CHAPTER VIII.

MECHANICS (CONTINUED).

THE MECHANICAL POWERS.

NUMEROUS and varied as machines are, they are all combinations of six Simple Mechanical Powers, known as the Le'-ver, the Wheel and Axle, the Pulley, the Inclined Plane, the Wedge, and the Screw. These we shall consider in turn.

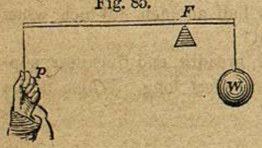
The Lever.

201. A Lever is an inflexible bar, capable of being moved about a fixed point, called the Fulcrum.

The lever is the simplest of the mechanical powers. Its properties were known as far back as the time of Aristotle, 350 years B. C. Archimedes, a hundred years later, was the first to explain them fully.

202. KINDS OF LEVER.—In the lever three things are to be considered; the fulcrum, or point of support, the weight, and the power. Two of these are at the ends of the bar, while the other is at some point between them. According to their relative position, we have three kinds of levers:—

Fig. 85.



A Lever of the First Kind is one in which the fulcrum is between the power and the weight; as in Fig. 85, where F represents the fulcrum, P the power, and W the weight.

A Lever of the Second Kind is one in which the weight is between the power and the fulcrum; as in Fig. 86.

Of what are all machines combinations? Name the six Simple Mechanical Powers. 201. What is a Lever? How does the lever compare with the other mechanical powers? How long ago was it known? 202. In the lever, how many things are to be considered? According to their relative position, how many kinds of levers are there? What is a Lever of the First Kind? What is a Lever of the Second Kind?

Fig. 86.

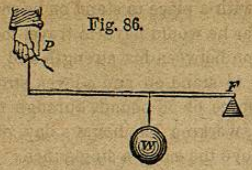
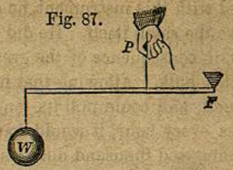


Fig. 87.



A Lever of the Third Kind is one in which the power is between the weight and the fulcrum; as in Fig. 87.

203. LEVERS OF THE FIRST KIND.—In levers of the first kind, the relative position of the three important points is

POWER FULCRUM WEIGHT OR WEIGHT FULCRUM POWER.

Fig. 88.

THE CROW-BAR.

Fig. 88 shows one of the commonest forms in which this kind of lever appears,—the crow-bar. The power is applied at the handle. The weight is at the other end, and consists of something to be moved. The fulcrum is a stone on which the crow-bar rests. Using an instrument in this way is called *prying*.

204. The nearer the fulcrum is to the weight the greater the advantage gained, and consequently the greater the space that P will have to pass through in moving W a given distance. This principle is stated in the following

Law.—With levers of the first kind, intensity of force is gained, and time is lost, in proportion as the distance between the power and the fulcrum exceeds the distance between the weight and the fulcrum.

Thus, in Fig. 88, if the distance from P to F be five times as great as that from W to F, a pressure of 10 pounds at P will just counterbalance a weight of 50 pounds at W, and will therefore move anything under 50 pounds; while, for every inch that W is moved upward, P will have to move five inches downward.

The distance through which the power must pass, to move a weight vastly greater than itself, becomes an important matter in practical applications of the lever. When Archimedes saw the immense power that could be ex-

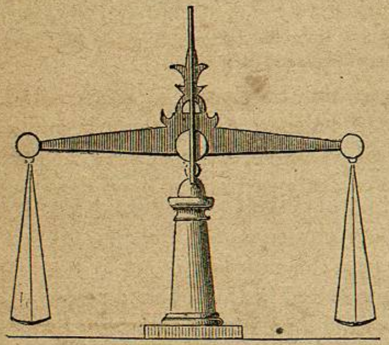
---

What is a Lever of the Third Kind? 203. In levers of the first kind, what is the relative position of the three important points? Give a familiar example of a lever of the first kind, and show its operation. 204. What is the law of levers of the first kind? Illustrate this with Fig. 88. What is sometimes an important matter in pracerted with this instrument, he declared that with a place to stand on he could move the earth itself. He did not say how far he would have to travel to do this, in consequence of the great disproportion between his strength and the earth's bulk. Allowing that he had a place to stand on and a lever strong enough, and could pull its long arm with a force of 30 pounds through two miles every hour, it would have taken him, working ten hours a day, over one hundred thousand millions of years to move the earth a single inch!

