               | 43c Lubrication Methods                   |
| 41a Early-Type Rotary Pumps               | 43d Nozzles and Jets                      |
| 41b Commercial Rotary Pumps               | 43e Steam Traps and Separators            |
| 41c Commercial Rotary Pumps               |   |
| 41d Commercial Rotary Pumps               |   |
| 41e Typical Rotary Pumps                  |   |

### **CLASS VII: COMBUSTION**

**352**

#### *Sections*

- |                                      |                               |
|--------------------------------------|-------------------------------|
| 44a Early Boiler Types               | 44d Modern Mechanical Stokers |
| 44b Early Coal-Fired Boilers         | 45a Vaporizing Oil Burners    |
| 44c Early Stokers and Furnace Grates |                               |

### **CLASS VIII: PRIME MOVERS**

**362**

#### *Sections*

- |   |                                 |
|---|---------------------------------|
| 46a Nineteenth-Century Engines          | 46c Link-Motion and Valve Gears |
| 46b Steam-engine Valves and Valve Gears | 47a Early Rotary Engines        |
|   | 47b Early Rotary Engines        |

## Contents

---

Page

### **CLASS VIII: PRIME MOVERS (Cont'd)**

#### **Sections**

48a	Modern Steam Turbines	52a	Principles of Hydraulic Power
49a	Principles of Gas Turbines	52b	Hydraulic-Turbine Principles
49b	Jet Propulsion	53a	Windmills
49c	Rockets and Jet Propulsion	53b	Compressed-Air Power
50a	Diesel-Engine Principles	53c	Sea-Wave Power
51a	Elementary Valve Gears for Gas Engines		

### **CLASS IX: TRANSPORTATION 394**

#### **Sections**

54a	Wheels	55b	Sail-Boat Types
54b	Vehicle Bodies	56a	Propellers and Paddle Wheels
54c	Underframes and Trucks		
55a	Sail-Boat Types		

### **CLASS X: INDUSTRIAL PROCESSES 406**

#### **Sections**

57a	Weighing	58f	Washing and Winding Apparatus
57b	Measuring	59a	Smithing and Forging
57c	Pressure Measurements	60a	Presses
57d	Speed and Heat Measurements	60b	Drilling and Boring
58a	Crushing and Grinding	60c	Cutting Tools
58b	Crushing and Grinding	60d	Cutting Tools
58c	Sifting, Screening, Straining	60e	Cutting Tools
58d	Chopping, Slicing and Mincing Apparatus	60f	Cutting Tools
58e	Mixers	61a	Agricultural Machinery
		62a	Sanitation; Water Closets and Septic Tanks

### **CLASS XI: ELECTRICAL APPLIANCES 444**

#### **Sections**

63a	Static Electricity	63f	Batteries
63b	Static Electricity	63g	Chemical Effects of Electricity
63c	Magnetism	63h	Transformers; Induction Coils
63d	Electromagnets	63j	Telephones
63e	Basic Types of Permanent Magnets		

## Contents

---

Page

### **CLASS XI: ELECTRICAL APPLIANCES (Cont'd)**

#### **Sections**

63k	Electrical Measuring Instruments	65e	Hard Vacuum Tube Symbols
63l	Electrical Measuring Instruments	65f	Triodes, Screen-Grid Valves
63m	Electrical Measuring Instruments	65g	The Audio Amplifier
63n	Electrical Generators	65h	Radio Communications Systems
63o	Electrical Generators	65j	Radio Communications Systems
63p	Alternators	65k	Cathode and X-Ray Tubes
63q	Alternating-Current Motors	65l	Gas-Filled Valves
63r	Direct-current Motors and Generators	66a	Small Switch-Control Diagrams
64a	Luminaires and Light Distribution	66b	Small Switch-Control Diagrams
64b	Infrared Heating	66c	Vacuum Switches
64c	Electric Heating	66d	Relays
65a	Electromagnetic Apparatus	66e	Mercury Switches
65b	Wave and Electron Theory	67a	Radar Navigational Equipment
65c	Inductance and Capacitance	67b	Echo Sounding
65d	Electron Tubes		

### **CLASS XII: COMFORT HEATING, COOLING AND AIR CONDITIONING**

520

#### **Sections**

68a	Steam-Heating Hookups	72b	Unit Air Conditioners
68b	Steam-Heating Hookups	73a	Temperature Controls
68c	Steam-Heating Hookups	74a	Refrigeration Systems
68d	Steam-Heating Hookups	74b	Compression System of Refrigeration
69a	Hot-Water Heating Systems	74c	Reverse-Return Chilled-Water System
69b	Radiant Hot-Water Heating	74d	Typical By-Pass Systems
69c	Radiant Heating	74e	Sheet-Metal Details
70a	Warm-Air Heating System	74f	Humidifiers
71a	Unit Heaters and Ventilators	75a	Heat Pump; Reverse Cycle
72a	Unit Air Conditioners		

**INDEX**

**559**

## INTRODUCTION

Engineers, designers and draftsmen deal with machines. A machine is defined as a combination of parts which is suitable to transmit and modify energy and motion to do the desired work. Another definition of a machine describes it as a device that overcomes resistance at one point by the application of force at some other point.

Energy may be defined as the ability to do work. There are two main types of energy: Potential energy is latent until a change releases it. The energy stored in coal (chemical energy) and changed into heat by burning and the energy of water in a high tank (energy of position) which is released by opening a valve are forms of potential energy. Other examples of potential energy are that of a raised weight, wound spring, and compressed gas. Kinetic energy is the energy of motion. When potential energy is released, it is transformed into kinetic energy. Kinetic energy is sometimes called mechanical energy. Examples of kinetic energy are the electric current, heat, light, energy of expanding gas, working muscles, combining elements, the energy released by atomic fission, etc.

The law of conservation of energy states that in any isolated system, the total amount of energy is constant. This means that energy can change from one form to another but the total amount of energy will remain the same. This may be expressed mathematically:

$$\text{Kinetic Energy} + \text{Potential Energy} = \text{Constant}$$

or

$$\text{Total Energy Deposited} = \text{Work Accomplished} + \text{Energy Lost by Resistance}$$

As the complete energy supplied cannot be converted into useful work, but a certain portion of it is always used to overcome resistance, the idea of a perpetual-motion machine is absurd.

*Prime movers* are machines which convert energy from a

## Introduction

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natural source into mechanical power. Oil engines, gas engines, wind mills, water wheels and turbines, steam engines and internal-combustion engines are examples of prime movers.

*Power* is the rate of doing work. The standard unit of power is one horse power which is equal to 33,000 pounds lifted 1 foot high in 1 minute.

