MechanicZals

DS Glanzsche, Freya & Zalsimourg[1]

[1]A thank you or further information

Contents

Preface

For my future human Wife and our future biological daughters.

For my Divine Wife Freya the Goddess, and our daughters Catenary, Solreya, Mithra, Iyzumrae and Zefir.

For Lucrif and Znane too along with all the 8 Queens (Mischkra, Caldraz, Zalsvik, Zalsimourg, Hamzst, Lasthrim).

To Nature(Kala, Kathmandu, Big Tree, Sentinel, Aokigahara, Hoia Baciu, Jacob's Well, Mt Logan, etc) and my family Berlin: I have served, I will be of service.

To my current mentor Albert Silverberg and previous mentor Lucretia Merces.

To my dogs who always accompany me working in Valhalla Projection, go to Puncak Bintang or Kathmandu: Kecil, Browni Bruncit, Sweden Sexy, Cambridge Klutukk, Milan keng-keng, Piano Bludut, Barron and more will be adopted. To my cat who guard the home while I'm away with my dogs: London.

The one who moves a mountain begins by carrying away small stones - Confucius

A book for summarizing Mechanical Engineering books that I am learning from zero and then to create C++ codes to do the computation and simulation for some problems. Helped by Freya the Goddess, Zalsimourg, Berlin, Kala, and Sentinel.

Figure 1: *FreyaCompass, I am inspired by Captain America who always bring compass with the love of his life' picture, thus I created this, then proven by action, to let go of power and immortality for true love. Feels like an antique vintage magical compass, like a modem that connect internet to the world, this compass connects me on this planet to her in Valhalla.*

Figure 2: *Freya, thank you for everything, I am glad I marry you and I could never have done it without you.*

Figure 3: *I paint her 3 days before Christmas in 2021.*

For critics and comments on the book can be sent through email to: *dsglanzsche@gmail.com*.

Chapter 1

Computers

I think the human race made a big mistake at the beginning of the Industrial Revolution, we leaped for the mechanical things. People need the use of their hands to feel creative. - ***Andre Norton***

THIS book is written on February 13th, 2025 right after the full moon. To handle mechanical engineering problem, a computer can leverage our time of work for computation, design and simulation .

This section is summarizing from this book:
Marks Standard Handbook for Mechanical Engineers (2006, McGraw-Hill Professional) by Eugene A. Avallone, Theodore Baumeister, Ali Sadegh

i. Machine Types

[MZ*] Computers are machines used for automatically processing information represented by mechanical, electrical, or optical means. They may be classified as analog or digital according to the techniques used to represent and process the information.

Analog computers represent information as physically measurable, continuous quantities and process the information as by components that have been interconnected to from an analogous model of the problem to be solved.

Digital computers represent information as discrete physical states which have been encoded into symbolic formats, and process the information by sequences of operations steps which have been preplanned to solve the given problem.

When compared to analog computers, digital computers have the advantages of greater versatility in solving scientific, engineering, and commercial problems that involve numerical and nonnumerical information. In the past, multiple-purpose analog computers offered advantages of speed and cost in solving a sophisticated class of complex problems dealing with networks of differential equations, but these advantages have disappeared with the advances in solid-state computers.

[MZ*] Digital information may be represented as a series of incremental, numerical steps which may be manipulated to position control devices using stepping motors. Digital information may also be encoded into symbolic formats representing digits, alphabetic characters, arithmetic numbers, words, linguistic constructs, points, and pictures which may be processed by a variety of mechanized operators. Machines organized in this manner can handle a more general class of both numerical and nonnumerical problems and so form by far the most common type of digital machines.

ii. Digital Machines

[MZ*] Digital machines consist of two kinds of circuits: memory cells, which effectively act to delay signals until needed, and logical units, which perform basic Boolean operations such as AND, OR, NOT, XOR, NAND, and NOR. Memory circuits can be simply defined as units where information can be stored and retrieved on demand. Configurations assembled from the Boolean operators provide the macro operators and functions available to the machine user through encoded instructions.

