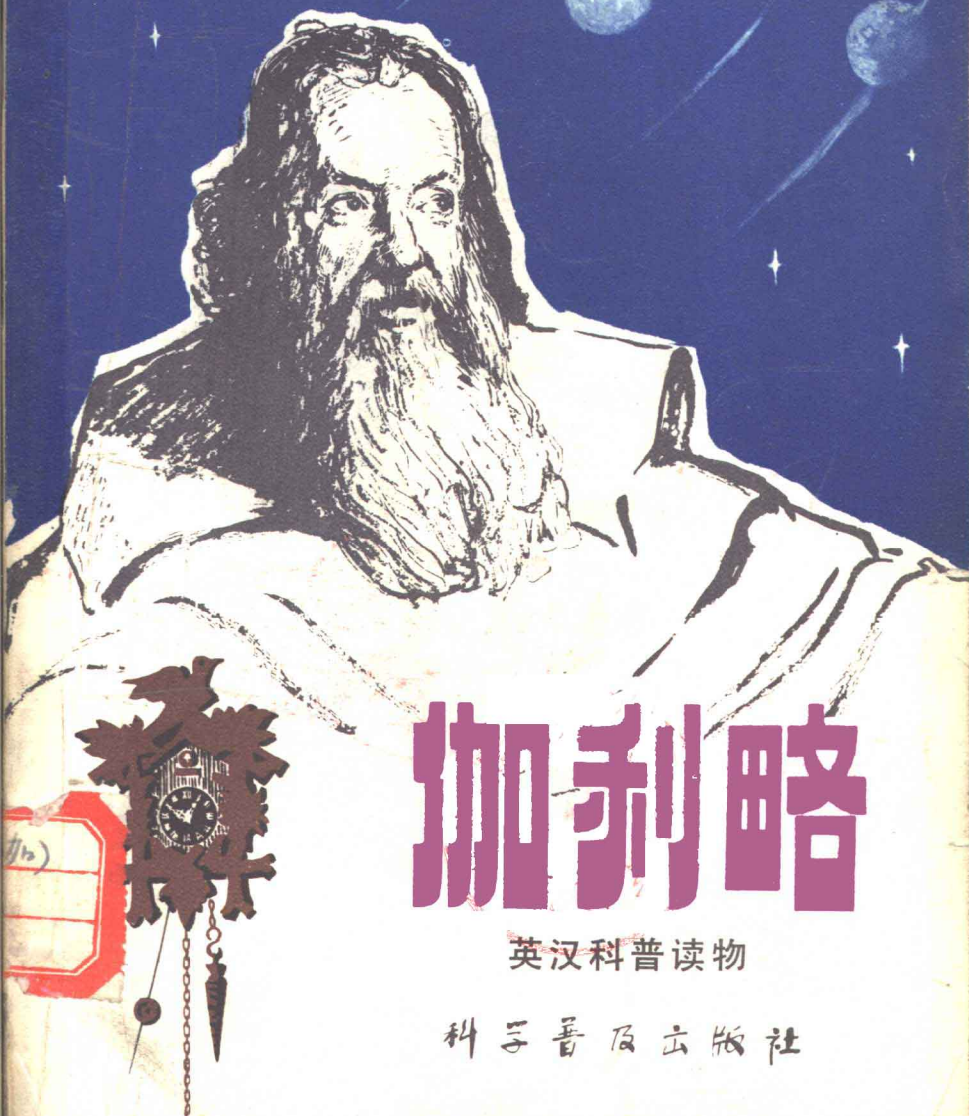


Galileo



伽利略

英汉科普读物

科学普及出版社

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(英) A. G. 艾尔 著

元 钧 译 注

科 学 出 版 社

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Chapter 1

THE PENDULUM¹

Galileo Galilei² was born in Italy in the year 1564. His father had a small business in the city of Pisa.³ This city is in the north of Italy near the sea.

He had two brothers and four sisters, but they were born after him.⁴ He was the oldest child in the family.

In 1572 his father sent him to school. 'You're eight years old now,' he said, 'and you're a clever boy. Work hard at school and don't waste your time. If you work well, your teacher will help you. Perhaps you'll be a doctor one day.'

Galileo was certainly the cleverest pupil in his class, so his teacher was pleased with him.⁵ He was clever with his hands, too.⁶ He liked to draw and to paint pictures. He liked to play music.