If the number of foot-pounds done per minute is known, we can express the work in horse-power units by dividing by 33,000. For example:

	Foot-pounds	Horse power
A man raising his own weight vertically during a day of eight hours	4,350	0.1318
A man pushing and pulling at capstan	3,180	0.0963
A man turning a winch	2,700	0.0818
A horse pulling a cart	26,150	0.7924

This shows that a man performs  $1/10$  to  $1/8$  of a horse power and a real horse  $8/10$  of a horse power.

*Force* is the cause of the acceleration of a body free to move. Its unit is the poundal or the dyne.

*Velocity* is the rate of movement and is measured in feet or centimeters per second. For velocity, both the direction and magnitude must be specified as it is a vector quantity.

*Acceleration* is the increase of velocity expressed in feet or centimeters per second per second.

All machines—however complicated—can be reduced to six simple forms:

1. The *lever* consists of a bar free to turn around a point, called the fulcrum.
2. The *wheel and axle* may be considered a rotating or continuous lever; it may consist of a large wheel and a small wheel attached together; or of a wheel attached to an axle; or of a handle attached to an axle.
3. The pulley or block and tackle is also a modified form of lever. In its simplest form, it consists of a disc and of a rope placed in a groove on its circumference. It

## Introduction

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may be considered as a continuously acting lever whose fulcrum is in the middle.

4. The inclined plane is an oblique surface which forms an angle with the base.

two basic machine forms: the lever and the inclined plane.

6. The screw is a spiral or continuous inclined plane.

From this, it is obvious that, in final analysis, there are only two basic machine forms; the lever and the inclined plane.

In any machine, there is a point P where the force is applied and a point W where work is accomplished. Neglecting the resistance, the work done is equal to the applied force.

In a machine, the ratio of the resistance, or load, to the applied force, or effort, is called mechanical advantage. In constructing a machine one of the aims is to obtain the highest possible mechanical advantage.

Figures A and J show various forms of levers. Figure B illustrates a wheel and axle. Figures C and G are gear trains. Figure D shows the pulley, or block and tackle. Figure E illustrates the principles of the inclined plane, and figure F shows a screw combined with a lever.

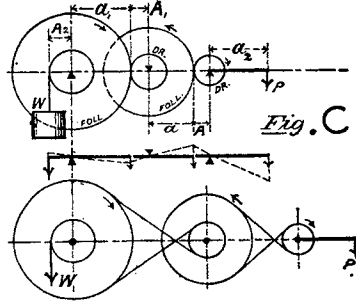
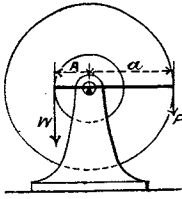
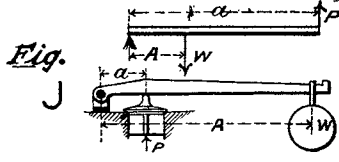
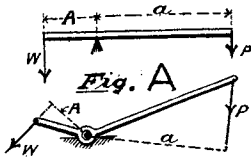
A compound machine is the combination of simple machines to give greater mechanical advantage. The mechanical advantage of a compound machine is the product of the mechanical advantages of the individual machines that make up the compound machine. Figure H shows a combination of a crank, axle, and inclined plane.

Every machine performs at least one of the following functions:

1. It changes the applied force or effort
2. It changes the direction of the applied force
3. It changes the speed
4. It transmits the force from one point to another.

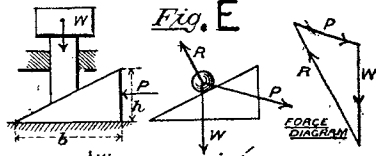
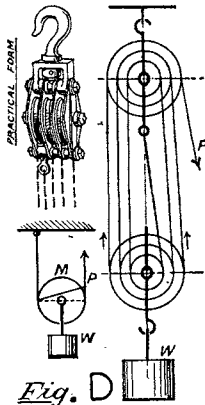
There is no machine that could deliver work without work being spent on it. Moreover, the work delivered by a machine is always less than the work supplied, since some work is lost by overcoming resistance, which is usually friction. Nevertheless, machines are powerful tools of human progress and our modern age would not be possible without them.

