

THE PREHISTORY OF AVIATION

BY BERTHOLD LAUFER

THE desire to fly is as old as mankind; in all ages man's imagination has been stirred by the sight of flying birds and seized by the ambition to sail upon the wind like one of them. There is a long record of ventures, experiments and failures, and the romance of flying still remains one of the most fascinating in the history of mankind.

It is to man's ingrained love for the fabulous, for the wondrous and extraordinary, to which we are indebted for the preservation of ancient records of flight. The prehistory of mechanical science is shrouded in mystery because primitive man was unable to render an intelligent account of it. Just as natural phenomena were regarded by him as wonders wrought by supernatural agencies, so any mechanical devices were interpreted as witchcraft. Every investigator and skilled artificer of prehistoric and early historic days has gone down in history as an enchanter or wizard who had made a pact with demoniacal powers. Many of the so-called magicians were simply clever mechanics whose work was beyond the comprehension of their contemporaries and whose achievements were so singular and awe-inspiring that they were believed to have been inspired by supernatural forces. This is the reason that those who made attempts at aerial flights were so often associated with magic and necromantic art and why in our middle ages solely witches and devils were endowed with the faculty of flying.

Ancient traditions regarding mechanical wonders must, therefore, be divested of their legendary garb and exposed in their historical nucleus, but we owe to them the preservation of many re-

Extract from Publication 253, Volume XVIII, No. 1, Anthropological Series, Field Museum of Natural History, Chicago.

cords, for the dry and bare bones of historical events are apt to be relegated to the waste basket.

The imaginative faculty of the human mind does not conceive things that have no reality in existence. The product of our imagination is always elicited by something that we have at least reason to believe exists. The question is: if these myths exist, how did they arise, and what germ of fact lies behind them.

In the same manner that astrology was the precursor of astronomy and alchemy evolved into the science of chemistry, so there is an abundance of lore which godfathers the history of aviation. To distinguish that primeval stage from the present accomplished fact we will simply speak of it as the prehistory of aviation and we will show that our modern progress is not due solely to the efforts of the present generation.

THE ROMANCE OF FLYING IN CHINA

At the threshold of the earliest recorded history of China an imperial flyer¹ appears, the emperor Shun who lived in the third millennium before our era; and he is not only the first flyer recorded in history but also the very first who made a successful descent in a parachute.

Shun's early life teemed with thrilling adventures. His mother died when he was quite young, and his father, Ku Sou, took a second wife by whom he had a son. He grew very fond of this son and gradually conceived a dislike for Shun which resulted in several conspiracies against the poor youngster's life. In spite of this, however, Shun continued in exemplary conduct towards his father and step-mother. His filial piety attracted the attention of the wise and worthy emperor, Yao. Yao had two daughters who instructed Shun in the art of flying like a bird. In the commentary to the annals of the Bamboo Books, Shun is described as a flyer. Se-ma Ts'ien has preserved the following tradition. "Ku Sou bade his son, Shun, build a granary and ascend it, and thereupon set the structure on fire. Shun who stood on top of the tower, spread out two large reed hats which he used as a parachute in making his descent and landed on the ground unscathed." Considering the fact that Chinese reed hats are umbrella-shaped, circular

¹Bladud, the legendary tenth king of Britain, is said to have made wings of feathers by means of which he attempted an aerial flight which resulted in his death in 852 B. C.

and very large (two to three feet in diameter) this feat would not seem impossible.² Shun later married the two sisters, and their father gave him a share in the government.

Winged flight, however, seldom appears as a real attempt. The emperor Shun is practically the sole example and seems to have found few imitators.

Chinese writers fable about a country of flying folk, Yü Min, located on an island in the southeastern ocean, a people with long jaws, bird-beaks, red eyes and white heads, covered with hair and feathers resembling human beings, but born from eggs.

The conception of bird-men is quite familiar to Chinese mythology and is often represented in Chinese art. Lei Kung, the god of thunder and lightning, has wings attached to his shoulders (usually those of a bat) by means of which he flies to wherever he wishes to produce a thunderstorm.

The first description of an air journey is found in a poem by Kü Yüan, who, having lost his position as statesman by the intrigues of his rivals, found solace from his disgrace by writing. In his poem, he surveys the earth to its four extreme points, travels all over the sky, then descends again in a flying chariot drawn by dragons.

