

工程技术英语注释读物

# POWER MACHINERY

## 动力机械

清华大学外语教研室 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。文章大部选自原著,对其中个别地方作了适当修改。专业内容浅近易懂。附有较详细的注释、参考译文和词汇表,便于读者自学,以培养独立阅读能力。

这本《动力机械》原文大部选自Oxford Junior Encyclopaedia Vol. 8, Engineering。

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,热烈欢迎广大读者提出宝贵批评意见,以便进一步修改。

编者

1982年6月

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# 1. ENERGY

1. **Energy.** This word means the capacity for doing work. When we say that a ton of coal, a lake of water high above a generating station, an electric battery, or a red-hot iron 'contains' a certain amount of energy, we are not referring to<sup>①</sup> anything that we can take out of the water, or coal, or whatever it is<sup>②</sup>; we are saying something about the state that it is in<sup>③</sup>. The coal possesses potential energy because the chemicals in it are in a condition to combine with oxygen<sup>④</sup>, releasing heat energy<sup>⑤</sup>. The water possesses potential energy because it is in a condition to fall. The amount of potential energy it possesses<sup>⑥</sup> depends on how far it can fall<sup>⑦</sup>. It could<sup>⑧</sup> fall to the centre of the earth, in theory; but in practice we always measure potential energy relative to<sup>⑨</sup> a given fall. When it does fall<sup>⑩</sup>, its energy is changed into kinetic energy, or energy due to its movement. It can then be made to do work<sup>⑪</sup>. In other

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① are referring to: 指的是。② take out of ... or whatever it is: 从中取得...或不管什么东西。take 的宾语是前面的关系代词 that。③ that it is in: 它所处的; 它所在的。定语从句, 说明 state。④ are in a condition to combine with oxygen: 处于能和氧化合的状态, 或简译为: 能和氧化合。be in a condition to (+动词原形): 处于能(做...)的状态。⑤ releasing heat energy: 从而释放热能。分词短语作状语, 表示结果。译时可加“从而”字样。⑥ it possesses: = which it possesses. 定语从句, 说明 the amount of potential energy. which 在从句中作宾语时可以省去。⑦ how far it can fall: 是 depends on 要求的宾语从句。⑧ could (+动词原形): 能(做); 可以(做)。这里仅表示一种假设, 不指过去。⑨ relative to: 相对于, 以...为标准。⑩ does fall: do (+动词原形): 确实(做); 果真(做)。用来加强语气。⑪ It can ... work: 于是就能使它做功。it 指代 water。

words<sup>①</sup> energy is a state of affairs, and not a 'thing' at all<sup>②</sup>.

Energy in the form in which it is directly available for doing work is known as<sup>③</sup> mechanical energy. Only two sources of mechanical energy are naturally available — wind power and water power — and, since the energy requirements today are far greater than can be conveniently and economically supplied by winds, waterfalls, and tides, we are very much concerned with the conversion of other forms of energy into the mechanical form<sup>④</sup>.

At present<sup>⑤</sup>, by far the greatest and most important source of natural energy available is in the form of chemical energy from natural fuels. Another natural source of energy is radiation from the sun. There is also electrical energy from lightning, though this is in far too unmanageable a form to be put to practical use<sup>⑥</sup>. In recent years, a new source of energy has been successfully exploited — a source which in future times promises to be of far the greatest importance<sup>⑦</sup> and that is matter itself. Energy <sup>果</sup> derived from the actual destruction of matter (as opposed to chemical energy<sup>⑧</sup>, which springs merely from the rearrangement of matter) is <sup>修</sup> popularly termed 'atomic', though the correct <sup>本</sup> term is nuclear energy. Finally, there is a rather special form of energy — heat. Heat is not a source but<sup>⑨</sup>

① In other words: 换句话说; 换言之。② not... at all: 决不; 完全不; 根本不。③ is known as: (通常) 叫做; (就是) 通常所说的。④ are ... concerned with the conversion of ... into ...: 关心... 转变成...。⑤ At present: 目前; 现在。by far (+形容词或副词的比较级或最高级): 远远, 最最; 很明显, 比... 得多。⑥ far too unmanageable ... to be put to practical use: 的确太难控制而无法付诸实用。too + (形容词或副词) to (+动词原形): 太... 以致不能(做)。put ... to use: 使用...; 利用...。⑦ promises to be of far the greatest importance: (看来) 有可能是最最重要的。⑧ as ... energy: 与化学能相反。相当于 which is opposed to chemical energy。⑨ not ... but: 不是... 而是。