In the evenings he often stayed at home and made his own toys. They were special toys, because they were little machines. They worked.⁷ His favourite machine could raise heavy things off the ground.⁸

At night he sat outside and watched the stars. His young head was full of⁹ strange ideas. His friends laughed at¹⁰ him. 'Galileo is dreaming again,' they said. They were wrong, of course. His thoughts were far, but he was not dreaming. He was trying to explain things to himself.

Does our world look like the moon? Are the stars nearer than the sun? His teacher could not answer questions like these.

'When you're thirteen,' said his father, 'I'll send you to a better school. There is a famous school at Vallombrosa,¹¹ near Florence.¹² The teachers there are very clever, so they will be able to answer your questions. They will help you to get a place in a university, too. If you want to be a doctor, you'll have to go to a university.'

The Galilei family left Pisa and made a new home in Florence. Galileo did not like his new school very much, but he loved Florence. He thought that it was a wonderful city. The river

Arno¹³ ran through the middle of it. There were beautiful buildings beside the river, and there were beautiful bridges across it. From Florence it ran down to Pisa. Then it reached the sea.

At that time Italy was not one country. It held many different states.¹⁴ Florence, Venice,¹⁵ Milan,¹⁶ Naples¹⁷ and Rome¹⁸ were the centres of important states.

The Pope¹⁹ owned a large state in the middle of Italy. Its centre was Rome, and the Pope lived there. He was the leader of the Roman Catholic Church.²⁰ He is still its leader, of course.

Before 1500 this was the only Church in West Europe, so it had great power. Then many countries began to free themselves from its power.²¹ They formed their own Churches. England, Holland,²² Denmark,²³ Sweden²⁴ and half the states of Germany²⁵ were among them. But in Italy the Church still had very great power in Galileo's time. The schools and universities were in its hands. It did not like some scientists' ideas, so it did not allow them to teach. Also it did not allow them to sell their books.

Florence and Pisa were in the state of Tuscany.²⁶ The Grand Duke²⁷ owned the state. He lived in Florence, and he was one of the Medici family.²⁸ The Medici were leaders of Florence for three hundred years. The Grand Dukes always liked new ideas, and later they were good friends of Galileo.

The years 1400 to 1600²⁹ were an important time in Europe. Artists and scientists were forming new ideas. Teachers and writers were thinking new thoughts. The best artists and scientists lived in Italy; so clever men came from many countries and worked in Italian universities.

In some countries artists had a hard life because they were poor. But in Italy the Popes and the great families liked to help them. They gave them work and money. So the artists often painted their best pictures in churches and in great men's houses. The Medici family gave them special help.

Before 1400 Florence already had the best artists in Europe. She had famous writers, too, like Dante³⁰ and Boccaccio.³¹ But her

greatest artists appeared when Lorenzo de Medici³² was leader of the state, in 1469 to 1492. Their names were Leonardo da Vinci, Michelangelo³⁴ and Botticelli.³⁵

Leonardo was a poor boy, but Lorenzo gave him work to do and books to read. Soon he was the greatest artist and scientist in the world. Michelangelo and Botticelli received the same help. In Lorenzo's house they learnt to paint. They practised on his walls³⁶ and in his churches.

Leonardo and Michelangelo also learnt to make sculptures there. They made beautiful figures of stone.³⁷ If you go to Florence today, you will see their sculptures and their pictures.

Galileo saw these things too. Like Leonardo, he was poor. After two years he had to leave the school at Vallombrosa. The teachers wanted to train him for the Church, but his father said,³⁸ 'No. He is my oldest boy. When I die, he will have to look after the family. If he works for the Church, he will always be poor. Honest men don't get rich in the Church. My Galileo is clever enough to be a doctor.'

Now he needed a rich helper,³⁹ but he was not an artist like Leonardo. He only had ideas, and they were still in his head.⁴⁰ So he had to work at home with his books.

He also used to⁴¹ visit the public library.⁴² The Grand Duke built this library in 1571, and he filled it with books for scientists and teachers.

