

工程技术英语注释读物

# MACHINES and MACHINE COMPONENTS

## 机械和机械零件

清华大学外语教研组 编  
英语读物注释小组



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## 编 者 的 话

《工程技术英语注释读物》按机械、动力、电力、电子、建筑、原子能等不同专业分册出版。材料大部选自原著,对其中个别地方作了适当修改。专业内容浅近易懂。附有注释,参考译文和词汇表,便于读者自学,以培养独立阅读的能力。

这本“机械和机械零件”是机械类的第三册。原文选自 *The New Encyclopædia Britannica*, vol. 11, 15th ed., 1974.

由于编者水平的限制,以及缺乏编写经验,书中肯定存在不少缺点错误,欢迎广大读者提出宝贵意见,以便进一步修改。

编 者

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# CONTENTS

## 目 录

1. General Considerations .....	1
2. The Simple Machines .....	12
3. Mechanisms .....	22
4. Gears .....	28
5. Cams .....	51
6. Linkages .....	55
7. Flywheels .....	69
8. Belt and Chain Drives .....	73
9. Couplings .....	86
10. Clutches .....	95
11. Brakes .....	101
12. Bearings .....	107
13. Lubrication .....	131
14. Shafts .....	149
15. Shaft Accessories.....	156
16. Screws .....	165
17. Springs .....	174

### 参考译文

一. 概述 .....	184
二. 简单机械 .....	190
三. 机构 .....	195

四. 齿轮 .....	198
五. 凸轮 .....	211
六. 连杆机构 .....	214
七. 飞轮 .....	221
八. 皮带传动和链传动 .....	223
九. 联轴节 .....	231
十. 离合器 .....	236
十一. 制动器 .....	240
十二. 轴承 .....	243
十三. 润滑 .....	259
十四. 轴 .....	270
十五. 轴的附件 .....	274
十六. 螺纹连接 .....	278
十七. 弹簧 .....	285
<b>总词汇表 .....</b>	<b>290</b>

## 1. GENERAL CONSIDERATIONS

The word machine has been given a wide variety of definitions,<sup>①</sup> but for the purpose of<sup>②</sup> this article it is a device, having a unique purpose, that augments or replaces human or animal effort<sup>③</sup> for the accomplishment of physical tasks. Tools may be regarded as<sup>④</sup> the simplest class of machines. The operation of a machine may involve the transformation of chemical, thermal, electrical, or nuclear energy into mechanical energy, or vice versa, or its function may simply be to modify and transmit forces and motions. All machines have an input, an output, and a transforming or modifying and transmitting device.

Machines that receive their input energy from a natural source, such as<sup>⑤</sup> air currents, moving water, coal, petroleum, or uranium, and transform it into mechanical energy are known as<sup>⑥</sup> prime movers. Windmills, waterwheels, turbines, steam engines, and internal-combustion engines are prime movers. In these machines the inputs vary; the outputs are usually rotating shafts capable of being used as<sup>⑦</sup>

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① has been ... definitions: give a definition: 下定义. a (wide) variety of: 各种各样的; 多种多样的. ② for the purpose of: 对...来说; 为了...起见. ③ augments ... effort: 原意“增大或代替人力或畜力”. 但汉语习惯不说“增大人力或畜力”, 而说“节省人力或畜力”. ④ be regarded as: 被看作是; 被认为是. ⑤ such as: 例如; 象这一类的; 这样的. ⑥ are known as: (被)叫做; (被)称作. ⑦ capable of ... as: capable of: 能够(做). 作定语, 说明 rotating shafts. being used as: 被用作. 是 capable of 要求的动名词.

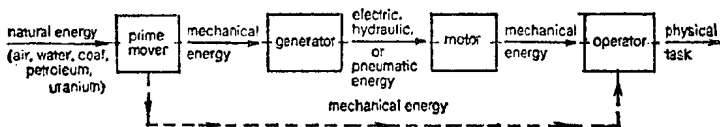


Figure 1: Flow of energy in machines.

inputs to other machines, such as electric generators, hydraulic pumps, or air compressors. All three of the latter devices may be classified as<sup>①</sup> generators;<sup>②</sup> their outputs of electrical, hydraulic, and pneumatic energy can be used as inputs to electric, hydraulic, or air motors. These motors can be used to drive machines with a variety of outputs,<sup>③</sup> such as materials processing, packaging, or conveying machinery.<sup>④</sup> All machines that are neither prime movers, generators, nor motors<sup>⑤</sup> may be classified as operators. This category also includes manually operated instruments of all kinds,<sup>⑥</sup> such as calculating machines and typewriters.