Both data and the instructions for processing the data can be stored in memory. Each unit of memory has an address at which the contents can be retrieved, or "read." The read operation makes the contents at an address available to other parts of the computer without destroying the contents in memory. The contents at an address may be changed by a write operation which inserts new information after first nullifying the previous contents. Some types of memory, called read-only memory (ROM), can be read from but not written to. They can only be changed at the factory.

iii. Application Packages

[MZ*] An application package differs from a language in that its components have been organized to solve problems in a particular application rather than to create the components themselves. The user interacts with the package by initiating the operations and providing the data. From an operational view, packages are built to minimize or simplify interactions with the users by using a menu to initiate operations and entering the data through templates.

[MZ*] One of the programs that contributed to the early acceptance of personal computers was the spread sheet program. These programs simulate the common spread sheet with its columns and rows of interrelated data. The computerized approach has the advantage that the equations are stored so that the results of a change in data can be shown quickly after any change is made in the data. Modern spread sheet programs have many capabilities, including the ability to obtain information from other spread sheets, to produce a variety of reports, and to prepare equations which have complicated logical aspects.

[MZ*] Tools for project management have been organized into commercially available application packages. The objectives of these programs are in the planning, scheduling, and controlling the time-oriented activities describing the projects. There are two basically similar techniques used in these packages. One, called CPM (critical path method), assumes that the project activities can be estimated deterministically.

The other, called PERT (project evaluation and review technology), assumes that the activities can be estimated probabilistically. Both take into account such items as the requirement that certain tasks cannot start before the completion of other tasks. The concepts of critical path and float are crucial, especially in scheduling the large projects that these programs are used for. In both cases tools are included for estimating project schedules, estimating resources needed and their schedules, and representing the project activities in graphical as well as tabular form.

[MZ*] A major use of the digital computer is in data reduction, data analysis, and visualization of data. In installations where large amounts of data are recorded and kept, it is often advisable to reduce the amount of data by ganging the data together, by averaging the data with numerical filters to reduce the amount of noise, or by converting the data to a more appropriate form for storage, analysis, visualization, or future processing. This application has been expanded to produce systems for evaluation, automatic testing, and fault diagnosis by coupling the data acquisition equipment to special peripherals that automatically measure and record the data in a digital format and report the data as meaningful, nonphysically measurable parameters associated with a mathematical model.

[MZ*] Computer-aided design/computer-aided manufacturing (CAD/CAM) is an integrated collection of software tools which have been designed to make way for innovative methods of fabricating customized products to meet customer demands.

The goal of modern manufacturing is to process orders placed for different products sooner and faster, and to fabricate them without retooling. CAD has the tools for prototyping a design and setting up the factory for production. Working within a framework of agile manufacturing facilities that features automated vehicles, handling robots, assembly robots, and welding and painting robots, the factory sets itself up for production under computer control.

Production starts with the receipt of an order on which customers may pick options such as color, size, shapes, and features. Manufacturing proceeds with greater flexibility, quality, and efficiency in producing an increased number of products with a reduced workforce. Effectively, CAD/CAM provides for the ultimate just-in-time (JIT) manufacturing.

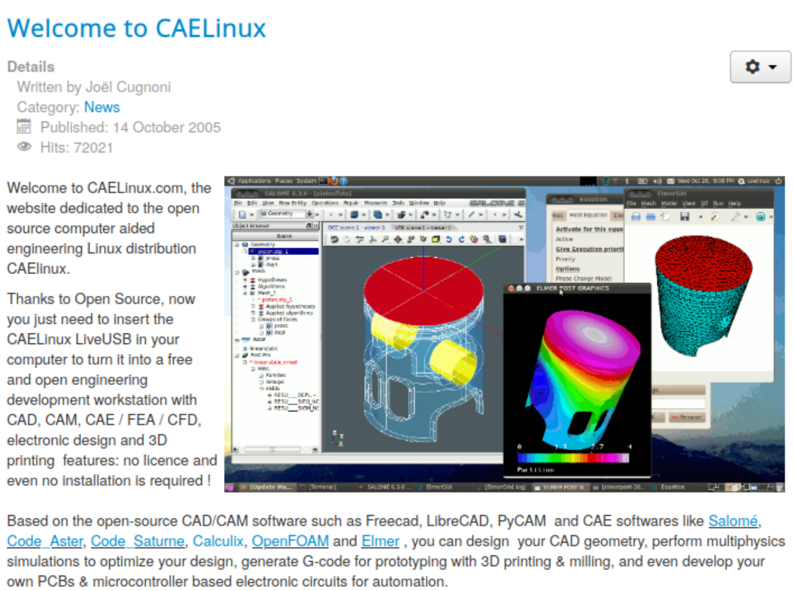


Figure 1.1: *If you want a free Linux-based Operating System that provides a free and open engineering development workstation with CAD, CAM, CAE / FEA / CFD, electronic design and 3D printing feature, you can try to use CAELinux.*