This idea is not alien to Chinese art. An aerial contest between a dragon chariot and winged beings astride scaly and horned dragons is represented on a gravestone of the Han period (second century A.D.)

Huang Ti, one of the ancient legendary emperors, attained immortality by mounting a long-bearded dragon, strong enough to transport his wives also and ministers—more than seventy persons. The officials of lower rank who were not able to find a seat on the dragon's back clung to the hairs of the dragon's beard, like strap hangers in the street cars. These, however, gave way, and the passengers were plunged to the ground, and also dropped the emperor's bow. The multitude of spectators reverentially watched the apotheosis and when Huang Ti had reached his destination, they picked up the hairs and his bow.

When the imagination of a nation is filled with the romance of air, when the very air is populated with winged genii and flying chariots, and when such subjects are glorified by art, it is the logi-

²Leonardo da Vinci was the first in our midst to conceive the idea of a parachute.



AERIAL CONTEST OF DRAGON-CHARIOT AND DRAGON-RIDERS
Stone Bas-relief of Han Period, A.D. 147. Shan-tung, China

cal step that imagination leads one or another to attempt the construction of some kind of an airship.

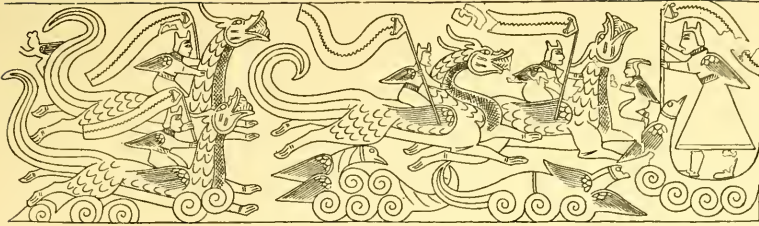
The history of the ancient Emperors, the *Ti wang shi ki*, contains the following notice: "Ki-kung-shi was able to make a flying chariot which, driven by a fair wind, traveled a great distance. At the time of the emperor Ch'eng T'ang the west wind blew Ki-kung-shi's chariot as far as Yü-chou. The emperor ordered this chariot to be destroyed so that it should not become known to the people. Ten years later, when the east wind blew, the emperor caused another chariot to be built by Ki-kung and sent him back in it."

The term "flying chariot" (*fei ch'o*) used in this passage is now current in China to designate an aeroplane.

Another account ascribes this invention to the Ki-kung nation, who are one-armed, three-eyed hermaphrodites. Most likely two distinct legends have here become contaminated.

A wood engraving of Ki-kung's chariot of comparatively recent origin reconstructed from the slender fabric of the ancient tradition is reproduced here. The Chinese draughtsman is decidedly wrong about producing a two-wheeled chariot as the sole indication of motive power given in the account itself is the wind. In ancient China only two devices were known to set a vehicle in motion, namely, a sail and a kite. A sail alone cannot lift a vehicle into the air, but this can be accomplished by several powerful kites. Therefore, Ki-kung's chariot was probably built on the aerostatic principle, being driven by a combination of sails and kites.

Possibly the chariot was similar to the aerial boat designed by Francesco Lana which was to be lifted by four copper globes from



AERIAL CONTEST OF DRAGON-CHARIOT AND DRAGON-RIDERS

which all the air had been extracted. The boat is then propelled by oars and sails.

Kung-shu Tse, a contemporary of Confucius, also called Lu Pan, is said to have carved a magpie from bamboo and wood; when completed he caused it to fly, and only after three days did it come down to earth. According to another tradition, Kung-shu made an ascent on a wooden kite in order to spy on a city which he desired to capture. This invention is sometimes ascribed to Mo Ti, and a great deal of confusion surrounds the accounts. As early as the first century of our era, real knowledge of this contrivance was lost.

This wooden bird and its affinity, the dove of Archytas, meet with a curious parallel in the west. The astronomer, Regiomontanus, who lived in Nuremberg in the 15th century is said to have constructed an eagle which he sent out high in the air to meet the emperor and accompanied him to the city gates. Considering the fact that such similar contrivances are reported from different parts of the world at widely varying times we cannot help concluding that a grain of truth must underlie these accounts, even though we grant that they are exaggerated. Perhaps Kung-shu's bird was a glider, or perhaps it was attached to or raised by a kite.