If the operator is a pump driven by an electric motor, the flow of energy from the prime mover at the power plant through the generator and motor to the operator is as shown in Figure 1. The operator can also be driven directly by a small, direct-connected prime mover, such as a

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① be classified as: 归类为; 分类为. ② generator: 一般译“发生器”, 这里指产生电能、液能或气能等几种机器的通称. ③ with a variety of outputs: 带有各种输出端的. 前置词短语, 作定语, 说明 machines. a variety of: 各种各样的. ④ materials ... machinery: materials processing (“材料加工”), packaging 和 conveying 都说明 machinery. ⑤ that are neither ... motors: 定语从句, 说明 all machines. neither ... nor ...: 既不..., 又不...; ...和...都不. ⑥ of all kinds: 各种的. 前置词短语, 作定语, 说明 manually operated instruments.



gasoline engine, as shown by the dotted line in Figure 1; for most<sup>①</sup> power-driven operators, however, the flow of energy from the prime mover follows the solid lines.

In some cases<sup>②</sup>, machines in all categories<sup>③</sup> are combined in one unit. In a diesel-electric locomotive, for example, the diesel engine is the prime mover, which drives the electric generator, which, in turn,<sup>④</sup> supplies electric current to the motors that drive the wheels.

The following are some examples supplied by an automobile.

In an automobile, the basic problem is harnessing the explosive effect of gasoline<sup>⑤</sup> to provide power to rotate the rear wheels. The explosion of the gasoline in the cylinders pushes the pistons down, and the transmission and modification of this translatory (linear) motion to rotary motion of the crankshaft is effected by the connecting rods that join each piston to the cranks (Figure 21) that are part of the crankshaft. The piston, cylinder, crank, and connecting rod combination is known as a slider-crank mechanism; it is a commonly used method of converting translation to rotation (as<sup>⑥</sup> in an engine) or rotation to translation (as<sup>⑥</sup> in a pump).

To admit the gasoline-air mixture to the cylinders and exhaust the burned gases, valves are used; these are opened and closed by the wedging action of cams (projections) on

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① most: 大多数; 大部分. ② in some cases: 在某些情况下. ③ in all categories: 各种的; 各类的. 前置词短语, 作定语, 说明 machines. ④ in turn: (本身)又, (同样)也. ⑤ is harnessing ... gasoline: is: 是. harnessing: 利用. 是动名词, 作表语. 不要把 is harnessing 误认为是现在进行时. ⑥ as: 例如.

a rotating camshaft that is driven from the crankshaft by gears or a chain.

In a four-stroke-cycle engine with eight cylinders, the crankshaft receives an impulse at some point along its length every quarter revolution.<sup>①</sup> To smooth out the effect of these intermittent impulses on<sup>②</sup> the speed of the crankshaft, a flywheel is used. This is a heavy wheel, attached to the crankshaft, that by its inertia<sup>③</sup> opposes and moderates any speed fluctuations.

Since the torque (turning force) that it delivers<sup>④</sup> depends on its speed, an internal-combustion engine cannot be started under load.<sup>⑤</sup> To enable an automobile engine to be started in an unloaded state and then connected to the wheels without stalling,<sup>⑥</sup> a clutch and a transmission are necessary. The former<sup>⑦</sup> makes and breaks<sup>⑧</sup> the connection between the crankshaft and the transmission, while the latter<sup>⑨</sup> changes, in finite steps,<sup>⑩</sup> the ratio between the input and output speeds and torques of the transmission. In low gear,<sup>⑪</sup> the output speed is low and the output torque higher than the engine torque, so that<sup>⑫</sup> the car can be started moving; in high gear,<sup>⑬</sup> the car is moving