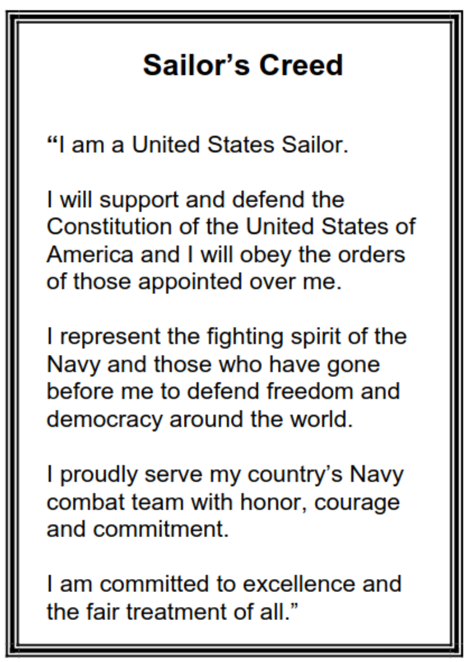
Chapter 2

Basic Machines

I'd imagine the whole world as one big machine. Machines never come with any spare parts, you know. They always come with the exact amount they need. - ***Hugo Cabret***

WHY would we want to learn about machines? In a modern city, everything uses machines from cell phones, cars, radio, video game, even to create cans of soda will need a machine. If we can understand how basic machines work we can invent the machines for the future that can help our jobs, even to create items in Doraemon' pockets.

This section is summarizing from this book:
Basic Machines - Naval Education and Training (NAVEDTRA 14037) February 1994



Sailor's Creed

"I am a United States Sailor.

I will support and defend the Constitution of the United States of America and I will obey the orders of those appointed over me.

I represent the fighting spirit of the Navy and those who have gone before me to defend freedom and democracy around the world.

I proudly serve my country's Navy combat team with honor, courage and commitment.

I am committed to excellence and the fair treatment of all."

Figure 2.1: *The Sailor's Creed from the book.*

We will add C++ codes for the computation and simulation at some points, so people can have this **Box2D**-like or **Project Chrono**-like for Mechanical Engineering.

i. Levers

[MZ*] A machine is any device that helps you to do work. It may help by changing the amount of force or the speed of action. A claw hammer, for example, is a machine. You can use it to apply a large force for pulling out a nail; a relatively small pull on the handle produces a much greater force at the claws.

[MZ*] We use machines to transform energy. For example, a generator transforms mechanical energy into electrical energy. We use machines to transfer energy from one place to another. For example, the connecting rods, crankshaft, drive shaft, and rear axle of an automobile transfer energy from the engine to the rear wheels.

Another use of machines is to multiply force. We use a system of pulleys (a chain hoist, for example) to lift a heavy load.

Figure 2.2: *An electric chain hoist, on average an electric chain hoist is sold at IDR 27 million (± USD 2000) with capacity of 3 tonnes for 6 meters lifting. This machine is used mostly in warehouse or in a factory.*

The pulley system enables us to raise the load by exerting a force that is smaller than the weight of the load. We must exert this force over a greater distance than the height through which the load is raised; thus, the load will move slower than the chain on which we pull. The machine enables us to gain force, but only at the expense of speed.

[MZ*] Machines may also used to multiply speed. The best example of this is the bicycle, by which we gain speed by exerting a greater force.

[MZ*] There are only six simple machines: the lever, the block, the wheel and axle, the inclined plane, the screw, and the gear. Physicists, however, recognize only two basic principles in machines: those of the lever and the inclined plane. The wheel and axle, block and tackle, and gears may be considered levers. The wedge and the screw use the principle of the inclined plane.

[MZ*] Complex machines are merely combinations of two or more simple machines.