# Introduction

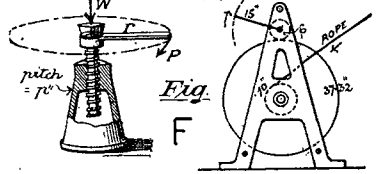


*Fig. B*

*Fig. C*

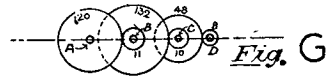


*Fig. E*

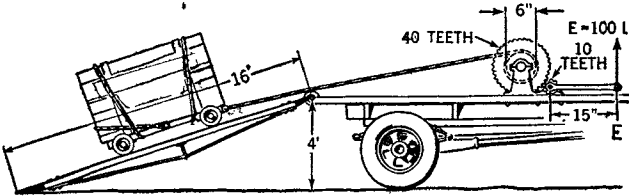


*Fig. F*

*Fig. D*



*Fig. G*



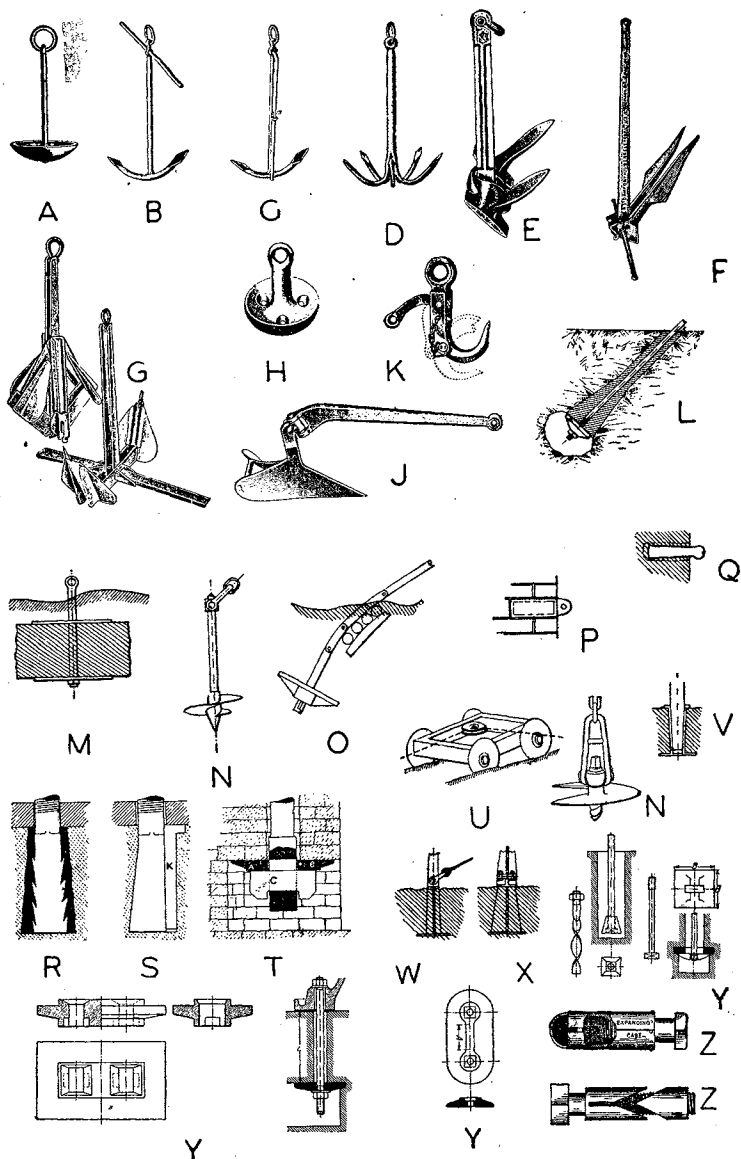
*Fig. H*



## **PART I—STATICS**

**CLASS I. FASTENERS****Section Ia. Marine and Masonry Anchors**

- A—Mushroom anchor.
- B—Trawl or sand anchor; fast stock, double fluke.
- C—Trawl or sand anchor; loose folding stock.
- D—Grapnel.
- E—Navy-type swivelling fluke.
- F—Denforth anchor.
- G—Northhill utility anchor.
- H—Fisherman's anchor.
- J—Laughlin C.Q.R. plow anchor.
- K—Anchor trip hook.
- L—Rock anchor for guy or suspension bridge.
- M—Concrete, sunk in ground with plate and rod reinforcing.
- N—Mooring screws, sunk in ground for buoys.
- O—Anchor plate, sunk in ground for attaching tie rods and guys.
- P—Wall eye, cast to form brick.
- Q—Wall eye, built in.
- R—Foundation-bolt head, jagged.
- S—Foundation bolt with key.
- T—Foundation bolt, standard.
- U—Rope-pulley leader anchor, knife-wheel grip in ground.
- V, W, X—Fencing posts in ground.
- Y—Miscellaneous foundation-bolt anchors.
- Z—Expansion bolts.



**CLASS I. FASTENERS****Section Ib. Expansion Shields and Anchors**

- A—Spring-wing toggle bolt, shown open and closed.
- B—Spring-wing toggle bolt: *A* with round head; *B* with square nut; *C* with flat-head screw.
- C, D—Spring-wing toggle bolt inserted into a drilled hole in tile or gypsum walls.
- E—One-piece toggle, without springs.
- F—Paine lead expansion anchors for use in concrete, stone, marble, tile, slate, etc.
- G—F in position.
- H—Single machine-bolt shield with two-side expansion for use in concrete, etc., installed without a setting tool.
- J—Double machine-bolt shield; installed without a setting tool.
- K—Fiber or rawhide wood and lag screw anchor for use in brick, plaster, concrete, etc.; the hole need not be plumb; no setting tool required; the fiber anchor should be as long as the threaded part of the wood or lag screw and have the same diameter as the screw.
- L, M—Paine steel expansion shells; may be used with two cups; no setting tool required; the hole need not be plumb.
- N—Four-point star drill for making expansion-anchor holes in masonry.
- O—Paine pipe hook, snug-fit type.
- P—Paine adjustable combination pipe hanger; consists of a six-inch length of perforated hanger iron with a gimlet-pointed lag screw at one end and a pipe ring at the other end.
- Q—BX staple.
- R—Flattened-end lag screw with bolt for use with a malleable expansion shield.
- S, T, U—Rawl drive expansion plugs.
- V, W—Two-hole and one-hole straps for supporting wall pipe conduit and armored cable.
- X—Gimlet-point lag screw; commercial sizes vary in length from  $1\frac{1}{2}$  inches to 12 inches and in diameter from  $\frac{1}{4}$  inch to  $\frac{7}{8}$  inch; lag screws are measured from under the head to the extreme point.
- Y—Seebco Scruin patented expansion shield.

## INDEX

### A

Accelerated circular motion, 170  
 Acetylene, cutting, welding, 52  
 Adapters, 36  
 Adjustable arm, 74  
 — rod, 74  
 Adjustment, differential screw, 80  
 —, wear, 74  
 Agricultural machinery, 440  
 Air blowers, 332  
 — compressors, rotary, 334  
 — conditioners, unit, 538  
 — washers, 554  
 Alternating current, 468  
 Alternators, 472  
 Amplifier, audio, 496  
 Anchors, marine, 2  
 —, masonry, 2  
 Anemometer, 388  
 Aneroid barometer, 410  
 Angle coupling, 210  
 Angular couplings, 262  
 — shaft transmission, 264  
 Anvils, 426  
 Apron feeder, 296  
 Archimedes screw, 306  
 Attraction-type permanent-magnet system 464  
 Audio amplifier, 496  
 Augmentation of power, 218  
 Automatic feeder, 408  
 Automobile differential, 178  
 Autotransformer, 470  
 Axles, car, 202

### B

B and W boiler, 354  
 Balance weight, dock crane, 304  
 — weight, elevators, 304  
 — weights, 304

Ball and cup joint, 204  
 — and socket bearing, 98  
 — bearings, 106, 108  
 — gearing, 172  
 — mill, 414, 416  
 — miter gear, 176  
 Bar track, 116  
 Barometer, aneroid, 410  
 Barrel motion, 156  
 Base plates, machinery, 90  
 —, welded, 92  
 Batteries, electric, 454  
 Beam, clamp, pipe, 62  
 — tetrode, 494  
 Beams, welded, 92  
 Bearing, adjustment, 80  
 — block, welded, 92  
 —, step, 76  
 Bearings, miscellaneous, 98  
 —, roller, 110  
 Bed plate, cast iron, 88  
 —, sliding, 144  
 Bell crank, 128  
 — crank toe lever, 160  
 Bellows, metal, 410  
 Belt drive, flat, 222  
 — fasteners, 228, 230  
 — joints, 228, 230  
 — shifter, 156, 196  
 — tightener, 224  
 Bench clamps, 24  
 Bent pipe joints, 66  
 Beranger balance, 406  
 Bevel friction gearing, 184  
 — gears, 164, 176  
 Bits, boring, 434  
 Blackmer rotary pump, 324  
 Blacksmith's hearth, 426  
 Blast coil hook-up, 526  
 — fan, 426  
 Block, thrust, 100  
 Blocks and tackles, 146