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① at some point: 在某一点(上). along its length: 沿着它的长度方向.  
every quarter revolution: 每转 1/4 圈. 是时间状语. ② effect of(...) on...:  
(...)对...的作用; (...)对...的影响. ③ by its inertia: 靠它的惯性; 借助其惯  
性. ④ that it delivers: 它所传递的. 是定语从句, 说明 torque. it: 代替  
后面的 internal-combustion engine. ⑤ under load: 在有负载的情况下;  
在荷载的作用下. ⑥ without stalling: 不致(使发动机)减速、停车或灭火.  
⑦ the former: 前者. 指上句中的 clutch. ⑧ makes and breaks: 接合  
与分离; 接通与切断. ⑨ the latter: 后者. 指上句中的 transmission. ⑩  
in finite step: 分几级; 分几档. ⑪ in low gear: 在低速档. ⑫ so that:  
因此; 所以; 结果; 以便. ⑬ in high gear: 在高速档.

at a substantial speed<sup>①</sup> and the torques and speeds are equal.

The axles to which the wheels are attached<sup>②</sup> are contained in the rear axle housing, which is clamped to the rear springs, and are driven from the transmission by the drive shaft.<sup>③</sup> As the car moves and the springs flex in response to<sup>④</sup> bumps in the road, the housing moves relative to the transmission; to permit this movement without interfering with the transmission of torque, a universal joint is attached to each end of the drive shaft.

The drive shaft is perpendicular to the rear axles. The right-angled connection is usually made with bevel gears having a ratio such that<sup>⑤</sup> the axles rotate at from one-third to one-fourth the speed of the drive shaft.<sup>⑥</sup> The rear axle housing also holds the differential gears that permit both rear wheels to be driven from the same source and to rotate at different speeds when turning a corner.<sup>⑦</sup>

Like<sup>⑧</sup> all moving mechanical devices, automobiles cannot escape from the effects of friction. In the engine, transmission, rear axle housing, and all bearings, friction is undesirable, since it increases the power required from the engine; lubrication reduces but does not eliminate this friction.

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① at a substantial speed: 以高速; 高速度地. ② to which ... attached: 安装车轮的. 是带前置词 to 的由 which 连接的定语从句, 说明 axles. ③ drive shaft: 主动轴; 传动轴; 万向轴. ④ in response to: 随... (而); 应...(而). ⑤ such that: 这样的以致于.... 连接副句, 表示结果. ⑥ at from ... shaft: 以主动轴转速的  $1/3 \sim 1/4$  的速度. at ... speed: 以...的速度; 以...的转速. from ... to ...: 从...到... one-third the speed of: ...速度的  $1/3$ . one-fourth the speed of: ...速度的  $1/4$ . ⑦ when turning a corner = when the rear wheels are turning a corner. (二个后轮)在转弯时. ⑧ like: 象...(一样); 如同.... 是前置词.

tion. On the other hand,<sup>①</sup> friction between the tires and the road and in the brake shoes makes traction and braking possible.<sup>②</sup> The belts that drive the fan, generator, and other accessories are friction-dependent devices. Friction is also useful in the operation of the clutch. Some of the devices cited above, and others that are described below, are found in machines of all categories,<sup>③</sup> assembled in a multitude of ways<sup>④</sup> to perform all kinds of physical tasks. Because of this diversity of function and the lack of common characteristics, this article will not be concerned with specific operators. Neither will it deal with the overall performance of prime movers, nor with the operation of hydraulic, pneumatic, or electrical devices.<sup>⑤</sup> It<sup>⑥</sup> will consider only the operation and structure of the basic mechanical devices that are the constituent parts of machines. The function of most of these devices is to transmit and modify force and motion.<sup>⑦</sup> Other devices, such as springs, flywheels, shafts, and fasteners, perform supplementary functions.

For the purposes of<sup>⑧</sup> this article a machine may be further defined as a device consisting of two or more resistant, relatively constrained parts that may serve to trans-

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① on the other hand: 从另一方面来说; 相反; 反之. ② makes ... possible: 使...成为可能. ③ of all categories: 各种的. ④ in a multitude of ways: 以许多种方法; 以各种方式. a multitude of: 许多的. ⑤ Neither ... devices. neither ... nor ...: 既不...又不...; ...和...都不. 主语 it (代替 this article) 位于 will 和 deal 之间. nor 后面的 with 与 deal 发生关系. deal with: 涉及; 论述. ⑥ It: 代替 this article. ⑦ is to transmit ... motion: is: 是. to transmit and modify ...: 不定式作表语. ⑧ For the purposes of ...: 对...来说; 为了...起见.

mit and modify force and motion in order to<sup>①</sup> do work. The requirement that the parts of a machine be resistant implies that they be capable of carrying imposed loads without failure or loss of function.<sup>②</sup> Although most machine parts are solid metallic bodies of suitable proportions, nonmetallic materials, springs, fluid pressure organs, and tension organs such as belts are also employed.