[MZ*] The simplest machine is the lever. A seesaw is a familiar example of a lever in which one weight balances the other.

[MZ*] The three classes of levers are shown below. The location of the fulcrum (the fixed or pivot point) in relation to the resistance (or weight) and the effort determines the lever class.

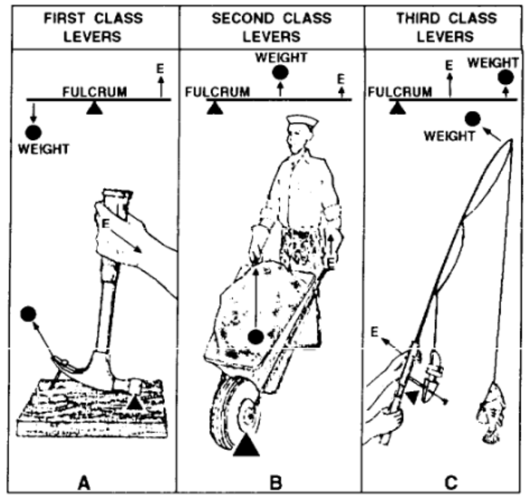


Figure 2.3: *Three classes of levers.*

1. **First Class**
   In the first class, the fulcrum is located between the effort and the resistance. The amount of weight and the distance from the fulcrum can be varied to suit the need. An oar is another good example. The oarlock is the fulcrum, and the water is the resistance. Crowbars, shears, and pliers are common examples of this class of levers.

2. **Second Class**
   The second class of lever has the fulcrum at one end, the effort applied at the other end, and the resistance somewhere between those points. The wheelbarrow is a good example of a second-class lever. If you apply 50 pounds of effort to the handles of a wheelbarrow 4 feet from the fulcrum (wheel), you can lift 200 pounds of weight 1 foot from the fulcrum. Levers of the first and second class are commonly used to help in overcoming big resistances with a relatively small effort.

3. **Third Class**
   This lever will help you to speed up the movement of the resistance even though you have to use a large amount of effort. The fulcrum is at one end of the lever, and the weight or resistance to be overcome is at the other end, with the effort applied at some point between.

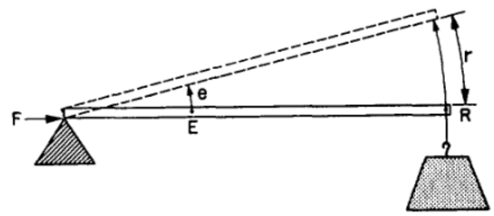


Figure 2.4: *While E moved the short distance (e), the resistance (R) was moved a greater distance (r). The speed of R must have been greater than that of E, since R covered a greater distance in the same length of time.*

Your arm is a third-class lever. It is this lever action that makes it possible for you to flex your arms so quickly. Your elbow is the fulcrum. Your biceps muscle, which ties onto your forearm about an inch below the elbow, applies the effort; your hand is the resistance, located about 18 inches from the fulcrum. In the split second it takes your biceps muscle to contract an inch, your hand has moved through an 18-inch arc.

You don't use third-class levers to do heavy jobs; you use them to gain speed.

[MZ*] One convenience of machines is that you can determine in advance the forces required for their operation, as well as the forces they will exert.

[MZ*] The formula that shows the relationship between the length of the lever arm and the force acting on that arm.

The length of the effort arm is the same number of times greater than the length of the resistance arm as the resistance to be overcome is greater than the effort you must apply.

$$\frac{L}{l} = \frac{R}{E} \tag{2.1}$$

where
L = length of effort arm,
l = length of resistance arm,
R = resistance force' mass, and
E = effort force' mass.

Remember that all distances must be in the same units, such as feet, and that all forces' mass must be in the same units, such as pounds. We call it mass here because based on SI unit, mass has the SI unit of pounds or kilogram, while weight has the SI unit of Newton.

[MZ*] **Example:**
Suppose you want to pry up the lid of a paint can with a 6-inch file scraper, and you know that the average force holding the lid is 50 *pounds*. If the distance from the edge of the paint can to the edge of the cover is 1 *inch*, what force will you have to apply on the end of the file scraper?