205. *The Balance.*—When bodies of equal weight are supported by the arms of a lever, they will balance each other when placed at equal distances from the fulcrum, as in Fig. 89. They are then said to be *in equilibrium.*

Fig. 89.

Fig. 90.



THE BALANCE.

On this principle the common Balance, represented in Fig. 90, is constructed. A beam is poised on the top of a pillar, so as to be exactly horizontal. From each end of the beam, at equal distances from the fulcrum, a pan is suspended by means of cords. The object to be weighed is placed in one of these pans, and the weights in the other.

When great accuracy is required, the beam is balanced on a steel knife-edge; the friction being thus lessened, it turns more easily. A balance capable of weighing ten pounds has been made so sensitive as to turn with the thousandth part of a grain.

206. The balance weighs correctly only when the arms of the beam are exactly equal. Hence dishonest tradesmen sometimes defraud those with whom they deal by throwing the fulcrum a little nearer one end of the beam than the other. When buying, they place the commodity to be weighed in the scale attached to the short arm; and, when selling, in the other, thus making double gains. To prove a balance, weigh an article first in one scale and then in the other; if there is any difference in the weight, the balance is not true.

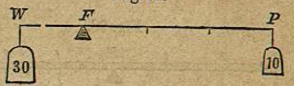
---

tical applications of the lever? Show this in the supposed case of Archimedes. 205. When are two bodies of equal weight, supported by the arms of a lever, said to be in equilibrium? What is constructed on this principle? Describe the Balance. When great accuracy is required, how is the beam balanced? How sensitive has a balance been made? 206. When does the balance weigh correctly? How do dishon-

The true weight of a body may be determined, with a false balance, by placing it in either scale, balancing it with shot or sand, and then removing the body and replacing it with weights till equilibrium is established. This is called *double weighing.* It must give the true weight; for whatever error is made in the first weighing is corrected in the second.

207. *The Steelyard.*—When bodies of unequal weight are supported by the arms of a lever, they will balance each other whenever the weight of the one multiplied into its distance from the fulcrum, is equal to the weight of the other multiplied into its distance from the fulcrum.

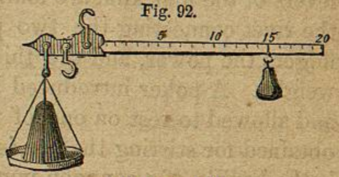
Fig. 91.



In Fig. 91, let the distance WF be one inch and PF three inches. The weight of the one body, 30 pounds, multiplied into its distance from the fulcrum, 1, gives 30; the weight of the other, 10 pounds, multiplied into its distance from the fulcrum, 3, gives 30. These products being equal, the bodies will balance each other.

208. On this principle the Steelyard is constructed. The Steelyard is a kind of balance, which, though not so sensitive as the one described above, answers very well for heavy bodies, and is conveniently carried, as it requires but a single weight, and may be held in the hand or suspended anywhere.

Fig. 92.



THE STEELYARD.

Fig. 92 represents the steelyard. It is a lever of unequal arms; from the shorter of which the article to be weighed is suspended, either directly or in a scale-pan, while a constant weight is moved on the longer arm from notch to notch till equilibrium is established. The number at the notch on which the weight then rests, shows the required weight in pounds. Thus, 15 pounds is the weight of the sugar-loaf in the Figure. The proper distances for the notches are found in the first place by experiments with known weights in the scale-pan.

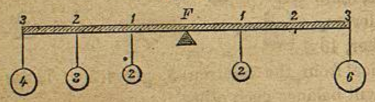
To enable the steelyard to weigh still heavier objects without increasing

---

est tradesmen sometimes defraud those with whom they deal? How may a balance be proved? How may the true weight of a body be determined with a false balance? What is this process called? 207. When will bodies of unequal weight supported by the arms of a lever be in equilibrium? Illustrate this with Fig. 91. 208. What is constructed on this principle? Describe the Steelyard, and the mode of weighing with it. How are the proper distances for the notches found in the first place? With the length of its beam, it is often provided with an additional hook, hanging in an opposite direction from the other hook and nearer the point from which the article to be weighed is suspended. When the instrument is supported by this hook, a new fulcrum is formed, and the weight is shown by a new row of notches adapted to it. The greater the difference of length between the arms of a steelyard, the greater the number of pounds that it can weigh.