The most distinctive characteristic of a machine is that the parts are interconnected and guided in such a way that<sup>③</sup> their motions relative to one another<sup>④</sup> are constrained. Relative to the block,<sup>⑤</sup> for example, the piston of a reciprocating engine is constrained by the cylinder to move on a straight path; points on the crankshaft are constrained by the main bearings to move on circular paths; no other forms of relative motion are possible.

On some machines the parts are only partially constrained. If the parts are interconnected by springs or friction members, the paths of the parts relative to one another may be fixed, but the motions of the parts may be affected by the stiffness of the springs, friction, and the masses of the parts.

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① in order to (+动词原形): 为了...; 以便于.... ② The requirement ... function. 在主句有“要求、主张、建议、希望”等意思的词时, 副句中的谓语可用动词原形. 这个动词原形的意思相当于 should (“应该”)(+动词原形). 这里 that the parts of a machine be resistant = that the parts of a machine should be resistant. that ... resistant: 是定语副句, 说明 requirement. that they be capable ... function = that they should be capable ... function. 是 implies 要求的宾语副句. ③ in such a way that: 通过...(方式)来; 以这样的方式来...; 从而.... ④ relative to one another: 彼此相对的. ⑤ block = cylinder block. 汽缸体.

If all the parts of a machine are comparatively rigid members whose deflections under load are negligible, then the constraintment may be considered complete and the relative motions of the parts can be studied without considering the forces that produce them.<sup>①</sup> For a specified rotational speed of the crankshaft of a reciprocating engine, for example, the corresponding speeds of points on the connecting rod and the piston can be calculated. The determination of the displacements, velocities, and accelerations of the parts of a machine for a prescribed input motion is the subject matter<sup>②</sup> of kinematics of machines. Such calculations can be made without considering the forces involved, because the motions are constrained.

According to the definition, both forces and motions are transmitted and modified in a machine. The way in which the parts of a machine are interconnected and guided to produce a required output motion from a given input motion is known as the mechanism<sup>③</sup> of the machine. The piston, connecting rod, and crankshaft in a reciprocating engine constitute a mechanism for changing the rectilinear motion of the piston into the rotary motion of the crankshaft.

Although both forces and motions are involved in the operation of machines, the primary function of a machine may be either the amplification of force<sup>④</sup> or the modification of motion. A lever is essentially a force increaser,<sup>⑤</sup>

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① **them:** 代替 relative motions. ② **subject matter:** 题材; 题目; 主题; 论题. ③ **mechanism:** 一般译“机构”. 在说明某些理论问题上的内部联系时, 常译“机理”或“机制”. ④ **amplification of force:** 原意是“把力放大”. 但汉语习惯说“(为了)省力”. ⑤ **force increaser:** 增力器. 即“省力的装置”.

while a gearbox is most often used as a speed reducer. The motions and forces in a machine are inseparable, however, and are always in an inverse ratio.<sup>①</sup> The output force on a lever is greater than the input force, but the output motion is less than the input motion. Similarly, the output speed of a gear reducer is less than the input speed, but the output torque is greater than the input torque. In the first case a gain in force is accompanied by a loss in motion,<sup>②</sup> while in the second case a loss in motion is accompanied by a gain in torque.<sup>③</sup>

Although the primary function of some machines can be identified, it would<sup>④</sup> be difficult to<sup>⑤</sup> classify all machines as either force or motion modifiers; some machines belong in both categories. All machines, however, must perform a motion-modifying function, since if the parts of a mechanical device do not move, it is a structure, not a machine. It is customary for machinery designers, when studying the motions of the parts, to<sup>⑥</sup> speak of<sup>⑦</sup> the mechanism of a machine.