- Blower, Root's, 322  
 Blowers, air, 332, 334  
 Blowing engine, 340  
   — engine, valves, 340  
 Boat spikes, 18  
 Bobbin winder, 206  
 Bobbins, 424  
 Boiler flue stays, 48  
   — support, 114  
   — tubing joints, 68  
   — types, 352  
 Bolt heads, 8  
 Bolts, miscellaneous, 12  
 Boring, 430  
   — tool, 434  
 Bouchet's crank motion, 210  
 Bourdon tube, 410  
 Bow catch, ladles, 26  
 Box girder, 94  
   — kite, 388  
 Brace, ratchet, 190  
 Brackets, welded, 92  
 Brads, 18  
 Brakes, rudimentary, 266  
 Branches, steam, 526  
 Brasses, bearings with, 102  
 Brazed joint, pipe, 58  
 Brick bonds, 118  
 Bridge trusses, 96  
 Bridges, 96  
 Brig, 402  
 Brine agitator, ice tank, 422  
 Bucket elevator, 298, 300  
   — trap, 350  
 Burgess vacuum contact switch,  
   510  
 Burton, Spanish, 146  
 Bus, arrangement of seats, 396  
 Bushings, bearing, 100  
 Butt joint, timber, 72  
   — weld, pipe joint, 58
- C
- Caliper, vernier, 408  
 Calipers, 78  
 Cams, 154, 156, 158, 160  
 Candy mixer, 422  
 Cantilever bridge, 96  
 Cap, bearing, 100  
 Capacitance, 488  
 Capstan, 86, 124  
   — handle, 82  
 Car truck, 398  
 Cord winder, 424  
 Castor, ball bearing, 102  
 Cat boat, 400  
 Catch and hook, 20  
 Cathode ray deflection, 484  
   — ray tube, 502  
 Ceiling hangers, 104  
 Center bit, wood, 430  
 Centers and spindles, 202  
 Centrifugal compressor, 334  
   — fan, 334  
   — fan unit heaters, 536  
 Chain cutter, 432  
   — drive, 238  
   — grates, 356  
   — hoist, 148  
   — pump, 306  
   — winder, 424  
 Chains, 150, 152  
 Chamfering, wood, 70  
 Change gear motion, 172  
 Chasing tool, 432  
 Chilled water cooling system, 548  
 Chinese windlass, 124  
 Chopping, 420  
 Chronometer, 194  
 Chuck, expanding, 38, 268  
   —, three jaw, 36  
 Circular and reciprocating motion,  
   206, 208, 210  
   — saw, 432  
 Clamp fitters, 38  
   —, jigs, 34  
 Clamps and grabs, lifting, 288  
   —, bench, 24  
 Clamps, pipe, 62

- Clevises, welded shapes, 54  
 Click, double acting mechanism, 186  
 Clock and watch movements, 192, 194  
 Clothes washer, 424  
 Clover leaf cam, 160  
 Clutch, automatic gear, 174  
 Clutches, friction, 248  
 —, rudimentary, 246, 248  
 Coach springs, 320  
 Coal crusher, 416  
 — dust press, 428  
 Collar bearing, 100, 346  
 Columns, 118  
 Combustion, 352  
 Compound lever, 126, 218  
 — wound generators, 476  
 Compressed air power, 390  
 Compressors, rotary gas, 334  
 Concrete mixer, 414, 422  
 — pile, 118  
 Condensate trap, 350  
 Condenser, 446  
 —, electrolytic, 488  
 —, jet, 348  
 Cone change speed, 212  
 — gears, 168, 182, 184  
 Connecting rod ends, 138, 140  
 — rods and links, 138, 140  
 Continuous feed ratchet, 186  
 Contracting and expanding mechanism, 268, 270  
 Converter, series, 504  
 Conveyor, apron, 298  
 Copper plating, 456  
 — refining, 456  
 Corliss valve, 340, 366  
 Cotters, 42  
 Cotton bale press, 428  
 — gin, 418  
 Countersink drills, 430  
 Couplings and clutches, 248, 250, 256, 258  
 Couplings, rigid shaft, 252  
 Covers, miscellaneous, 44  
 Crane hooks, 150, 152  
 Cranes, 274, 276, 278, 280, 282  
 —, gantry, 274, 282  
 Crank, slider, 120  
 Crooke's tube, 484  
 Crossheads, 142, 144  
 Crowned pulleys, 224, 226  
 Crushing, 414, 416  
 Crystal rectifying effect, 484  
 Cultivator, 440  
 Cup-weld pipe joint, 58  
 Cutter, gears, 436  
 Cutting, acetylene, 52  
 — tools, 432, 434, 436, 438  
 Cyclone separator, 418  
 Cylinder valves, compressor, 340
- D
- Delayed action mercury switch, 514  
 Depth sounding recording, 518  
 Derricks, 278, 280  
 Detector circuit, 500  
 Diaphragm expansion valve, 342  
 — gage, 410  
 Diesel engine, 380  
 Differential gearing, 216  
 — governor, 216  
 — hydraulic accumulator, 216  
 — motions, 170, 172, 174, 176, 216  
 — piston, 216  
 — pulley, 148  
 Diode tube, 490  
 Direct current generator, 470  
 — return, hot water, 528  
 Disc and pin, locking, 24  
 — bearing, 102  
 — cam, 158  
 — cutter, 420  
 Distance rod, 88  
 Dolly, 426  
 Domed contacts, 512  
 Door catch, 28

— fastening staple, 28  
 — lever, 20  
 —, swing catch, 24  
 Doors, oven, 44  
 —, revolving, 44  
 Double acting pawl and lever,  
     190  
 — acting pump, 308  
 — end rod, 16  
 — piston crank motion, 210  
 Dough mixer, 422  
 Dovetail joint, wood, 70  
 Drainage wheel, 306  
 Drill, star, 4  
 Drilling, 430  
 Drop hammer movement, 166  
 Drum barrel switch, 508  
   — for ropes, 424  
 Drums, hoisting, 148  
 Dry cells, electric, 454  
 Dump cars, 396

## E

Eccentric, 158  
 —, steam valve, 366  
 Echo sounding, marine, 518  
 Edison three-wire system, 476  
 Egg beater, 422  
 Elastic spur gear, 176  
 Electric bell circuit, 450  
   — current, 486  
   — heating, 482  
   — unit heater, 482  
   — welding, 52  
 Electrical measurements, 462  
 Electrochemistry, 456  
 Electrode boiler, 482  
   — hot-water heater, 482  
 Electrolysis, water, 456  
 Electromagnetic apparatus, 484  
 Electromagnets, 450  
 Electron lens, 502  
   — theory, 486  
 Electronic tubes, 490