209. When more than two bodies are supported on the arms of a lever, if the weight of each be multiplied by its distance from the fulcrum, the lever will be in equilibrium (that is, the bodies will balance each other) when the sums of the products on the two sides of the fulcrum are equal.

Fig. 93.

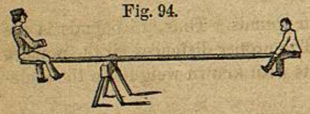


Thus, in Fig. 93 equilibrium is maintained, because the products of the weights on one side into their distances, added together, equal the sum of the products on the other:—

weights		*distances*			*weights*		*distances*		
2	×	1	=	2	2	×	1	=	2
3	×	2	=	6	6	×	3	=	18
4	×	3	=	12					
Sum of products,				20	*Sum of products,*				20

210. *Practical Applications.*—Familiar examples of levers of the first kind are found in the scissors and pincers; the rivet connecting the two parts being the fulcrum, the fingers the power, and the thing to be cut or grasped the weight. A poker introduced between the bars of a grate and allowed to rest on one of them, that *purchase* may be obtained for stirring the fire, is a lever of the first kind. So is the handle of a common pump.

Fig. 94.



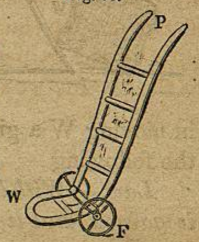
When children teeter on a board balanced on a wooden horse, they use a lever of the first kind. According to the principles of the lever, if one is heavier than the other, to preserve the balance, he must sit nearer the fulcrum, as shown in Fig. 94.

what are some steelyards provided, and for what purpose? What steelyards weigh the greatest number of pounds? 209. If more than two bodies are supported on the arms of a lever, when will they balance each other? Apply this principle in Fig. 93. 210. Give some familiar examples of levers of the first kind. When children teeter on a board, what kind of lever do they use? If one is heavier than the other, where

211. *Bent Levers.*—Sometimes the arms of a lever are bent, instead of straight. In that case the same principles hold good, only that the arms of the lever are estimated, not by their actual length, but by the perpendicular distance from the fulcrum to the line of direction in which the power and weight respectively act.

As an illustration of bent levers of the first kind, we may take the truck used for moving heavy articles, represented in Fig. 95. The axis on which the wheels turn represents the fulcrum; the weight is applied at W, and the power at P. The clawed side of a hammer, used in drawing out nails, is also a bent lever. The fixed point on which the head of the hammer rests is the fulcrum; the friction of the nail is the weight; and the power is applied at the extremity of the handle.

Fig. 95.

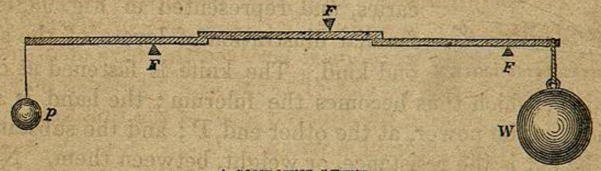


THE TRUCK.

212. *Compound Levers.*—Simple levers of the first kind may be combined into Compound Levers.

213. In compound levers, equilibrium is established when the power, multiplied by the first arms of all the levers, is equal to the weight multiplied by the last arms of all the levers.

Fig. 96.



A COMPOUND LEVER.

Thus, in Fig. 96, which represents a compound lever formed of three simple ones, let the long arm of each lever be three times the length of its short arm; then 1 pound at P will balance 27 pounds at W, because

$$1 \text{ pound} \times 3 \times 3 \times 3 = 27 \text{ pounds} \times 1 \times 1 \times 1.$$

214. Levers of the Second Kind.—In levers of the second kind, the relative position is

must he sit to preserve the balance? 211. What is meant by a bent lever? How are the arms of a bent lever estimated? Give some familiar examples of bent levers. 212. How may simple levers of the first kind be combined? 213. When is equilibrium established in a compound lever? Illustrate this with Fig. 96. 214. In levers

POWER WEIGHT FULCRUM OR FULCRUM WEIGHT POWER.

Fig. 97.

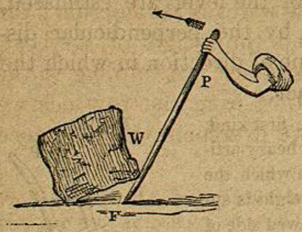


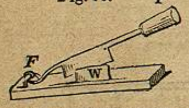
Fig. 97 shows how the crow-bar may be used as a lever of the second kind. The power is applied at the handle; the fulcrum is at the other end, and the weight to be moved is between them.