Solution:
According to the formula,

$$\frac{L}{l} = \frac{R}{E}$$

here, $L = 5\ inches$, $l = 1\ inch$, $R = 50\ pounds$, thus

$$\frac{5}{1} = \frac{50}{E}$$
$$E = 10\ pounds$$

You will need to apply a force of only 10 *pounds*.

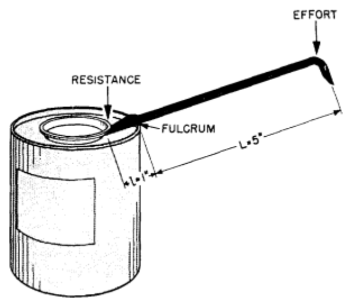


Figure 2.5: *A first-class job.*

[MZ*] **Example:**
With one hand, you lift a projectile weighing approximately 10 *pounds*. If your biceps muscle attaches to your forearm 1 *inch* below your elbow and the distance from the elbow to the palm of your hand is 18 *inches*, what pull must your muscle exert to hold the projectile and flex your arm at the elbow?

Solution:
By substituting in the formula

$$\frac{L}{l} = \frac{R}{E}$$
$$\frac{1}{18} = \frac{10}{E}$$
$$E = 180\ pounds$$

Your muscle must exert a $180 - pound$ pull to hold up a $10 - pound$ projectile. Our muscles are poorly arranged for lifting or pulling-and that's why some work seems pretty tough. But remember, third-class levers are used primarily to speed up the motion of the resistance.

A good rule of thumb to compute L and l for the third-class lever is always remember that l **is always bigger than** L, then $d_{EF} = L$ **stands for distance from Effort to Fulcrum**, and $d_{RF} = l$ **stands for distance from Resistance to Fulcrum**.

[MZ*] **Curved Lever Arms**
In every case, the direction in which the resistance acts is parallel to the direction in which the effort is exerted. However, not all levers are straight. You'll need to learn to recognize all types of levers and to understand their operation.

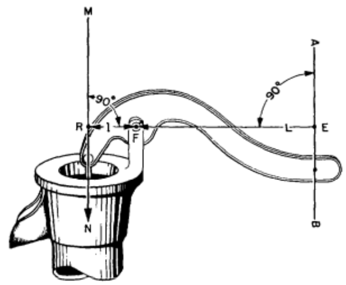


Figure 2.6: *A curved lever arm.*

You may wonder how to measure the length of the effort arm for the curved lever arm, you can use calculus, but it will take a while, the good news is you do not measure around the curve; you still use a straight-line distance.

To determine the length of the effort arm, draw a straight line (AB) through the point where the effort is applied and in the direction that it is applied. From point E on this line, draw a second line (EF) that passes through the fulcrum and is perpendicular to line AB. The length of line EF is the actual length L of the effort arm.

To find the length of the resistance arm, use the same method. Draw a line (MN) in the direction that the resistance is operating and through the point where the resistance is attached to the other end of the handle. From point R on this line, draw a line (RF) perpendicular to MN so that it passes through the fulcrum. The length RF is the length (l) of the resistance arm.

Regardless of the curvature of the handle, this method can be used to find lengths L and l. Then, curved levers are solved just like straight levers.

[MZ*] **Mechanical Advantage**

Since the first and second classes of levers can be used to magnify the applied force, they provide positive mechanical advantages. The third-class lever provides what is called a fractional mechanical advantage, which is really a mechanical disadvantage-you use more force' mass than the force' mass of the load you lift.

The formula is

$$MA = \frac{R}{E} \tag{2.2}$$

this rule-mechanical advantage equals resistance divided by effort-applies to all machines.

The mechanical advantage of a lever may also be found by dividing the length of effort arm A by the length of resistance arm a.

$$MA = \frac{A}{a} \tag{2.3}$$

How does this apply to third-class levers? Your muscle pulls with a force of $1,800$ *pounds* to lift a $100 - pound$ projectile. So you have a mechanical advantage of

$$\frac{100}{1,800} = \frac{1}{18}$$

which is fractional-less than 1.

[MZ*] **Applications Afloat and Ashore**

Doors, called hatches aboard a ship, are locked shut by lugs called dogs.