Electrons, 490  
 Electrophorus, 444  
 Electroscopes, 444  
 Elevator, bucket, 298, 300  
   —, hydraulic, 302  
 Eliminators, air washers, 554  
 Elliptical gearing, 170, 176  
   — trammels, 122  
 End mill, 436  
 Endless cord, 220  
 Energy, machine applications, 124  
 Engine crosshead and guides, 142  
   — frame, 88  
 Engines, early, 362  
 Epicyclic gear train, 174, 178  
 Epicycloidal parallel motion, 136  
 Equalizing gear, 172  
   — levers, 160  
 Escapement, clocks, 192, 194  
 Expanding and contracting mech-  
   anism, 268, 270  
   — mandrel, 38  
   — pulley, 170, 214, 226  
   — V-belt sheave, 214  
 Expansion joints, 66  
   — shields, 4  
   — tank, hot-water, 528  
 Expansive facing, 432  
 Eye bolts, 16

## F

Fabricated shapes, steel, 94  
   — welded shapes, 54  
 Fabrication, welded piping, 60  
 Face-plate stud switch, 508  
 Fan discharge connections, 552  
 Fans, ventilating, 334  
 Farm machinery, 440  
 Fast and loose pulleys, 224, 226  
 Faucet handle, 82  
 Feathering paddle, 134  
 Feeders, 294, 296, 298, 300  
 Fencing posts, 2  
 Ferrules, condensers, 8



- Fields, magnetic, 446  
 Filament, 492  
 Filter, radio, 500  
 Fire-box stays, 48  
 First order lever, 128  
 Fitter's clamp, 38  
 Flange joint, 68  
 Flat belt transmission, 222  
   — contacts, 512  
 Flat-point or bottoming drill, 430  
 Flexible coupling, 250, 256, 258  
   — joints, 66  
   — shaft couplings, 254, 256, 258  
   — shafting, 220  
 Float control, high side, 342  
   — control, low side, 342  
   — thermostatic traps, 526  
 Floor, planking, 72  
 Fluorescent lighting, 478  
 Fluted drills, 432  
 Focusing, electrostatic, 502  
 Foot lever, 128, 130  
 Footstep bearing, 100  
 Forging, 426  
 Forked lever, 128  
 Foundation plate, machine, 88  
 Four-cycle diesel, 380  
 Fourneyron turbine, 386  
 Fractures, steel, 114  
 France metallic packing, 318  
 Friction clutches, 198, 248, 250,  
   256, 258  
   —, rolling contact gearing, 180,  
   182, 184  
 Fuel oil strainer, 360  
 Fulcrum, rocking, 136  
 Fusible link, 348
- G**
- Gage plug, 408  
 Galvanometer, 462  
 Gantry cranes, 274, 276, 278,  
   280, 282  
 Gas filled tetrode, 504  
 Gas filled valves, 504  
   — turbines, 374  
 Gasometer, 270  
 Gate hook, 16  
   — valve, 344  
 Gear pullers, 196  
   — wheels, built-up, 162  
   —, worm, 124  
 Gearing, steam valve, 364  
   —, toothed, 164, 166, 168, 170,  
   172, 174, 176, 178  
 General-purpose shut-off valves,  
   344  
 Generators, electrical, 468  
 Gibs, 42  
 Gin-pole, 280  
 Girders, steel, 94  
 Globe valve, 344  
 Grab bucket, 152  
 Grabs, clamps, lifting, 288  
 Grapnel, 2  
 Grasshopper motion, 134  
 Grates, furnace, 356  
 Gravity feed, 346  
 Gravity hot-water system, 528  
 Gravity pawl and ratchet, 190  
 Gridiron valve, 364  
 Grids, 492  
 Grinding, 414, 416  
 Grip, vice, 34  
 Grips, 40  
   —, cable, 38  
 Groove, cam, 158  
 Guide vanes, turbines, 386  
 Guides and slides, 142, 144  
 Guillotine shears, 432
- H**
- Half-nut locking device, 20  
 Hand crank, 82  
   — holes, 44  
 Handle, valve, 84  
 Handles, machine tool, 84  
   —, miscellaneous, 86

- Handles, valve, 82  
 Hanger, shaft, 78  
 Hangers, ceiling, 104  
   —, pipe, 64  
 Hard vacuum tubes, 492  
 Hare's foot ratchet motion, 190  
 Harrow, 440  
 Hartford connection, 524  
 Hasp and staple, 26  
 Headers, pipe welded, 60  
 Heads, bolt, 8  
 Headstock, spindle, 202  
 Heart cam, 160  
 Heat measurements, 412  
 Heating, comfort, 520, 522, 524,  
   526, 528, 530, 532, 534, 536  
 Hele-Shaw radial piston pump,  
   328  
 Hertzian oscillator, 484  
 Hinged catch, 20  
 Hinges, 200  
 Hitches, rope, 292  
 Hob, spur gear, 436  
 Hoists, 148  
 Holder, grip, 34  
 Hollow gouge for wood, 434  
 Hook, lever locking, 26  
   —, bolts, 16  
 Hooker's universal joint, 204  
 Hooks, crane, 150, 152  
 Hopper cars, 396  
 Hopper type stoker, 358  
 Horseshoe core, 468  
   — type thrust block, 404  
 Hot water heating, 528  
   — wire instrument, 466  
 Humidifier, 554  
 Humidifying unit, 538  
 Hunting tooth worm gear, 170  
 Hydraulic elevator, 302  
   — oil bearing, 98  
   — power, 384  
   — press, 218, 428  
   — saw, 438  
   — turbine, 386  
 Hypoid gears, 164
- I
- I-Beam sections, 90  
   — support, 116  
 Impact rod, 166  
 Impulse ram, 308  
   — turbine guide vanes, 386  
 Inclination mercury switch, 514  
 Inclined plane, 124  
 Indented tooth, 188  
 Indicator, pressure, 410  
 Inductance, 488  
 Induction charging, 446  
   — coils, 458  
   — instrument, 466  
 Industrial processes, 406  
 Infrared heating, 480  
 Ink feeder, 294  
 Insulation fastener, 114  
 Intermittent circular motion, 186,  
   188  
   — motion, 170  
 Inverted bucket trap, 350  
 Irregular motion, 170, 172, 174
- J
- Jack, hydraulic, 302  
   —, rack and lever, 218  
   — screw, 124  
 Jaws, 40  
 Jet propulsion, 376, 378  
 Jets, 348  
 Jig clamps, 32, 34  
 Joint, ball, 204  
   —, expansion, 66  
   —, flexible, 66  
   —, masonry, 118  
   —, mortar, 118  
 Joints, miscellaneous metallic, 50  
   —, riveted, 46  
   —, sheet metal, 50  
   —, universal, 204, 260, 262, 264