Starting from realistic means of flight, Chinese efforts developed into mysticism and magic. In the second century B. C. alchemistic lore began to infiltrate from the west. The notion of flight was a link of paramount importance in the chain of mystic dreams which held the people enthralled for many centuries. Alchemists sought the elixir of life, people ascended to heaven upon drinking concoctions, or upon the back of cranes, of ducks or tigers.

In this later history two singular ideas come to the fore; levitation by means of starvation and by means of remedies taken in-

ternally—live on air to conquer the air. These doctrines and practices of Taoism are partially traceable to India.

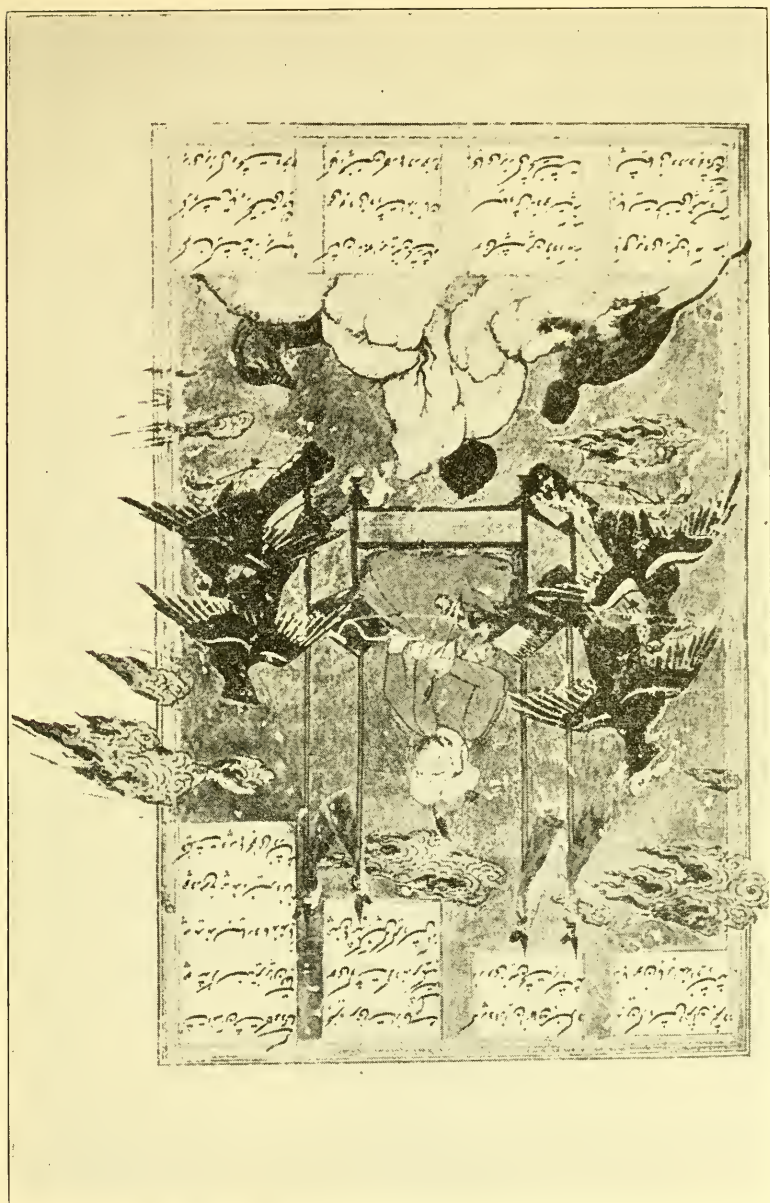
T'ao Hung-king, a distinguished physician and adept in the mysteries of Taoism, compounded a "flying elixir" of gold, cinna-bar, azurite and sulphur. It was said to have the color of hoar frost and snow and to have a bitter taste. When swallowed it produced levitation of the body. It is the only example in the history of the world of teaching to fly by means of medicine taken internally.