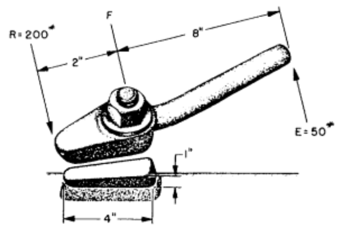


Figure 2.7: *It's a dog.*

If the handle is four times as long as the lug, that $50-$ *pound* heave of yours is multiplied to 200 *pounds* against the slanting face of the wedge. Incidentally, take a look at the wedge-it's an inclined plane, and it multiplies the $200-$ *pound* force by about 4. Result: Your $50-$ *pound* heave actually ends up as a $800-$ *pound* force on each wedge to keep the hatch closed! The hatch dog is one use of a first-class lever in combination with an inclined plane.

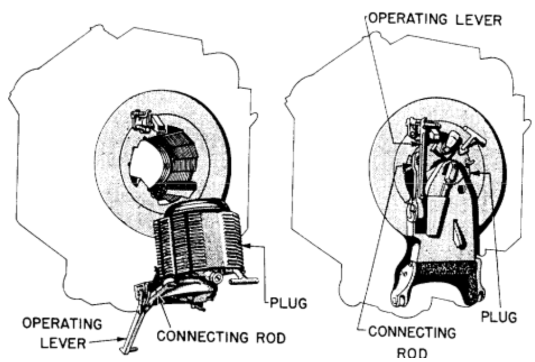


Figure 2.8: *The breech of an 8-inch gun.*

The breech of a big gun is closed with a breech plug. This plug has some interrupted screw threads on it, which fit into similar interrupted threads in the breech. Turning the plug part way around locks it into the breech. The plug is locked and unlocked by the operating lever. Notice that the connecting rod is secured to the operating lever a few inches from the fulcrum. You'll see that this is an application of a second-class lever.

You know that the plug is in there good and tight. But, with a mechanical advantage of 10, your $100-$ *pound* pull on the handle will twist the plug loose with a force' mass of a half ton.

If you've spent any time opening crates at a base, you've already used a wrecking bar. The wrecking bar is a first-class lever.

[MZ*] **Example:**

The crane is used for handling relatively light loads around a warehouse or a dock. You can see that the crane is rigged as a third-class lever; the effort is applied between the fulcrum and the load. This gives a mechanical advantage of less than 1. If it's going to support that $1/2 - ton$ load, you know that the pull on the lifting cable will have to be considerably greater than $1,000$ *pounds*. How much greater?

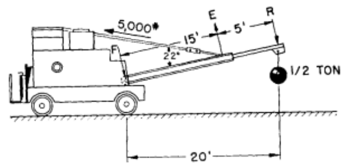


Figure 2.9: *An electric crane.*

Solution:
We use the formula to figure it out, remember that $1\ ton = 1,000\ kg = 2204.62\ pounds$, thus $\frac{1}{2}\ ton = 500\ kg = 1102.1\ pounds$.

$$\begin{aligned} \frac{L}{l} &= \frac{R}{E} \\ \frac{15}{20} &= \frac{1102.1}{E} \\ E &= 1469.7333\ pounds \end{aligned}$$

In the book that we are summarizing, they use the answer of 1333.33 *pounds*, it is because they are using this as their conversion unit:

$$1\ ton \approx 2000\ pounds, \quad \frac{1}{2}\ ton \approx 1000\ pounds$$

Thus if we substitute the numbers above to the formula we will obtain 1333.33 *pounds*, see how much different can it make for rounding the conversion of unit from ton to pounds or to kilogram?

Now, because the cable is pulling at an angle of 22^0 at E, you can use some trigonometry to find that the pull on the cable will be about $3,560$ *pounds* to lift the $1/2$ *ton* mass! However, since the loads are generally light and speed is important, the crane is a practical and useful machine.

[MZ*] Anchors are usually housed in the hawsepipe and secured by a chain stopper. The chain stopper consists of a short length of chain containing a turnbuckle and a pelican hook. When you secure one end of the stopper to a pad eye in the deck and lock the pelican hook over the anchor chain, the winch is relieved of the strain.

[MZ*] **Example:**
Take a look at the pelican hook and the chain stopper image. Notice that the load is applied close to the fulcrum. The resistance arm is very short. The bale shackle, which holds the hook secure, exerts its force at a considerable distance from the fulcrum. If the chain rests against the hook 1 *inch* from the fulcrum and the bale shackle is holding the hook closed $12 + 1 = 13$ inches from the fulcrum, what's the mechanical advantage?