215. The nearer the weight is to the fulcrum the greater the advantage gained, and consequently the greater the space that P will have to pass through in moving W a given distance. This principle is stated in the following

Law.—With levers of the second kind, intensity of force is gained, and time is lost, in proportion as the distance between the power and the fulcrum exceeds the distance between the weight and the fulcrum.

Thus, in Fig. 97, if the distance P F be five times as great as W F, a pressure of 10 pounds at P will counterbalance a weight of 50 pounds at W, and move any thing under 50 pounds; while, for every inch that W is moved, P will have to move five inches in the same direction.

Fig. 98.



THE CHIPPING-KNIFE.

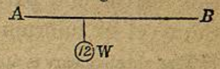
216. *Practical Applications.*—The common chipping-knife, used by apothecaries, and represented in Fig. 98, is a familiar illustration of levers of the second kind. The knife is fastened at one end, F, which thus becomes the fulcrum; the hand is applied, as the power, at the other end, P; and the substance to be cut is the resistance, or weight, between them. Nut-crackers and lemon-squeezers work on the same principle, and are levers of the second kind.

A door turned on its hinges, and an oar used in rowing, are also examples of this kind of lever. In the former case, the hinge is the fulcrum; the hand applied at the knob is the power; and the weight of the door, which may be regarded as concentrated in its centre of gravity somewhere between the two, is the resistance. In the latter case, the point at which the oar enters the water is the fulcrum; the rower's hand is the power; and the weight of the boat, acting at the row-lock, is the resistance. According to the law laid down in § 215, the further from the row-lock we grasp the oar, the more easily we overcome the resistance and produce motion.

of the second kind, what is the relative position of the three important points? How may the crow-bar be used as a lever of the second kind? 215. What is the law of levers of the second kind? Apply this in Fig. 97. 216. What familiar articles will serve as illustrations of levers of the second kind? Show how a door turned on its hinges is

217. Two persons carrying a weight suspended from a stick between them, use a double lever of the second kind. Power is applied at each end, and each end in turn becomes the fulcrum to the other, the weight resting on some intermediate point. The relation of the power at one end to the weight is governed by the same law as that of the power at the other end; and therefore the weight, to be divided equally, must be suspended from the middle of the stick. If it is not so suspended, the man who is nearer the weight carries more than the other in proportion as he is nearer.

Fig. 99.



Thus, let a 12-pound weight, W, be suspended from a bar three feet long, at a distance of one foot from A and two feet from B. Then A will carry two-thirds of the weight, and B one-third. On this principle, when it is desired that one of the horses harnessed to a carriage should draw more than the other, it is necessary only to make the arm of the whiffle-tree to which he is attached proportionally shorter.

Fig. 100.

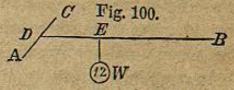


Fig. 100 shows how a weight may be equally distributed between three persons. B, being twice as far from E as D is, bears one-third of the weight, W; while A and C, at the extremities of the equal-armed lever A D C, bear equal portions of the remaining two-thirds, or one-third each.

Fig. 101.

218. Levers of the Third Kind.—In levers of the third kind, the relative position is

FULCRUM POWER WEIGHT OR WEIGHT POWER FULCRUM.

The forceps, represented in Fig. 101, is a lever of the third kind. The two sides unite at one end to form the fulcrum; the article to be grasped is the weight; and the fingers, applied between the two, constitute the power.

219. Levers of the third kind, unlike those before described, involve a mechanical disad-

a lever of the second kind. Show how an oar acts as a lever of the second kind. 217. When two persons carry a weight suspended from a stick between them, what kind of a lever do they use? Where is the fulcrum? To be equally divided, where must the weight be suspended? If the weight does not hang from the middle of the vantage; that is, to produce equilibrium, the power must always be greater than the weight.

Law.—With levers of the third kind, intensity of force is lost, and time is gained, in proportion as the distance from the weight to the fulcrum exceeds the distance from the power to the fulcrum.

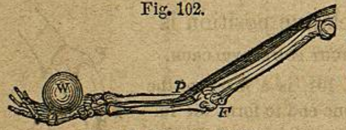
Thus, in Fig. 101, if F W be three times as great as F P, it will require a power of three pounds at P to counterbalance a resistance of one pound at W. Levers of this class, therefore, are never used when great power is required, but only when a slight resistance is to be overcome with great rapidity.