But Galileo had one real friend, the teacher at the Pisa school. With this man's help he was able to go to Pisa university. He was now seventeen years old. Soon every teacher in the university knew him. Some did not like him, because he was too clever for them.⁴³

'You ask too many questions,' they said. 'You're only a boy. You must listen to us and you must accept our ideas.'⁴⁴

'Some teachers have wrong ideas,' replied Galileo. 'They say that Aristotle was always right. But Aristotle⁴⁵ lived two thousand years ago. Many things have changed since then.'

'True things do not change.'

'I know. But Aristotle made mistakes. He only knew a small corner of the world.⁴⁶ Men are always finding out⁴⁷ new facts. For example, Francis Drake⁴⁸ has just sailed round the world; he returned to England last year.'

'Do you think that Drake is cleverer than Aristotle?'

'No. But men like Drake and Columbus⁴⁹ have taught us new facts. We must learn from life⁵⁰; we can't learn from books alone.⁵¹ Some things in Aristotle's books aren't true.'

Many teachers were angry because he talked like this. Their answer was always the same: 'The leaders of the Church say that his books are true. If you don't accept the Church's ideas, you'll soon be in trouble⁵².'

But Galileo did not think that this was a good answer. 'The Church gives orders,' he said, 'but it doesn't give reasons. In these days men are beginning to think for themselves.⁵³ You can't order them to accept ideas. You must explain your ideas to them, and you must be ready to answer their questions properly.'

Galileo's life was full of questions. He tried to answer them⁵⁴ himself. If possible he liked to find the answers by experiment. He liked to weigh things and to measure them.

'Archimedes⁵⁵ is my teacher,' he used to say. 'He lived a long time ago, like Aristotle; but he made experiments and he tested his ideas properly. He wasn't just a writer. He was a real scientist.'

Galileo always wanted to test his own ideas. 'I test them with numbers first,' he said. 'Then I test them with my hands and eyes. If they give the same answer, it will usually be correct.'

'For example, look at that pot and that box. One is round and one is square.⁵⁶ Which holds the bigger amount of sand? We can measure them with a ruler and find the answer with numbers, but men make mistakes with numbers. We can weigh them with sand and without sand, but we use numbers for that too.'

'What can we do next? We can fill the pot with sand and empty it into the box.⁶⁰ That will give a clear answer without numbers.'

Of course his questions were harder than that. Why do things fall to the ground? Why do they not fall up to the ⁶¹sky? Why can heavy ships sit in the water⁶²? The cleverest teachers in the state could not tell him. He had to look for his own answers.

He did not always find them, but the questions themselves were important. Scientists were still looking for the answers to some questions a hundred years later.

Galileo often visited the big church in Pisa. He was not a very good artist himself, but he loved its pictures and its sculptures. It was quiet there, too, so he could think.

One day, when he was sitting in the church, he noticed a lamp. It was hanging on a long cord.⁶³ While he was looking at it, a boy came and lit it.⁶⁴ Then the boy went away, but the lamp was still moving. It was swinging from side to side.⁶⁵

That was not unusual. Things will often swing, if they are hanging on a cord. But he was watching the swings with special care.⁶⁶ 'That's strange,' he thought. 'Every swing takes the same amount of time.'⁶⁷ He pushed the lamp and watched again. At first it made long swings. Then they grew shorter. But the short swings and the long ones took the same time.

Galileo wanted to be certain.⁶⁸ He wanted to test the time of every swing. 'There isn't a clock in the church,' he said to himself, 'but I don't need one. I can feel my pulse.'⁶⁹

He was learning to be a doctor, so he knew the use of a pulse.⁷⁰ 'Hold your arm, just above your hand,' his teacher used to say, 'and you'll feel the pulse. It is pumping your blood.'⁷¹ If you're sitting, it will pump slowly. If you're running, it will pump quickly. Also if you're ill, it will usually pump your blood quickly.'

So Galileo felt his pulse and watched the swings of the lamp. Yes. Every swing was taking the same time.

Then he went home. He got a cord and a heavy piece of iron.⁷² He fixed the iron to the end of the cord,⁷³ and he allowed it to swing. Then he tested the swings, and they were slower than his pulse. 'My pulse pumps seventy-two times in a minute,' he said.

'If I use a shorter cord, perhaps the swings will be quicker.'

He tested this idea and it was correct. Now the swings were quicker than his pulse; so the cord was too short. He tried again and again.⁷⁴ At last the swings were just right.⁷⁵ The cord was swinging seventy-two times in a minute.