a form of energy — and the distinction is an important one<sup>①</sup>. Just as several thousand tons of water in a lake are a source of energy only if the lake is high up <sup>②</sup> a mountain, so <sup>③</sup> several thousand therms of heat are a source of energy only if the heat is available at a high temperature. Moreover, heat is the lowest form of energy. The other forms — chemical, electrical, mechanical, nuclear — are, in the natural course of events<sup>④</sup>, constantly being converted to<sup>⑤</sup> heat, but the heat can be converted into one of the other forms of energy only with considerable waste. Heat at a high temperature is in its nature<sup>⑥</sup> constantly being converted to heat at a low temperature, but the reverse is not possible without the expenditure of mechanical energy.

2. Conversion of Energy into Work. The conversion of mechanical energy into work is dealt with in mechanics. The conversion of chemical energy into work is almost invariably achieved in practice by first converting the chemical energy into heat. The fuel, in fact<sup>⑦</sup>, is burned, either under a boiler or in the engine cylinders, and the heat is then converted to work in a heat engine. Nuclear energy is converted into heat in a more direct way. Electrical energy can be converted into work direct, by means of an electric motor, but in practice electricity is not a primary source of energy. It can be obtained direct from chemical energy by means of the electric battery, but it is usually derived from a source of mechanical energy (such as<sup>⑧</sup> a steam engine

① one: 这里是代词, 常常用来代替上文中刚提过的单数可数名词, 复数用 ones, 以免重复。这里用来代替 distinction. ② high up ...: 高高在...之上。③ Just as ..., so ...: 正如(...一样)...也...。④ in the natural course of events: 按(事物的)自然趋势; 照常理说。⑤ are (constantly) being converted (to): (经常地) 被转变(成)。这是被动形式的现在进行式。⑥ in its nature: 自然而然地; 天然地。⑦ in fact: 事实上, 实际上。⑧ such as: 例如。

or water turbine) by means of an electric generator. As<sup>①</sup> a form of energy, electricity is important simply because it is so<sup>②</sup> convenient and can so easily be transported to where it is needed<sup>③</sup>.

3. Conservation of Energy. When one form of energy is converted into another<sup>④</sup>, no energy is destroyed in the process. This fact, known as the law of conservation of energy, may not at first sight appear to be true<sup>⑤</sup>. We know, for example<sup>⑥</sup>, that it is not possible for a dynamo, driven by an electric motor, to generate enough electricity to keep the motor going.<sup>⑦</sup> But this is because some of the energy of the motor is wasted as heat in the windings and bearings of the dynamo, and the motor itself wastes some of the current provided by the dynamo in the same way<sup>⑧</sup>. This wasted energy, however, has not been destroyed; it has been converted into heat. Again, if a tightly coiled and secured spring is put into a bath of acid and dissolved, the mechanical energy in the spring would appear to have been lost<sup>⑨</sup>. The acid, however, gets hotter<sup>⑩</sup> when a coiled spring is dissolved than when an uncoiled spring is dissolved; the mechanical energy in the coiled spring has been converted into heat.

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① As: 作为。② so: 非常; 如此。③ where it is needed: 是 to 的宾语从句。④ another = another form of energy. ⑤ may not at first sight appear to be true: 乍看起来, 似乎是不正确的。⑥ for example: 例如。⑦ it is not possible ... going: (由一个电动机来驱动的)发电机要发出...是不可能的。it 作引词时, 在句中可作形式主语或形式宾语, 引出后面不定式短语、动名词短语、从句表示的真正主语或宾语。这里它引出不定式短语 to generate ... 作主语。for 后面的名词又是 generate 的行为主体。to keep (+名词)(+动名词): 使...继续不断地(做)。⑧ in the same way: 以同样的方式。⑨ would appear to have been lost: 看来似乎已经损失掉了。⑩ gets hotter: 变得更热(些)。

## 2. SOLAR ENERGY

Light and heat from the sun reach the earth by radiation of waves. The total amount of solar radiation that falls on the earth in one month<sup>①</sup> is greater than the amount of heat that could be produced by burning the whole of the estimated coal reserves in the world; but it is not easy to<sup>②</sup> put this heat energy to useful work.