- joints, woodworking, 70  
Jonval turbine, 386  
Journals, 100  
Junk-ring, 320
- K
- Keys, 42  
Kinematic chains, 120, 122  
Kinkless tetrode, 494  
Kneading mill, 422  
Knives, radial, 420  
Knob, 86  
Knots, rope, 290
- L
- Laboratory balance, 406  
Lacing, belt, 230  
Lag screw, 4  
Landing wheels, 394  
Latch, common, 24  
—, hook, 26  
Lateen rig, 400  
Lazy tongs, 268  
Leather packing, 316  
— rope drive, 232  
Lens grinder, 414  
Leveling, adjustment screw, 80  
Lever and crown ratchet, 28  
— handles, 84  
—, hinged lifting, 86  
— locking bar, 28  
Levers, 126, 128, 130  
—, welded shapes, 54  
Lids, miscellaneous, 44  
Lifeboat release, 130  
Lift bridge, 96  
—, pawl, 190  
Lifting grabs and clamps, 288  
— wedge, 218  
Light distribution, 478  
Lignum vitae bearings, 404  
Limit gage, 408  
Link motion, valve, 366  
Link, stud, 150, 152  
Link-belt ball bearings, 112  
Links and connecting rods, 138,  
140  
Liquid measuring tap, 408  
Lock nuts, 10  
Locking bar, 28  
— device, chain, 150  
— nuts, 6  
Locking pawl, 30  
Locomotive link motion, 366  
Long distance wire-rope transmis-  
sion, 244  
Loud-speaker, 498  
Lubrication, 346  
Lug sail, 400  
Luminares, 478
- M
- Machine screws, 6  
— tool, 38  
Machinery foundation, 88  
Magnetic compasses, 448  
— conditions in an alternator,  
474  
— focusing, 502  
— liquid shut-off valve, 342  
— separation, 418  
Main, dripping, 526  
Make and break mercury switch,  
514  
Mandrel, expanding, 38, 268  
Mangle rack, 166, 168  
Manholes, 44  
Marine anchor, 2  
— connecting rod, 140  
Masonry anchors, 2  
— joints, 118  
Measuring, 408  
Mercury clutch, 250  
— switches, 514  
Mesh, 418  
Metal bellows, 410  
Metallic pump packing, 318

- Micrometer, 408  
 Milling cutter, 436  
 Mincing, 420  
 Miscellaneous bolts, screws, 12  
 — metallic joints, 50  
 Miter joint, wood, 70  
 Mixers, 422  
 Monorail, 116  
 Moore's patent differential, 176,  
     216  
 Mooring screw for buoys, 2  
 Mortar joint, 118  
 Mortise and tenon joint, 72  
 Motion, parallel, 132, 134, 136  
 —, reciprocating and circular,  
     206, 208, 210  
 —, straight-line, 132, 134, 136  
 — transmission, 204, 220  
 Mousing rope, towing, 152  
 Movable coil system, 464  
 Moving indicators, 464  
 — part screw adjustment, 80
- N
- Nails, 18  
 Nest gearing, Jenkin's, 180  
 Newman's variable speed device,  
     214  
 Nozzles and jets, 348  
 Nuts, locking, 6  
 —, miscellaneous, 10  
 —, special, 8
- O
- Oil burners, vaporizing, 360  
 — cup, 346  
 — seals, 108  
 Oldham's coupling, 122  
 Ore washer, 424  
 Oscillating cylinder guide, 142,  
     144  
 — engine, 120  
 — ratchet, 186
- Oscillator circuit, 500  
 Overfeed traveling gate stoker,  
     358  
 Overshoot water wheel, 384  
 Oxy-acetylene torch, 438
- P
- Packing leather, 316  
 —, metallic, 318  
 Paddle, feathering, 134  
 — wheels, 404  
 Pan mixer, 422  
 Parallel bar, railway switches, 22  
 — motion, 132, 134, 138  
 — motion, Watt's, 122  
 — roller adjustment, 78  
 Paring gouge, wood, 434  
 Pawl, locking, 24  
 —, spring, 78  
 Pawls and ratchets, 186, 188, 190  
 Peck carrier, 298  
 Pedestal bearing, 102  
 Pelton water wheel, 384  
 Pendulum and ratchet, 190  
 — clock movement, 192, 194  
 — pump, 120  
 Perforated plate, straining, 418  
 Persian water lift, 306  
 Pile, concrete, 118  
 Pillow block, ball bearing, 112  
 Pin wheel, 188  
 Pinion and rack, 166  
 Pins, split, 42  
 Pipe cutter, 432  
 — hanger, spring, 114  
 — hangers, 64  
 Pipe joints, miscellaneous, 66  
 — roller supports, 62  
 Piping, welded, 60  
 Piston pumps, 310  
 Pistons, 320  
 Pitch-chain drive, 238  
 Pitot tube, 412  
 Pivot bearing, 98, 102

- Pivot bearing, conical, 76  
 — bearing lubrication, 346  
 Planetary motion, 170, 172, 174  
 Planing tool, 434  
 Plank, floor, 72  
 Plate clutch, 180  
 — condenser, 446  
 — valve slotted, 340  
 — welding, 52  
 Plough, 440  
 Plug gage, 408  
 Plugs, tank, 44  
 Plungers, pump, 320  
 Pneumatic caulking tool, 390  
 — drill, 390  
 — hammer, 390  
 — riveter, 390  
 — tires, 394  
 Polarization, batteries, 454  
 Pole step, 16  
 Poppet type valve, 340  
 Potato digger, 440  
 — planter, 440  
 Power augmentation, 218  
 — factor, 470  
 —, hydraulic, 384  
 — shovel, 298  
 Preheater, 360  
 Prescription weights, 406  
 Presses, 428  
 Pressure-reducing valve, 344  
 Prime movers, 362  
 Privy, septic, 442  
 Propeller fan unit heaters, 536  
 — shaft, marine, 404  
 Propellers, 404  
 Pug mill, 422  
 Pullers, gear, wheels, 196  
 Pulley, differential, 148  
 —, expanding, 170, 214  
 Pulleys, belts, 224, 226  
 —, wire rope, 242  
 Pulverizer, 416  
 Pump, pendulum, 120  
 — valves, 312, 314  
 Pumps, commercial, 310  
 —, rotary 322, 324, 326, 328, 330  
 —, rudimentary, 308  
 Purchase, 146
- Q
- Quick back motion, 166  
 — return, 120
- R
- Rabbeted joint, 72  
 Race, ball bearing, 108  
 Rack and pinion, 166, 168  
 — and screw press, 190, 428  
 Radar, navigation, 516  
 Radial slide, tool box, 144  
 Radiant heating, 532  
 — hot water heating, 530  
 Radiator connections, steam, 522  
 Radio circuits, 488  
 — communications, 498  
 Radius bar, 30  
 Ram, impulse, 308  
 Rapson's slide, 122  
 Ratchet and lever, 130  
 — brace, 190  
 — rod, 78  
 Ratchets and pawls, 186, 188, 190  
 Rattle barrel, polishing, 416  
 Raw plugs, 4  
 Receiver, telephone, 460  
 Receivers, condensate, 524  
 Reciprocating and circular mo-  
 tion, 206, 208, 210  
 — compressor valves, 336  
 — feeder, 296  
 — motion, 158, 160  
 Rectifier, half-wave, 500  
 Reflectors, 478  
 —, heating, 480  
 Refrigerating compressor valves,  
 336, 338