KITES AS PRECURSORS TO AEROPLANES

Kites were first invented and put to a practical test in ancient China. The toy we used to fly in our boyhood days is but a poor degenerate orphan compared to the Chinese kites which are wonders of technique and art. The ordinary Chinese kites are made of a light framework of bamboo over which is spread a sheet of strong paper, painted in brilliant hues with human or animal figures. The figures are designed for a distant vista and may seem, at a close proximity, distorted, but from a distance appear most beautiful, and waving and soaring as the kite moves on like a real bird. They are maintained by a long tough cord wound over a reel which is held in the hand and is continually turned as the paper plane rises or falls. The most complicated one of these is the centipede kite. One in the American Natural History Museum in New York measures 40 ft. in length. Mechanically kites are constructed on the principle underlying the behavior of a soaring bird, which performs its movements with peculiar warped and curved surfaces.

The ninth day of the ninth month in the autumn is devoted to the festival called Ch'ung-yang. Friends join for a picnic in the hills and set kites adrift. This also is the day for holding kite contests. The cord near the kite is stiffened with cut glass. The kite-flyer manoeuvres to get his kite to windward of that of his rival, allows his cord to drift against that of his rival, and by a sudden jerk cuts it through, so that the hostile kite is brought down.

A musical kite was invented in the tenth century by Li Ye who fastened a bamboo flute to the kite's head. Sometimes two or three flutes are attached one above the other, more frequently, however, a musical bow made of light willow-wood or bamboo, and strung with a silken cord is attached to the kites.



KAI KAWUS FLIGHT TO HEAVEN

From a Persian Illustrated Manuscript of the Shahnameh, Dated 1587-88
Courtesy of Metropolitan Museum of Art, New York

Courtesy of Field Museum

Kites were originally used for military signaling. The idea that a kite drives away bad spirits is of local and recent development—found more in Korea than in China and bears no relation to the origin of kites, and cannot be clearly traced. They seem not to have existed in times of early antiquity, and therefore they are not mentioned in the treatise on the art of war by Sun Wu in the 6th century B. C.

Kung-shu's wooden bird was not a flying kite. The earliest notion of this looms up in the life of Han Sin who died in 196 B. C., one of the three heroes who assisted Lu Pang in ascending the throne as the first emperor of the Han dynasty. He wanted to dig a tunnel to the palace and in order to measure the distance he is said to have flown a kite. Some say he measured the cord, others say that he ascended the kite, but it is most probable that he introduced kites into warfare using them in trigonometrical calculations of the distance from the hostile army. The story is however not well authenticated for it appears only in comparatively late sources and Han Sin's kite is said to have been made of paper, while paper was invented only 300 years later.

Chinese authors are wont to speak of paper kites. Paper was invented in A. D. 105. Ever since paper has come into use, kites have been made of this material, and no other material has been used for them. But the framework might have been covered by some other light material, silk or hemp. Chinese records, however, are reticent on this point.

From China knowledge of kites was diffused to all other nations of Eastern Asia, that experienced the influence of Chinese civilization such as Korea, Japan, and nearby countries. In some parts of Indonesia, kites are put to the practical purpose of catching fish. Kites were introduced into India through Malay or Chinese immigrants. Kite-flying is a popular amusement in the spring and contests are held for high stakes.

In Siam, kite flying is a state ceremony, as well as a public festivity connected with agriculture and the northeast monsoon.

All data at our disposal goes to prove that the kite spread from the far east westward, to the near east and finally to Europe and makes its debut there as a Chinese contrivance.

In European literature kites are first described by the Italian Giovanni Batista in his book on natural magic, and the Jesuit Athan-

asius Kircher who also wrote a book on China which is based on information received from members of his order working in China. Kites were flown in England as a pastime. In the middle of the seventeenth century they were employed for the purpose of letting off fireworks. They were finally used in Europe by Alexander Wilson and in the United States by Benjamin Franklin for scientific purposes in making temperature and electrical experiments. The classical experiment of Benjamin Franklin which identified lightning with electricity is, of course, well known.

Both in China and Japan there are stories current about men riding on kites. Athanasius Kircher mentions that in his time kites were made of such dimensions that they were capable of lifting a man.

About the year 1826, the principle of the kite was turned to a practical purpose by George Pocock a schoolmaster of Bristol, who found that by attaching several kites one beneath another they could be elevated above the clouds. In January the following year he claimed to have covered several miles between Bristol and Malborough at twenty miles an hour. He proposed to use kites for shipwrecking and to tow boats, and for military purposes to elevate a man for reconnaissances and signaling.

In 1876, Joseph Simmons claims that he was drawn into the air to a height of 600 feet by means of two superimposed kites and adjusting his weight by guy lines to the earth. Others have also reported such success.