To produce hot water at a temperature of about 70°C., the sun's radiant energy is trapped by allowing it to fall on to<sup>③</sup> a 'flat-plate' absorber — a metal plate with a matte black surface and covered with two sheets of plate glass<sup>④</sup>. Copper tubing for circulating water is soldered to its underside. The absorber depends for its effectiveness on<sup>⑤</sup> the facts that at low temperatures all wavelengths are absorbed but only very long wavelengths are re-radiated by it, and that<sup>⑥</sup> the glass transmits short wavelengths, such as light radiation, but is opaque to long wavelengths, such as heat radiation. The sun's rays are thus absorbed, and the energy is converted to heat which is passed into the circulating water. Some radiation can be

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① **that falls ... one month**: 这是定语从句, 说明 the total amount of solar radiation. ② **it is not easy to** (+动词原形): 不易于(做...); (做...) 是不容易的. it 是引词, 引出后面的不定式作主语, 参看第4页注⑦. ③ **allowing it to fall on to**: allow ... to (+动词原形): 使 ... 能(做). it 代替 solar radiation. on to = onto: 到...上. ④ **covered with ... glass**: 同 with ... surface 并列, 都说明 metal plate. ⑤ **depends ... on**: 取决于. 中间被 for its effectiveness 隔开. ⑥ **that**: 引出的这个从句, 同前面 that at low temperatures ... by it 并列, 都是 the facts 的同位语从句. that 引导主语、宾语、表语、同位语从句时, 是连词, 在从句中不担任成份.

captured even in cloudy weather. About half of the solar energy falling on to the plate<sup>①</sup> is captured in the hot water, which can be stored in heat-insulated tanks for use later. Solar water-heaters are widely used in many countries, and special houses heated entirely by solar energy in winter have been built.

The efficiency with which heat is converted into power depends on there being a big temperature difference to work with<sup>②</sup>;

therefore the supply of heat needs to be at as high a temperature as practicable<sup>③</sup>. In very sunny regions, plants have been built with concave mirrors to focus the sun's rays on to small boilers; these generate steam to drive steam engines. Other power plants for pumping water from wells have flat-plate absorbers containing liquids which boil at a lower temperature than water and which produce a gas, instead of steam, to drive the engine.

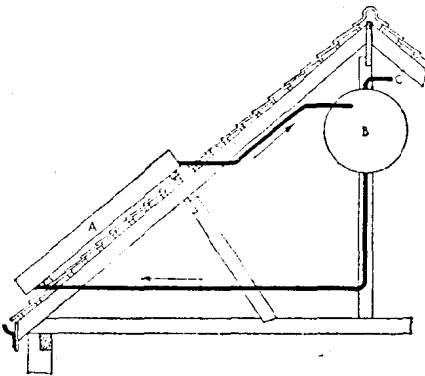


Fig. 2—1. Diagram of a solar water-heating system on the roof of a house

A. Flat-plate heat collector. B. Hot-water storage tank. C. Hot-water outlet

The arrows show the direction of the flow of water

er and which produce a gas, instead of steam, to drive the engine.

① falling on to the plate: 分词短语作定语, 说明 solar energy. ② there being ... difference to work with: 这个动名词短语是 depends on 的宾语. to work with = to work with a big temperature difference: 利用一个很大的温差来工作. ③ needs to be ... practicable: 要求把温度提高到能实际利用的程度. as high ... as (...): 象(...)那么高的...

'Solar cells', made of very pure silicon specially treated, convert solar energy directly into electricity. Although they are costly to install<sup>①</sup>, many have been used to produce small amounts of power in space vehicles.

Solar radiation is used to distil salt water in the semi-deserts where<sup>②</sup> fresh water is short. Concave-reflector furnaces have also been built for melting metals at temperatures up to<sup>③</sup> 3,000°C.

### 3. COMBUSTION

To start a substance burning<sup>④</sup>, two things are needed: a supply of oxygen (usually in the air) and sufficient heat to<sup>⑤</sup> set the chemical reaction off. All ordinary fuels begin to vaporize, or give off<sup>⑥</sup> gases, some time before<sup>⑦</sup> they become hot enough to burn, and so in practice it is usually the gases given off by substances that<sup>⑧</sup> burn. If a lighted match is held an inch or so<sup>⑨</sup> below a spill of paper, the gases can be seen coming off<sup>⑩</sup> before the paper lights. And jets of burning gas can be often seen spurting from a lump of coal. Flame is simply a region of hot gas in which some of the particles, usually white-hot carbon particles, emit light.