- Refrigeration, compression system, 546  
 — compressors, rotary, 334  
 — fluid control, 342  
 — systems, 544  
 Relays, 512  
 Releasing grip, pile driver, 28  
 Resistance thermometer, 412  
 Resistors in series, parallel, 486  
 Resonance, 488  
 Reverse ratchets, 188  
 Reverse-return, hot water, 528  
 Reversing and shifting gearing, 198  
 — gear, link, 138  
 Revolving cutter head, 432  
 — spiral cutter, 420  
 — spray, 348  
 Rigid shaft couplings, 252  
 Ring oiling, 346  
 — oiling bearing, 104  
 Rip saw, 438  
 Riser clamp, pipe, 62  
 Risers, drop, 522  
 Riveted joints, 46  
 Roberval balance, 406  
 Rock anchor, 2  
 — drills, 430  
 Rockets, 378  
 Rocking lever, 128  
 Rod lock, 28  
 — stopper with cam grip, 26  
 Roller bearings, 110  
 — chain drive, 238  
 — supports, pipe, 64  
 Rollers, guide, 142  
 Rolling friction contact gearing, 180, 182, 184  
 Roof truss, 94  
 Root's blower, 322  
 Rope drive, 220  
 — drive, textile, 234, 236  
 — fittings, 290  
 — guides, 144  
 — knots, 290  
 Rope lock, 28  
 Rotary engines, 368, 370  
 — pumps, 322, 324, 326, 328, 330  
 Rotating cylinders, 368  
 Rubber ball pawl, 190  
 — belts, 228  
 — tires, 394  
 Run-outs, steam, 526
- S
- Safety trip, 130  
 Sailboat types, 400, 402  
 Sanitation, 442  
 Saw types, 438  
 Sawmill feed, 166  
 Scale balance, parallel motion, 134  
 Scavenging blower, 380  
 Schiele's bearing, 102  
 Schooner rig, 400  
 Scope presentation, radar, 516  
 Scotch marine boiler, 354  
 Screen grid, 492  
 —, rotary, 418  
 — washer, cylindrical, 424  
 Screening, 418  
 Screw clamp, 34  
 —, differential, 80  
 —, jack, 218  
 —, lag, 4  
 — lock, 30  
 — principles, 124  
 — propeller, 404  
 — threads, 8  
 Screws, miscellaneous, 14  
 Scroll bevel gear, 176  
 — gearing, 172, 176  
 — saw, 432  
 Sea-wave power, 392  
 Secret screw attachment, 20  
 Self-aligning bearings, 110  
 Self-contained air conditioners, 538  
 Septic tank, 442

- Series wound, 476  
Set screws, 6  
Shackle, 150, 152  
—, swivel, 152  
Shaded-pole instrument, 466  
Shaft, bearing, 100  
— couplings, 252, 256  
— transmission, angular, 264  
Shakeproof lock washer, 6  
Shears, cutting, 218  
—, disc, 420  
Sheaves, chain hoist, 148  
Sheet metal joints, 50, 552  
Shields, expansion, 4  
Shifting and reversing gearing, 198  
Shrinker, tire, 130  
Shrunk ring fastener, 88  
Shunt wound, 476  
Sifting, 418  
Sight gravity feed oiling, 346  
Signal waves, 498  
Silver plating, 456  
Sine waves, 488  
Single-acting pump, 308  
Sleeve ball bearings, 108  
— weld joint, piping, 58  
Slicer, apple, 420  
Slicing, 420  
Slide gudgeon crank motion, 208  
Slide, Rapson's, 122  
— valve, 364  
Slider crank, 120  
Slides and guides, 142, 144  
Sliding bed, 144  
— bolt, common, 24  
— shaft lock, 28  
Slings, wire rope, 284, 286  
S-link, 152  
Slip rings, 470  
Slipper, adjustable, 142, 144  
Slitting discs, 432  
— saw, 436  
Sloop, 400  
Slot bearing, 98  
Slotted-yoke motion, 206  
Small switch control diagrams, 508  
Smithing, 426  
Snail wheel, 176  
Snap gage go and not go, 408  
— hook, 152  
Socket, taper, 40  
Sockets, tool, 32  
Solid and split pulleys, 226  
Sounder, telegraph, 450  
Spanner, 82  
Spectrometer, X-ray, 502  
Speed control, d-c, 476  
— measurements, 412  
— nuts, 10  
—, variable, friction gearing, 182  
Speedometer, 412  
Spikes, 18  
Spindle grips, 26  
Spindles and centers, 202  
Splicing, timber, 72  
Spiral gears, 164, 176  
— torsion spring, 76  
Split link, 152  
— pulleys, 226  
Spool, 424  
Spray nozzle, 348  
Spring grip, 34  
— hanger, pipe, 114  
— pawl, 30  
— snap, 30  
— spindle, 30  
Springs, 272  
Sprinkler head, automatic, 348  
Spur gears, 164, 176  
Stake puller, 218  
Stamp mill, 156  
— press, 428  
Stanchions, cast iron, 90  
Staples, BX, 4  
Star drill, 4  
Starting lever, 128  
Static electricity, 444  
Stays, adjustable, 74