'This idea could help doctors in their work,' he thought. He made a small machine, and he showed it to his teachers. They were pleased.

'You wind this cord round the top of the machine,' he told them. 'You fix this iron to the bottom of the cord, and you allow it to swing. If you want a shorter cord, you wind it up.⁷⁷ If you want a longer cord, you wind it down.⁷⁸'

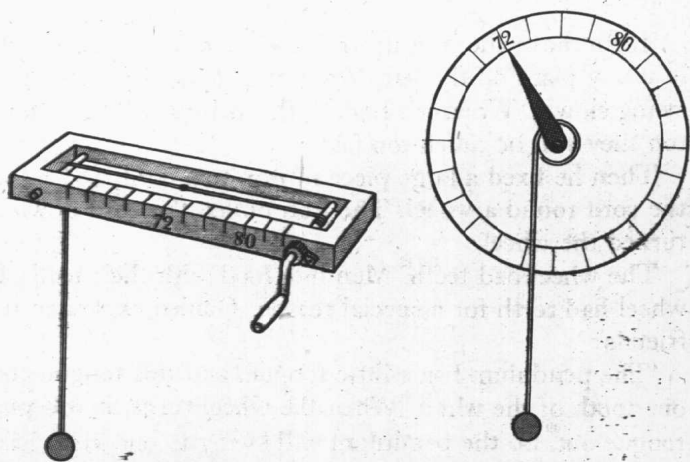
'There's a mark on the cord,⁷⁹ and there are numbers on the machine. When the mark is beside number 72,⁸⁰ the cord will swing seventy-two times in a minute. When it's beside number 80, it will swing eighty times. This cord is the *pendulum* of the machine. It must hang freely and swing freely. Don't move the machine while the pendulum is swinging.'

With this machine a doctor could measure a man's pulse quickly and correctly. Galileo made many copies of it,⁸¹ and he sold them to doctors. In 1607 a doctor at Padua⁸² university wrote a book about his own work, and he showed pictures of Galileo's machines. There were three kinds. The best one had a face like a clock.

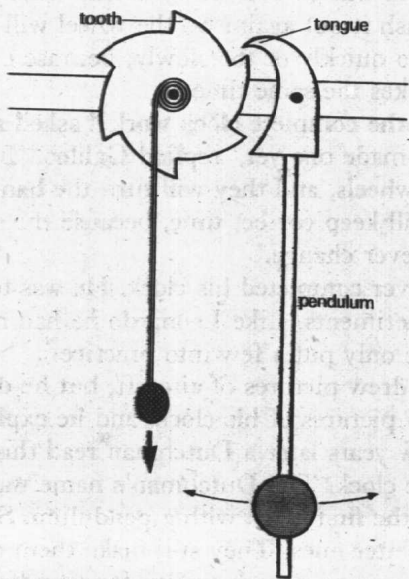
In our own days doctors have watches, so they do not need that kind of machine. But then they did not have watches. There were only big clocks, and these did not keep correct time.

Later Galileo needed a good clock for his experiments. He thought about this for a long time; then his first pendulum gave him an idea.

For his new pendulum he did not use a cord. If you pull a₃₃ cord too much, it will get longer. So now he used a light metal. He took a thin bar of this metal, and he fixed a small piece of iron to the end.



He showed pictures of Galileo's machines



The pendulum has a little tongue

'I can move the iron up the bar,' he said to himself. 'I can fix it at any place on the bar. When it's at the bottom, the bar will swing slowly. When it's higher, the swings will be faster. At the top they will be much too fast.'

Then he fixed a large piece of iron to a cord, and he wound the cord round a wheel. The iron pulled the cord down and turned the wheel.

The wheel had teeth.⁸⁵ Men bite food with their teeth, but this wheel had teeth for a special reason.⁸⁶ Galileo explained it to his friends:

'The pendulum has a little tongue,⁸⁷ and this tongue goes over one tooth of the wheel.⁸⁸ When the wheel turns, it will push this tongue out.⁸⁹ So the pendulum will swing to one side.⁹⁰ Like this.'

He showed them. 'When it swings back,' he continued, 'its tongue will go over the next tooth. Then the wheel will push it out again.'