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① to install: 不定式说明形容词 costly. ② where: 连接定语从句,说明 semi-deserts. ③ up to: 高达; 达到. ④ start (+名词+动名词): 使...开始(做). ⑤ sufficient (+名词) to (+动词原形): 足以使...的... ⑥ give off: 发(散)出; 释放出. ⑦ some time before: 在...之前有一段时间. ⑧ it is ... that: 这是一种强调句型,被强调的部分放在 it is 之后,其余部分放在 that 之后,作定语用. 本句强调的是主语 the gases given off by substances. ⑨ or so: ...左右; ...上下; 大约. ⑩ the gases can be seen coming off: 可以看到气体冒出来. coming off: 从...跑出来,冒出来,用来修饰 gases.

Most fuels — such as coal, petrol, paraffin<sup>①</sup>, or coal gas— are composed principally of carbon (C) and hydrogen (H). In combustion, the carbon combines with the oxygen (O) of the air to give carbon dioxide (CO<sub>2</sub>), and the hydrogen to give water (H<sub>2</sub>O)<sup>②</sup>. If we hold a cold kettle over a gas flame we may see droplets of water condensing on it, this is the ‘ash’ of the gas flame which normally goes into the air as steam.

When all the constituents of a fuel have completely combined with oxygen, so that everything that can burn<sup>③</sup> has burnt, combustion is said to be<sup>④</sup> ‘complete’. If there is a shortage of air (that is, of oxygen<sup>⑤</sup>), and the chemical reactions are not completed, the combustion is incomplete, and the unburnt gases are lost up the chimney<sup>⑥</sup> or in the exhaust. There is always some carbon monoxide (CO) (which could be burnt to carbon dioxide (CO<sub>2</sub>)) in the exhaust gases from a petrol engine.

An efficient boiler must be designed to burn the fuel completely. In some designs, air is blown in above the fire as well as<sup>⑦</sup> under it to ensure sufficient oxygen. The chimney gases from boiler furnaces are often analysed with an instrument called a CO<sub>2</sub> recorder to check on the efficiency of the combustion.

Unlike solids, gases and vapours can be mixed with air, and if the mixture is more or less<sup>⑧</sup> correct it will burn without

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① petrol, paraffin: 汽油在英国称 petrol, 在美国称 gasoline; 煤油在英国称 paraffin, 在美国称 kerosine. ② the hydrogen to give water (H<sub>2</sub>O): = the carbon combines with the hydrogen of the air to give water (H<sub>2</sub>O). ③ that can burn: 定语从句, 说明 everything. that 引导定语从句时, 代替前面的名词, 在从句中作主语或宾语. ④ is said to be: (一般)认为是; 可以认为是. ⑤ of oxygen: = there is a shortage of oxygen. ⑥ are lost up the chimney: 沿烟囱向上而被白白浪费掉. ⑦ as well as: 以及; 还有. ⑧ more or less: 或多或少; 在不同程度上; 大致.

any outside oxygen to keep it going<sup>①</sup>. The explosive burning of the mixture of petrol vapour and air in a petrol-engine cylinder is an example. The acetylene torch used by a welder burns a mixture of oxygen and acetylene, and the flame is so hot that<sup>②</sup> it can be used for cutting steel plates even under water.

The ordinary burner of a gas stove uses a mixture of gas and air, the air being drawn in by the jet of gas<sup>③</sup>, and the mixture is released at the end of a tube or through small holes too fast for the flame to spread back to the inside of the burner<sup>④</sup>. If the flame of many gas burners is gently turned down<sup>⑤</sup>, there comes a point when the flame will travel back to the inside of the burner — in fact the burner 'lights back':

A gas-air mixture will burn in a closed space only if the proportions of the mixture are right — neither too much air for the gas nor<sup>⑥</sup> too much gas for the air. That is why<sup>⑦</sup> a motor-car engine will not 'fire'<sup>⑧</sup> if the mixture is either too rich or too weak. An ordinary flame burns only in that region where the mixture of fuel vapour and air is within the limits of combustion<sup>⑨</sup>. This means that a jet of oxygen will burn in a hydrogen atmosphere in just the same way that<sup>⑩</sup> a jet of hydrogen will burn in an oxygen atmosphere. The importance