While all machines have a mechanism, and consequently perform a motion-modifying function, some machines do not have a planned force-modifying purpose; the forces that exist<sup>⑧</sup> are caused by friction and the inertia of the moving masses and do not appear as<sup>⑨</sup> a useful output

---

① (be) in an inverse ratio: 成反比. ② loss in motion: 运动的损失. in: 在...方面. ③ gain in torque: 扭矩的增大. in: 在...方面. ④ would (+动词原形): 总是(做); 总会(做). ⑤ (be) difficult to (+动词原形): 难以(做). ⑥ it is customary ... to (+动词原形): 习惯于(做). for (+名词)+to (+动词原形): 是带意思上主语动词不定式. 该名词是动词不定式意思上的主语. ⑦ speak of: 谈到; 论及. ⑧ that exist: 存在的; 所产生的. 定语从句, 说明 forces. ⑨ appear as: 表现为; 作为...出现.

effort. This group would include measuring instruments and clocks.

The “work” referred to<sup>①</sup> in the definition will be interpreted in its scientific sense. In the science of mechanics, work is something that forces do<sup>②</sup> when they move in the direction in which they are acting, and it is equal to the product of the average force and the distance moved.<sup>③</sup> If a man carries a weight along a horizontal path, he does no work according to this definition, since the force and the motion are at right angles to one another;<sup>④</sup> that is,<sup>⑤</sup> the force is vertical and the motion horizontal. If he carries the weight up a flight of stairs or a ladder, he does work, since he is moving in the same direction in which he is applying a force. Mathematically, if  $F$  equals force (in pounds or kilograms),<sup>⑥</sup> and  $S$  equals distance (in feet or metres),<sup>⑦</sup> work is then equal to the applied force  $F$  multiplied by the distance this force moves  $S$ ; or  $\text{WORK} = F \times S$ .

When a force causes a body to rotate about<sup>⑧</sup> a fixed axis, or pivot, the work done<sup>⑨</sup> is obtained by multiplying the torque ( $T$ ) by the angle of rotation.

These concepts of work are fundamental in defining the mechanical work function of machines in terms of<sup>⑩</sup>

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① referred to: 所涉及的. ② that forces do: 是定语从句, 说明 something. ③ the distance moved: 所移动的距离. ④ (be) at right angles to one another: 彼此成直角; 互相垂直. ⑤ that is: 即; 也就是. ⑥ in pounds or kilograms: 以磅或公斤为单位; 单位为磅或公斤. in: 以... 为单位; 单位.... ⑦ in feet or metres: 以英尺或米为单位; 单位为英尺或米. ⑧ cause ... to (+动词原形): 使...(做). rotate about 绕... 旋转. ⑨ the work done: 所做的功. ⑩ in terms of: 用...(术语); 通过; 按照; 依据.



forces and motions, and they bring out<sup>①</sup> the inseparability of forces and motions in machines. Because of friction, the work output from a machine is always less than the work input, and the efficiency, which is the ratio of the two, is always less than 100 percent.

The ratio of the output to input forces is the mechanical advantage (MA), and it defines the force-modifying function, while the ratio of the input to output motions is the velocity ratio (VR), and it defines the motion-modifying function. When the efficiency is high, these ratios are approximately equal; if the output force is ten times the input force,<sup>②</sup> the input motion must be ten times the output motion; *i.e.*, what<sup>③</sup> is gained in<sup>④</sup> force is lost in<sup>④</sup> motion. Friction affects the mechanical advantage but not the velocity ratio.

To calculate the efficiency from the ratio of output to input work, it would<sup>⑤</sup> be necessary to<sup>⑥</sup> know the work done by the output and input forces over<sup>⑦</sup> a specified distance. Since this would<sup>⑧</sup> entail the determination of average forces over<sup>⑨</sup> the interval, it would be inconvenient. The efficiency of a machine is more easily determined from instantaneous values of load and the rate at which the load is moving. For this purpose,<sup>⑩</sup> power formulas are most useful.

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① bring out: 产生; 出版; 表明; 显示; 阐明; 说出. ② (be) ten times the input force: 是输入的力的十倍; 比输入的力大九倍. be x times y: 是 y 的 x 倍; 比 y 大(x-1)倍. ③ what = that which; the thing which. ④ in: 在...方面. ⑤ would (+动词原形): 总是(做). ⑥ be necessary to (+动词原形): 必须(做). ⑦ over: 通过; 越过. 是前置词. ⑧ would (+动词原形): 将(做); 总是(做). ⑨ over: 参看⑦. ⑩ for this purpose: 为此; 为了这一目的; 就这一点来讲.