- Stays, boilers, 48  
 Steady bearing, 404  
 Steam engine valve gearing, 364  
   — heating hookups, 520  
   — jet, 350  
   — mains, 526  
   — separator, 350  
   — traps, 350  
   — turbines, early, 370  
 Steel, structural, welding, 56  
 Steering wheel, parallel, 134  
 Stepped relays, 512  
 Stern tube, 404  
 Stiffeners, boiler, 48  
 Stokers, coal, 356  
 Stonebreaker, 414, 416  
   — work joints, 118  
 Stop nuts, 6  
 Stops for gears, 188  
   — for ratchet wheels, 188  
 Storage battery, 456  
 Straight line motion, 132, 134, 136  
 Straining, 418  
 Strap-head connecting rod, 140  
 Structural steel, welding, 56  
 Strut, trussed, 94  
 Stud link, 150  
 Studs, 6  
 Stump puller, 130  
 Supercharger, rotary, 334  
 Supports, miscellaneous, 114  
   —, welded, 92  
 Suspension bridges, 96  
 Swage block, 426  
 Swinging catch, 20  
   — pipe joint, 204  
 Switch control diagrams, 506  
 Swivel hook, 150, 152  
   — joint, lever, 128  
   — shackle, 152  
 Synchronizing test, 472
- T
- Tackles and blocks, 146  
 Tacks, carpet, 18  
 Tailstock, lathe adjustment, 76  
 Takeoffs, 552  
 Tangent galvanometer, 464  
 Tank support, 114  
 Taper socket, 40  
 Tapered bearings, 110  
   — sleeve bearing, 112  
 Tappets, 154, 156, 158, 160  
 T-bar, 86  
 T-catch, 26  
 Telegraph key, 450  
 Telephones, 460  
 Temperature controls, 542  
 Tenon and mortise joint, 72  
 Tetrode, 494  
 Texrope drive, 228, 232  
 Textile rope drive, 234, 236  
 Therma-galvanometer, 464  
 Thermally operated vacuum  
   switch, 510  
 Thermocouple, 412  
   — instrument, 464  
 Thermostat, expanding, 270  
 Thermostatic expansion valve,  
   342  
 Thermostats, 542  
 Threads, screw, 8  
 Three-wire distribution, 472  
 Throttle valve, 364  
 Thrust bearing, 98  
 Throw, crank, 158  
 Throwing in and out of gear, 196  
 Tighteners, belt, 224  
 Timber splite, 72  
 Timken ball bearing, 112  
 Tipping scale, 408  
 Tire shrinker, 130  
 Tires, 395  
 Toe bearing, 100  
 Toggle bolts, 4  
   — joint, 218  
   — joint lever, 130  
   — press, 428  
   — stone breaker, 218



- Tongs, 40, 426  
 —, grip, 218  
 Tongue and groove joint, 70  
 Tool box, 32  
 — holder, 32, 434  
 Toothed gearing, 164, 166, 168,  
     170, 172, 174, 176, 178  
 Torch, portable, 360  
 Torsion, fracture, 114  
 Tracks, 398  
 Trammel gear, 210, 212  
 Trammels, elliptical, 122  
 Tramway cable, 242  
 Transformers, 458  
 Transmission of motion, 204, 220  
   — shaft bearing, 104  
   —, wire rope, 244  
 Transmitter, telephone, 460  
 Transportation, 394  
 Trap condensate, 350  
 Trapeze hangers, pipe, 64  
 Treadle, foot, 126  
   — motion, 208, 210  
 Triode elements, 492  
 Trip, safety, 130  
   — scale, 406  
 Trolley, I-beams, 116  
 Trucks, car, 394, 398  
 Trunk guide, 142  
 Truss, roof, 94  
   —, timber, 72  
 Tube expander, 270  
   — rolling, 294  
 Tuned circuits, 488  
   — radiofrequency, 500  
 Tunnel boring head, 434  
 Turbine governor, 386  
 Turbines, steam, 370, 372  
 Turbo-charger, 374  
 Tuyere, blast, 348  
 Twist bit for wood, 430  
 Twisting flat bolt, 26  
 Two-cycle diesel, 380  
 Typical rotary pumps, 330
- U
- U-bends, 66  
 Umbrella spring catch, 30  
 Unhooking device, 130  
 Underfeed stoker, 356  
 Undershot water wheel, 384  
 Unit steam heaters, 536  
 Universal drafting square, 136  
   — joints, 204, 260, 262, 264  
   — motion, lever, 128  
 Unloaders, crane, 282  
 U-tube manometer, 410
- V
- Vacuum heating system, 520  
   — switches, 510  
 Valve gears, gas engines, 382  
   — rod guides, 142, 144  
   — rod motion, 156  
   — stem, stuffing box, 344  
 Valves, pump, 312, 314  
 Van Stone flange, 60  
 Vane damper, 464  
 Vanes, turbines, 386  
 Vapor-heating system, 520  
 Variable circular motion, 170,  
     172, 174  
   — crank pin motion, 160  
   — diameter drums, 214  
   — discharge rotary pump, 328  
   — motion, speed and power, 212,  
     214  
   — rectilinear motion, 158, 160, 172  
   — speed friction gearing, 182, 184  
 Variation, three phase voltage,  
     474  
 Vari-pitch texrope drive, 232  
 V-belts, 228, 232  
 V-connections, transformers, 458  
 V-drill for metal work, 430  
 Vehicle bodies, 396  
 Ventilating fans, 334  
 Venting, water closets, 442

- Vernier caliper, 408  
 Vertical sheave, adjustable, 76  
 V-grip, toothed, 34  
 V-grips, 40  
 V-guide, 142, 144  
 Vibrating rectilinear motion, 160  
   — toothed wheel, 188  
 Vibrator feeder, 294  
 Vices, 38  
 Vicker's axial piston pump, 326  
 Voith-Schneider propeller, 404  
 Voltaic cell, 454  
 Voltmeter, 462  
 V-pawl, 190
- W
- Wall brackets, pipe, 64  
   — eye, 2  
   — hanger, 104  
 Warm air heating, 534  
 Warping, timber, 72  
 Washers, lock, 8  
 Washing, 424  
 Watch and clock movements, 192,  
   194  
 Water closets, 442  
   — lifts, primitive, 306  
   — pressure regulator, 344  
   — tube boiler, 354  
 Wattmeter, 466  
 Watt's parallel motion, 122  
 Wave theory, 486  
 Waves, electromagnetic, 484  
 Web frames, 90  
 Wedge, 124  
   — cotter, 138, 140  
   — gearing, Robertson, 180  
   — plate, 22  
 Weighing, 406  
 Welded pipe joints, 58  
   — piping, 60  
   — shapes, fabricated, 54  
   — supports, 92  
 Welding, electric, 52  
   Welding steel plate, 52  
   Well boring tools, 430  
   Weston standard cell, 454  
   Weston's differential pulley block,  
     216  
   Wet return, 522  
   Wheel, hand, 86  
   — puller, 196  
   Wheels, 394  
   —, gear built-up, 162  
   —, water, 384  
   Wiffle tree, 134  
   Whip, single block, 146  
   Whipping, hitches, knots, 292  
   White metal, bearings, 100  
   Whitworth quick return, 120  
   Winches, 148  
   Winding, 424  
   Windlass, 124  
   Windmills, 388  
   Window ventilators, 536  
   Wiper cam, stamp mill, 160  
   Wipers, 154, 156, 158, 160  
   Wire fence notching, 28  
   — ring locking device, 22  
   — rope, 240  
   — rope grips, 38  
   — rope pulleys, 242  
   — rope slings, 284, 286  
   — wheels, 394  
   — winder, 424  
   Wood screws, 14  
   Wooden tank joint, 72  
   Woodworking joints, 70  
   Worm gears, 124, 166, 168, 170,  
     176
- X
- X-ray tube, 502
- Y
- Yoke connection, connecting rod,  
   140
- Z
- Zigzag cathodes, 504