220. *Practical Applications.*—The sugar-tongs, which resembles in shape the forceps above described, is a familiar example of the third kind of lever. So is the fire-tongs; and hence the difficulty of raising heavy pieces of coal with this instrument, particularly when the hand is applied near the rivet or fulcrum.

The sheep-shears is another lever of the third kind, admirably adapted to the work it performs; because the wool, being flexible, has to be cut rapidly, while it does not require any great degree of force.

A door becomes a lever of the third kind when one attempts to move it by pushing at the edge near the hinges. The mechanical disadvantage is shown by the great strength required to move it when the power is there applied. So, when a painter attempts to raise a ladder lying on the ground with its bottom against a wall, by lifting the top and walking under it grasping round after round in succession, he experiences great difficulty as he approaches the bottom, because the ladder, when he passes its centre of gravity, becomes a lever of the third kind.

Fig. 102.



HUMAN ARM AND HAND.

Nature uses levers of the third kind in the bones of animals. The fore-arm of a man, represented in Fig. 102, will serve as an example.

---

stick, which man will carry the more? Illustrate this with Fig. 99. How may one of the horses harnessed to a carriage be made to draw more than the other? How may a weight be equally distributed between three persons? 218. In levers of the third kind, what is the position of the three important points? What instrument is an example of the third kind of levers? 219. To produce equilibrium in the third kind of levers, what is necessary? State the law for levers of the third kind. Illustrate this with Fig. 101. 220. What common articles are levers of the third kind? What is said of the sheep-shears? When does a door become a lever of the third kind?

The fulcrum, F, is at the elbow-joint; the biceps muscle, descending from the upper part of the arm and inserted near the elbow at P, operates as the power; while the weight, W, rests on the hand. If the distance F W be 15 times as great as F P, it will take a power of 15 pounds at P to counterbalance one pound at W; and when the arm is extended, the disadvantage is still greater, in consequence of the muscle's not acting perpendicularly to the bone, but obliquely.

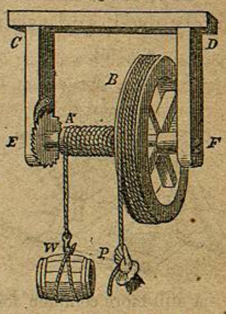
This accounts for the difficulty of holding out a heavy weight at arm's length. In proportion as power is lost, however, quickness of motion is gained; a very slight contraction of the muscle moves the hand through a comparatively large space with great rapidity. Here, as in all the works of creation, the wisdom of Providence is shown in exactly adapting the part to the purpose for which it is designed. With so many external agents at his command, man does not need any great strength of his own; quickness of motion is much more necessary to him, and this the structure of his arm ensures.

The Wheel and Axle.

221. The Wheel and Axle is the second of the simple mechanical powers. It consists of a Wheel attached to a cylinder, or Axle, in such a way that when set in motion they revolve around the same axis.

222. In the simplest form of the wheel and axle, the power is applied to a rope passing round the wheel, while the weight is attached to another rope passing round the axle.

Fig. 103.



THE WHEEL AND AXLE.

This form of the machine is shown in Fig. 103. C D is a frame; B is the wheel; A is the axle, attached to the frame at its extremities E and F by gudgeons, or iron pins, on which it turns. P is the power, and W is the weight.

223. The wheel and axle is simply a revolving lever of the first kind. One application of the lever can not move a body any great distance; but, by means of the wheel and axle, the action of the lever is continued unin-

---

Under what circumstances does a ladder become a lever of the third kind? In what does Nature use levers of the third kind? Show, by Fig. 102, how the fore-arm is a lever, and point out the relation between power and weight. How is the wisdom of Providence shown, in making the arm such a lever? 221. What is the second simple mechanical power? Of what does the Wheel and Axle consist? 222. In the simplest form of this machine, how is the power applied, and how the weight? Illusterruptedly. This machine has therefore been called *the perpetual* or *endless lever.*

224. The wheel and axle must turn round their common axis in the same time. In each revolution, a length of rope equal to the wheel's circumference is pulled down from the wheel, while only as much rope is wound round the axle as is equal to the axle's circumference. There is, therefore, a loss of time, greater or less according as the circumference of the wheel exceeds that of the axle; but, by the law of Mechanics already stated, there must be a corresponding gain of power.