'The tongue will go over every tooth, one by one.⁹¹ And every tooth will push it out again. So the wheel will turn slowly. It can't turn too quickly or too slowly, because every swing of the pendulum takes the same time.'

'How will the complete clock work?' asked a friend.

'I haven't made one yet,' replied Galileo. 'But this wheel will turn bigger wheels, and they will turn the hands of the clock.⁹² The clock will keep correct time, because the swings of the pendulum never change.'

Galileo never completed his clock. He was too busy with⁹³ different experiments. Like Leonardo he had many wonderful ideas, but he only put a few into practice.⁹⁴

Leonardo drew pictures of aircraft, but he did not build one. Galileo drew pictures of his clock, and he explained them in a report. A few years later a Dutchman⁹⁵ read this report and made the complete clock. The Dutchman's name was Huygens.⁹⁶

That was the first clock with a pendulum. Since then men have made better ones. They still make them now. We use a pendulum for many church clocks, for grandfather clocks⁹⁷ and for cuckoo-clocks.⁹⁸

Have you seen a cuckoo-clock? They make them in Switzerland.⁹⁹ A little bird comes out at every hour and calls the time.¹⁰⁰ 'Cuckoo! Cuckoo! Cuckoo!' — that is three o'clock.

Many clocks now go by electricity.¹⁰¹ But if the supply of electricity stops, the clocks will stop. Clocks like Galileo's do not stop like that, and they keep good time.¹⁰² Some have worked for two hundred years, and they are still working.

Make a pendulum yourself one day. Hang some iron on a cord and allow it to swing. Then feel your pulse. Does it pump your blood seventy-two times in a minute? Is it slower than your pendulum?¹⁰³

Remember Galileo, too, when you test your own ideas. How do you test food? You smell it and taste it. You use your nose and teeth and tongue. You can test many things like that with your hands and eyes. So do not only use numbers on paper. Weigh things and measure them. Make a proper experiment.

第一章 注 释

1. THE PENDULUM ['pendjuləm] — (钟) 摆。
2. Galileo Galilei ['gali'leiau 'gali'leii:] — 伽里列奥·伽利略 (1564—1642), 意大利著名天文学家。
3. Pisa ['pi:zə] — 比萨, 意大利北部的一座城市, 有著名的比萨斜塔。
4. but they were born after him. — 但是他们都比他出生晚。
5. so his teacher was pleased with him. — 所以他的老师对他很满意。
6. He was clever with his hands, too. — 他的手也很巧。
7. They worked. — 这些机器能运转。
8. His favourite machine could raise heavy things off the ground. — 他心爱的一种机器能把笨重的东西从地上举起。
9. (be) full of — 充满。
10. laughed at — 嘲笑。
11. Vallombrosa [valəm'blu:zə] — 瓦朗布罗萨, 在佛罗伦萨附近。
12. Florence ['florəns] — 佛罗伦萨, 意大利一城市。
13. The river Arno — 阿诺河。
14. It held many different states. — 那时意大利由许多邦国组成。

15. Venice ['venɪs] — 威尼斯，意大利一城市。
16. Milan [mi'læn] — 米兰，意大利一城市。
17. Naples ['neɪplz] — 那不勒斯，意大利一港口城市。
18. Rome [rəʊm] — 罗马，意大利首都。
19. Pope [pəʊp] — 罗马教皇。
20. the Roman Catholic Church — 罗马天主教会。
21. to free themselves from its power — 摆脱教会的统治。
22. Holland ['hɒlənd] — 荷兰。
23. Denmark ['denmɑ:k] — 丹麦。
24. Sweden ['swi:dn] — 瑞典。
25. Germany ['dʒə:məni] — 德国。
26. Tuscany ['tʌskəni] — 托斯卡纳。
27. The Grand Duke — 大公，欧洲某些公国的君主。
28. the Medici ['medɪtʃi:] family — 梅迪奇家族。
29. The years 1400 to 1600 — 指欧洲文艺复兴时期。
30. Dante ['dænti] — 但丁 (1265—1321)，意大利著名诗人，代表作有《神曲》。
31. Boccaccio [bo'kɑ:tʃiəu] — 薄伽丘 (1313—1375)，意大利小说家，代表作有《十日谈》。
32. Lorenzo [lɒ'renzəu] de Medici — 洛伦佐·德·梅迪奇 (1448—1492)，意大利佛罗伦萨的政治家、文学美术的保护者。
33. Leonardo da Vinci [də'vɪntʃi] — 列奥那多·达·芬奇 (1452—1519)，意大利雕刻家、画家、建筑家、工程师及科学家。
34. Michelangelo [maɪkə'lændʒɪləu] — 米开兰基罗 (1475—1564)，意大利雕刻家、画家、建筑家兼诗人。