Laurence Hargrave, an Australian, introduced a new principle, the cellular construction of kites. This type of box kite formed the starting point of Alexander Graham Bell's researches and construction of tetrahedral and triangular kites. The wings of the modern biplane are closely modeled after the Hargrave box kite. The man-lifting kite has developed into an aeroplane. The speed plane of our day is but a first cousin to the kite.

Another Chinese apparatus deserves mention here as it served as a source of inspiration to Sir George Cayley one of the great pioneers of modern aviation. He says that his first experiments were made with a Chinese aerial top which served at once to illustrate the principle of the helicopter and air-screw. Though but a toy a few inches long, its capacity to demonstrate certain principles in aeronautics made a lasting impression on his youthful mind.

THE DAWN OF AIRSHIPS IN ANCIENT INDIA

Although the Aryan Indians of the Vedic period had numerous aerial deities, such as the Gandharvas, elves "haunting the fathomless spaces of air," no allusion is made in the Rigveda to their manner of locomotion. The Vedic gods did not fly, but preferred driving in luminous cars drawn by fleet horses, cows, goats or spotted deer. Indra, the favorite national god, primarily a storm and thunder god, is borne in a golden chariot drawn by tawny chargers as an eagle is borne on its wings, faster than thought.

A myth of post-Vedic times tells of quaking mountains with wings gifted with the power of flight. They flew around like birds, alighted wherever they pleased and with their incessant motion made the earth unsteady. With his thunderbolt, Indra clipped their wings and settled them permanently in their places; their wings were transformed into thunder clouds.

The Açvine (horsemen), the twin dieties, probably representing the dawn and the morning star, traverse heaven and earth in a single day, drawn in a sun-like chariot by horses or birds or swans or eagles. Other Vedic gods, Surya, the sun god, Agni, the personification of the sacrificial fire, drive in chariots or are represented as birds. Pushan, who is closely connected with the sun, moves in golden ships sailing over the aerial ocean. The sun on one hand appears as a boat in which Varuna, the god of the sky, navigated the aerial sea, and on the other hand as a chariot with Varuna as the charioteer. This conception arose from the experience of seeing the sun set in the sea.

The Maruts, the gods of the winds, are described as having yoked the winds as steeds to their pole; that is, their chariot is driven by winds.

In post-Vedic literature the Indians profess to have had two distinct types of flying machines, the Garuda airship of native manufacture constructed on the principle of bird-flight, and the Yavana airship ascribed to the Greeks whose manufacture was scrupulously guarded as a secret. Whether the ancient Indians ever really navigated the air or whether their dirigibles are fiction is irrelevant. The main thing is they had the idea, and their ideas about aeronautics were not worse or more defective than those of Europe from the 16th century to the first part of the 19th century. They saw two points clearly—that aircraft must operate on the principle of

the flight of birds and that a mechanism is required to start the machine, to keep it in midair, and to make it descend. They devoted considerable thought to problems of the air and efforts were made to construct aircraft of various types.

The Greek records are silent as to aircraft, so that we do not know whether the Greeks really, as asserted, did supply them with flying machines. Certainly Greek mechanists and artisans enjoyed a high reputation in India, and marvelous inventions were ascribed to them, such as marvelous automata, movable figures of beautiful women.

The vehicle of the god Vishnu is Garuda, a celestial bird originally a solar bird. This mythological conception proved very fertile in stimulating imagination and according to Indian stories led to construction of airships, and attempts at flying.

The most popular collection of Indian folk-lore contains the story of the weaver as Vishnu. A weaver became infatuated with the king's daughter. His friend, a carpenter, made a wooden airship for him in the shape of a Garuda, which was set in motion by a switch or spring. Equipped with all the paraphernalia of the god, he flew to the seventh story of the palace where the princess had her apartment. She took him for Vishnu, and he married her according to the rites of the Gandharvas (by mutual consent). To her father's questions, she said she was the consort of a god. The king thereupon became overbearing to his neighbors who made war upon him. He implored the pseudo-Vishnu for help through his daughter. He accordingly appeared above the battlefield with bow and arrow, ready to die. But Vishnu, not wishing his authority to suffer among men, as it would if he allowed the weaver to die, entered his body and scattered the enemy. After the victory the weaver told the whole story to the king, who rewarded him and married him to his daughter. The most interesting point to this story is that a garuda is used to rout an enemy.