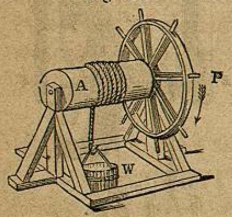
Viewing the wheel and axle as a lever of the first kind, we have the circumference of the wheel for the long arm, and that of the axle for the short arm. If the diameters of the wheel and the axle are given instead of their circumferences, they may be taken for the two arms; and so with the radii, if they are given. In practice, an allowance of 10 per cent. of the weight must be made for the stiffness of the ropes and the friction of the gudgeons. —From these principles is deduced the following law:—

225. Law of the Wheel and Axle.—*With the wheel and axle, intensity of force is gained, and time is lost, in proportion as the circumference of the wheel exceeds that of the axle.*

Thus, in Fig. 103, if the circumference of the wheel B is five feet and that of the axle A one foot, a power of 40 pounds at P will counterbalance a weight of 200 pounds at W, and of course lift any thing under 200 pounds.

226. Different Forms.—The wheel and axle is extensively used, and assumes a variety of forms.

Fig. 104.



Instead of having a rope attached to it, the wheel is often provided with projecting pins, as shown in Fig. 104, to which the hand is directly applied. This form of the machine is used in the pilot-houses of steamboats for moving the rudder. In calculating the advantage in this case, instead of the circumference of the wheel we must take the circumference of the circle described by the point to which the hand is applied.

A still more common form, much used in drawing water from wells and loaded buckets from mines, is shown in Fig. 105. Instead of a wheel, we

---

trate this with Fig. 103. 223. What has the wheel and axle been called, and why? 224. Explain the operation of the wheel and axle, and show how great the loss of time and gain of power will be. Viewing the wheel and axle as a lever, what is the long arm? What is the short arm? What, besides the circumference, may be taken as the arms of the lever? What allowance must be made in practice? 225. State the law of the wheel and axle. Illustrate this law with Fig. 103. 226. Describe the form of

have here a *Winch,* or handle, attached to the axle. In this case, to calculate the advantage gained, we must compare the circle described by the extremity of the handle (shown in the Figure by a dotted line) with the circumference of the axle.

Fig. 105.

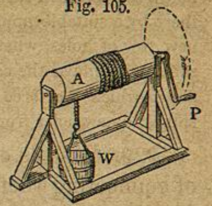


Fig. 106.

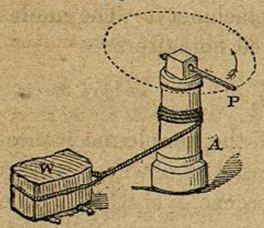
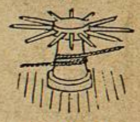


Fig. 106 shows a third form of the wheel and axle. Here the axle A is vertical, instead of horizontal. A bar inserted in its head, at the extremity of which the hand is applied, takes the place of the wheel. If the circumference of A is 3 feet and the circle described by P is 12 feet, a power of 1 pound at P will counterbalance a weight of 4 pounds at W.

227. *The Capstan.*—The Capstan (see Fig. 107) is a familiar example of this form of the wheel and axle. It is used by sailors for warping vessels up to a dock, raising anchors, &c.; and consists of a massive piece of timber, round which a rope passes. This is surmounted by a circular head, perforated with holes, into which, when the instrument is to be used, strong bars, called *handspikes,* are inserted. Several men may work at each handspike, pushing it before them as they walk round the capstan. The handspikes act on the principle of the lever. The longer they are, therefore, the more easily the men overcome the resistance, but the further they have to walk in doing it.

Fig. 107.



THE CAPSTAN.

228. *The Windlass.*—This is a similar form of the wheel and axle, used on shipboard for various purposes.

The windlass is not vertical, like the capstan, but horizontal or parallel to the deck. It is a round piece of timber, supported at each end, and perforated with rows of holes. Pushing against handspikes inserted in these

---

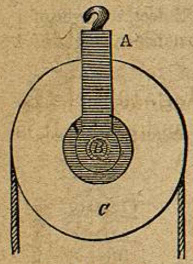
the wheel and axle used in the pilot-houses of steamboats. In calculating the advantage in this case, what must we substitute for the circumference of the wheel? Describe the form of the machine used in drawing water from wells. How is the advantage ascertained in this case? Describe a third form of the wheel and axle, exhibited in Fig. 106. 227. What machine is a familiar example of this third form? For what is the Capstan used? Of what does it consist? How is it worked? How do the handspikes act? 228. What similar instrument is often substituted for the capholes, the boatmen turn the barrel of the windlass halfway over. It is held there by a suitable apparatus, till the handspikes are removed and put in a new row of holes, when the process is repeated. The windlass acts on the same principle as the capstan, but is less convenient, on account of the manner in which the force is applied, and the necessity of removing the handspikes to new holes from time to time.