35. Botticelli [ˌbɒtɪˈtʃɛli] — 博蒂赛利 (1445? —1510), 意大利文艺复兴时期画家。
36. They practised on his walls. — 他们在他的墙上实习绘画。
37. They made beautiful figures of stone. — 他们雕刻出优美多姿的石像。
38. look after — 照顾, 照料。
39. a rich helper — 一个有钱的资助者。
40. and they were still in his head — 而这些见解还在他的头脑中。
41. used to — 惯常。
42. the public library — 公共图书馆。
43. He was too clever for them — 对他们来说, 伽利略太聪明了。
44. accept our ideas — 接受我们的观点。
45. Aristotle [ˈærɪstɒtl] — 亚里士多德(公元前384—322), 希腊哲学家。
46. a small corner of the world — 世界的一个小角落。
47. finding out — 发现。
48. Francis Drake — 弗朗西斯·德雷克(1540? —1596), 英国海军上将。
49. Columbus [kəˈlʌmbəs] — 哥伦布(1446—1506), 意大利探险家, 但为西班牙王廷服务, 于1492年发现美洲。
50. We must learn from life. — 我们必须向生活学习。
51. we can't learn from books alone. — 我们不能只学书本。

52. you'll soon be in trouble — 你很快就会倒霉的。
53. men were beginning to think for themselves — 人们开始独立思考问题。
54. by experiment — 用实验的方法。
55. Archimedes [ɑ:ki'mi:di:z] — 阿基米得 (公元前287?—212), 古希腊著名数学家, 物理学家。
56. with numbers first — 先用数字。
57. round [raund] — 圆的。
58. square [skweə] — 方的。
59. which holds the bigger amount of sand? — 哪个能容纳更多的沙子?
60. empty it into the box — 把罐里的沙子倒入盒中。
61. Why do they not fall up to the sky? — 物体为什么不朝天上跑呢?
62. Why can heavy ships sit in the water? — 为什么大船能呆在水面上呢?
63. a long cord — 一根长绳子。
64. lit it =lighted it — 把灯点亮。
65. It was swinging from side to side. — 灯来回摆动。
66. with special care — 特别细心。
67. Every swing takes the same amount of time. — 每一次摆动所需的时间相同。
68. wanted to be certain — 要求弄确切。
69. I can feel my pulse. — 我能数自己的脉搏。
70. the use of a pulse — 脉搏的用途。
71. It is pumping your blood. — 脉搏不断压送血液。
72. a heavy piece of iron — 一块大铁片。

73. He fixed the iron to the end of the cord — 他把铁片固定在绳子的末端。
74. again and again — 一再。
75. At last the swings were just right. — 摆速终于和脉搏的跳数相一致（指每分钟七十二次）。
76. wind [waɪnd] — （过去式为wound）卷，绕。
77. you wind it up — 你把绳子绕紧。
78. you wind it down — 你把绳子放松。
79. There's a mark on the cord — 绳上有标记。
80. beside number 72 — 在数字72的旁边。
81. made many copies of it — 复制了许多套。
82. Padua ['pædjʊə] — 帕多瓦，意大利一地名。
83. a light metal — 一种轻金属。
84. a thin bar of — 一根细的……
85. teeth [ti:θ] — （单数为tooth [tu:θ]）牙齿，轮齿。
86. for a special reason — 为了特殊的原因。
87. tongue [tʌŋ] — 舌，舌簧。
88. this tongue goes over one tooth of the wheel — 舌簧扣在轮子的一个轮齿上。
89. it will push this tongue out — 轮子就把舌簧推出去。
90. swing to one side — （摆就）摆向一边。
91. one by one — 一个接一个地。
92. the hands of the clock — 钟的指针。
93. busy with — 忙于。
94. put...into practice — 把…付诸实践。
95. Dutchman ['dʌtʃmən] — 荷兰人。