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① **keep it going**: 使混合气继续燃烧。keep (+名词+现在分词): 使(...)保持(...状态); 使(...)继续(做)。② **so (+形容词) that**: 如此之(...)以致于。③ **the air being drawn in by the jet of gas**: 这是一种独立分词结构, air 是意思上的主语, being drawn 是意思上的谓语, 可译成一个句子。④ **too fast for the flame to spread back to ... burner**: 太快了, 所以火焰来不及往回蔓延到煤气头喷烧口里去。参看第二页注⑥。不定式短语 to spread 前面的 for the flame 是不定式意义上的主语。⑤ **is ... turned down**: 被关小; 被拧小。⑥ **neither ... nor ...**: ...或...都不; 既不...也不...。⑦ **that is why**: 这就是为什么...的原因。why 引出表语从句。⑧ **fire**: 点火; 发动。这里是动词。⑨ **where ... combustion**: 这里是定语从句, 说明 region。⑩ **in just the same way that**: 以完全与...相同的方式; 同样。

of the limits of combustion was first appreciated when the safety lamp was invented to avoid explosions of 'fire-damp' in coal-mines.

Oxygen is not essential to all forms of combustion although in practice it is always used. Hydrogen, for instance, will burn in chlorine or chlorine in hydrogen<sup>①</sup>. Some substances can even burn in themselves, the heat set free in their decomposition maintaining the burning<sup>②</sup>. A flame of acetylene, for example, burning in itself (and liberating much soot) can be so maintained.

The oxygen can be within the combustible itself, either mixed in it or as part of its actual structure. Gunpowder and matches are examples of the mixed type: with<sup>③</sup> gunpowder the combustibles, sulphur and charcoal, are mixed with nitre which provides the oxygen. When a match is struck, the friction generates enough heat to ignite the mixture which, when once ignited<sup>④</sup>, continues to burn. With guncotton the oxygen comes from within the nitro-cellulose molecules of which the guncotton is made.

## 4. EXPANSION AND CONTRACTION

Most substances, whether solid, liquid, or<sup>⑤</sup> gaseous, ex-

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① chlorine in hydrogen: = chlorine will burn in hydrogen. ② the heat ...maintaining the burning: 这也是独立分词结构, heat 是意思上的主语, 分词 maintaining 是意思上的谓语, 参看第九页注③. set free in their decomposition (在它们分解时释放出来的)是过去分词短语, 说明 heat. 动名词 burning 是 maintaining 的宾语. ③ with: 对于...来说. ④ when once ignited: = when it (= mixture) is once ignited. once: 一经. ⑤ whether ... or: 无论是...还是. 后面的 when heated = when they(代替 substances) are heated.



pand when heated. We generally have to make some allowance for<sup>①</sup> this expansion when we are building a structure or piece of machinery. For example, railway lines are normally laid in lengths with a small gap between each length<sup>②</sup>, so that the line can safely stretch a fraction of an inch longer<sup>③</sup> in very hot weather; without that safety gap<sup>④</sup>, the rails might buckle dangerously on an ordinary 'sleeper-and-ballast' railway track. Modern railways have a tendency to<sup>⑤</sup> weld their lengths of rail together, but guard against buckling by special methods of anchoring the track.

Another example is the 'seizing' of a motor-car engine when the piston jams against the cylinder walls. The reason for this may be the lack of lubricating oil, which causes friction to develop and, consequently, the piston to get hotter<sup>⑥</sup>. The heating then causes an extra expansion of the piston which has not been allowed for in the design, and the piston wedges itself in<sup>⑦</sup> the cylinder.

1. **Solids.** If the length of a rod is measured at different temperatures it will be found that<sup>⑧</sup> it<sup>⑨</sup> expands or contracts according to<sup>⑩</sup> the rise or fall in temperature — in fact, that its changes of length are directly proportional to the changes of temperature. The change of length which occurs for each unit length of a

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① have to make ... allowance for: 必须考虑(到); 必须估计(到); 必须为...留余量。② with a small gap between each length: 每两根中间留有很小的间隙。这个介词短语作状语, 表示方式, 说明 are laid. ③ stretch a fraction of an inch longer: 伸长零点几英寸。a fraction of: 一小部分; 分之一; 零点几。④ without that safety gap: 如果没有这个安全间隙。介词短语, 表示条件。⑤ have a tendency to (+动词原形): 有...的趋势; 有...的倾向。⑥ the piston to get hotter: 活塞变得更热。⑦ wedges... in: 楔入, 楔住, 插入。⑧ it will be found that: 将会发现。it 是引词, 作形式主语, 代替后面 that 引出的从句。⑨ it: 代替 the length of a rod. ⑩ according to: 根据; 按照。