229. Wheels enter largely into machinery. The modes of connecting them will be considered hereafter.

The Pulley.

230. The Pulley is the third of the simple mechanical powers. It consists of a wheel with a grooved circumference, over which a rope passes, and an axis or pin, round which the wheel may be made to turn. The ends of the axis are fixed in a frame called a *block*.

Fig. 108.



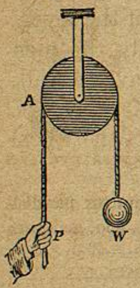
THE PULLEY.

Fig. 108 gives a view of the pulley. A represents the block, B the axis, and C the wheel. Round the groove in the wheel passes a rope, at one end of which the power acts, while the weight is attached to the other.

231. Kinds of Pulley.—Pulleys are of two kinds,—Fixed and Movable.

232. *Fixed Pulleys.*—A Fixed Pulley is one that has a fixed block.

Fig. 109.



FIXED PULLEY.

Fig. 109 represents a fixed pulley. The block is attached to a projecting beam. P is the power, and W the weight. For every inch that P descends, W ascends the same distance. There is, therefore, no loss of time, and no gain in intensity of force. One pound at P will just counterbalance one pound at W.

233. In this rule, as well as all the others pertaining to the Mechanical Powers, it must be remembered that friction is not taken into account. In the case of the pulley, in consequence of the stiffness of the rope and the friction of the pin, an allowance of 20 per cent. of the weight, and often more, must be made in practice.

---

stan? How does the Windlass differ from the capstan? Of what does the windlass consist? How is it worked? What makes it less convenient than the capstan? 229. What is said of wheels? 230. What is the third simple mechanical power? Of

234. Though no power is gained with the fixed pulley, it is frequently used to change the direction of motion. The sailor, instead of climbing the mast to hoist his sails, stands on deck, and by pulling on a rope attached to a pulley raises them with far less difficulty. With equal advantage the builder uses a fixed pulley in raising huge blocks of stone or marble, and the porter in hoisting heavy boxes to the lofts of a warehouse.

235. With two fixed pulleys, horizontal motion may be changed into vertical; horses are thus enabled to hoist weights, as shown in Fig. 84.

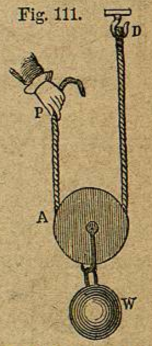
236. Fig. 110 shows how a person may raise himself from the ground, or let himself down from a height, by means of a fixed pulley. In lofty buildings an apparatus of this kind is sometimes rigged near a window, to furnish means of escape in case of fire.

Fig. 110.


FIRE ESCAPE.

237. *Movable Pulleys.*—A Movable Pulley is one that has a movable block.

Fig. 111.

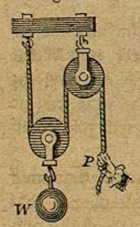


MOVABLE PULLEY.

Fig. 111 represents a movable pulley. A is the wheel. One end of the rope is fastened to a support at D, while the power is applied to the other at P.

238. To raise the weight a given distance with the movable pulley, the hand must be raised twice that distance. Time, therefore, being lost in the proportion of 2 to 1, the intensity of the force is doubled. A power of one pound at P will counterbalance two pounds at W, and raise anything under two pounds.

Fig. 112.



239. A movable pulley is seldom used alone. It is generally combined with a fixed pulley, as shown in Fig. 112. No additional power is thus

---

what does the Pulley consist? What is the Block? Point out the parts of the pulley in Fig. 103. 231. How many kinds of pulleys are there? 232. What is a Fixed Pulley? Point out the parts in the Figure. What is the gain with this pulley? 233. What allowance must be made for friction in the case of the pulley? 234. If no power is gained by the use of the fixed pulley, why is it used? Give examples. 235. How may horizontal motion be changed into vertical? 236. What does Fig. 110