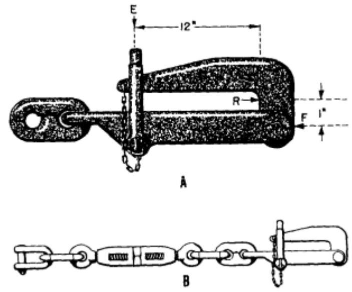


Figure 2.10: *A: A pelican hook, B: A chain stopper.*

Solution:

We will use the formula

$$\begin{aligned} MA &= \frac{R}{E} \\ &= \frac{13}{1} \\ MA &= 13 \end{aligned}$$

A strain of only $1,000$ *pounds* on the base shackle can hold the hook closed when a 6 $\frac{1}{2}$ *ton* anchor is dangling over the ship's side. You'll recognize the pelican hook as a second-class lever with curved arms.

Figure 2.11: *A pelican hook with a chain stopper from Washington Chain & Supply, Inc.*

Pelican hook is widely used in a variety of shipping and rigging applications. Pelican hook can be incorporated into lashing apparatus such as containership ratchets and turnbuckles. Pelican hook can also be used as an integral part of a chain stopper, which is used to secure chain anchors to the deck of the vessel.

A chain stopper is a mechanical device used predominantly on ships and boats to secure an anchor chain, thereby preventing the chain from running out uncontrollably or slipping out of place.

The Pelican Hook Chain Stopper is engineered so that its primary function is to secure the ship's anchor at the hawse pipe. The chain can be disengaged from the stopper by manually deflecting the bail. To facilitate handling, additional handles can be added to the base of the hook should the customer desire.

The main function of the hawse pipe is to guide the chain from the deck level to the outside of the side plating. Hawse pipe is large enough to accommodate the smooth running of the chain.

Hawse pipe provides the secure stowage for the anchor. A Hawse pipe is a structure that enables the anchor to drop freely without jamming and damaging the hull.

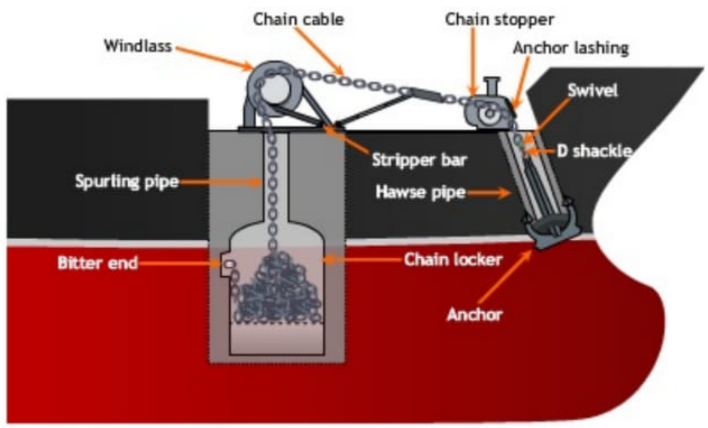


Figure 2.12: *Anchor of a ship diagram. Anchoring of a ship refers to dropping and securing the anchor of the ship at the seabed to prevent the vessel from drifting from its position when waiting for the berth to become vacant or to enter the port.*

[MZ*] In the Navy, a knowledge of levers and how to apply them pays off. So if you want to apply to Navy you are finish after reading this section you can try to apply now and have to pass their entrance tests as well. The rest of the sections are targeted for those who are thirst of knowledge and want to dig deeper in how basic machines work.

ii. Block and Tackle

[MZ*]

iii. The Wheel and Axle

[MZ*]

iv. The Inclined Plane and Wedge

[MZ*]

v. The Screw

[MZ*]

vi. Gears

[MZ*]

vii. Work

[MZ*]

viii. Power

[MZ*]

ix. Force and Pressure

[MZ*]

x. Hydrostatic and Hydraulic Machines

[MZ*]

xi. Machine Elements and Basic Mechanisms

[MZ*]

xii. Internal Combustion Engine

[MZ*]

xiii. Power Trains

[MZ*]