Another garuda is described in a collection of old Indian stories. The wife of a rich man's son is stolen, and a carpenter's son, to rescue her, builds a wooden Garuda. It is supplied with three springs, one in front to make it go upward, on the side to make it float smoothly along, and one beneath to make it descend.

Again reference to airships is found in a collection of stories

written during the 11th century. Vasavadatta desired to mount an aerial chariot and visit the earth. The carpenters who were summoned said that flying machines were known only to the Greeks. Later in the same story, Viçvila makes an aerial journey on a mechanical cock, but says that the secret should be revealed to no one but a Greek. Pukvasaka, his father-in-law, commanded him to build a flying machine, but Viçvila who had learned the secret from the Greek artisan not daring to reveal it, fled with his wife during the night on the cock, to the country whence he had come. The artisans were flogged; meanwhile a stranger appeared who said, "Do not flog the artisans: I will build a flying machine." In the nick of time he produced a flying machine in the form of a Garuda. When the Queen refused to mount it alone, the stranger said it could carry the entire city. So the king and his personnel, his wives and officials set out and circumnavigated the earth. On his return, he did honors to the craftsman.

In a Sanskrit romance of the 7th century, a king, desirous of marvels, was carried away, no one knows whither, on an aerial car made by a Greek who had been taken prisoner. The term used in this passage means "a mechanical vehicle which travels on the surface of the air."

As regards winged flight, only one example is known to me from Indian literature. The *Katha Sarit Sagara* contains the following tale: A young Brahman, having seen the prince of the Siddhas flying through the air, wished to rival him, and fastening wings of grass to his side and continually leaping up he tried to learn to fly. The prince took pity on the boy who was making such an earnest effort, and by means of his magic power took the boy on his shoulder and made him one of his followers.

In Indian art, particularly in the sculpture of the Buddhists, winged beings in the act of flying are frequently represented.

Among the marvelous abilities promised as a reward for yoga practice was "traversing the air." What has been observed as flying by modern yogins proved to be hopping close to the surface of the ground without seemingly touching it.

More interesting, however, are two charming motifs of folklore presented by India to the world, magic boots and the enchanted flying horse.

FROM BABYLON AND PERSIA TO THE GREEKS AND THE ARABS

From the Euphrates Valley large fragments have been recovered of a legend of the sovereign Etana who, as a reward for having helped a wounded eagle, is carried on his back to the dwelling of the gods. They reach the heaven of Anu and halt at the gate of the ecliptic. The eagle is next urging Etana on to the dwelling place of Ishtar, six hours distant, but either his strength is exhausted or the goddess intervenes, for a precipitous descent begins. They fall through space three double hours and finally reach the ground. The close of the story is wanting, but the purpose of the flight has failed.

This is the only record of flight recorded in cuneiform literature. Although it is found in Babylon and several different cylinder seals illustrate the legend, it is thought to be of Iranian or possibly Aryan origin.

There is an ancient Persian tradition of especial interest which was transmitted to Europe at an early date. In the semi-legendary history of Iran, there was a king, Kai Kawus, who was easily led astray by passion. He built seven palaces on Mt. Alburz, then he tried to restrain the demons of Mazandaran, one of which retaliated and sowed the seeds of discontent in his heart, so that he set his mind on attaining supremacy in the celestial abode. He built a throne, supported and raised by four starving eagles. As an incentive for the birds to fly, four pieces of flesh were fastened to the top of four spears planted on the sides of the throne. The flight was of short duration; the strange vehicle soon came down in a crash and the grandees found the king unconscious in a forest.

The Iranian motif of an aerial vehicle lifted by starved eagles was adopted by the Greek Romances of Alexander the Great which became widely known throughout the middle ages.

Of all the flying stories of classical antiquity the one that has left the most lasting impression and inspired the greatest number of imitators is that of Daedalus (Cunning Worker). He incurred the wrath of king Minus and, in order to escape imprisonment, fashioned a pair of artificial wings coated with wax for himself and his son. They mounted and flew westward over the sea. Icarus, however, disregarded his father's advice and flew too near the sun; the wax on his wings softened and melted, and he fell headlong into the sea.

It does not matter if the story is or is not true. It is the flight of human imagination, the impulses and visions of a genius, very often his errors, which have stimulated inventions and progress.

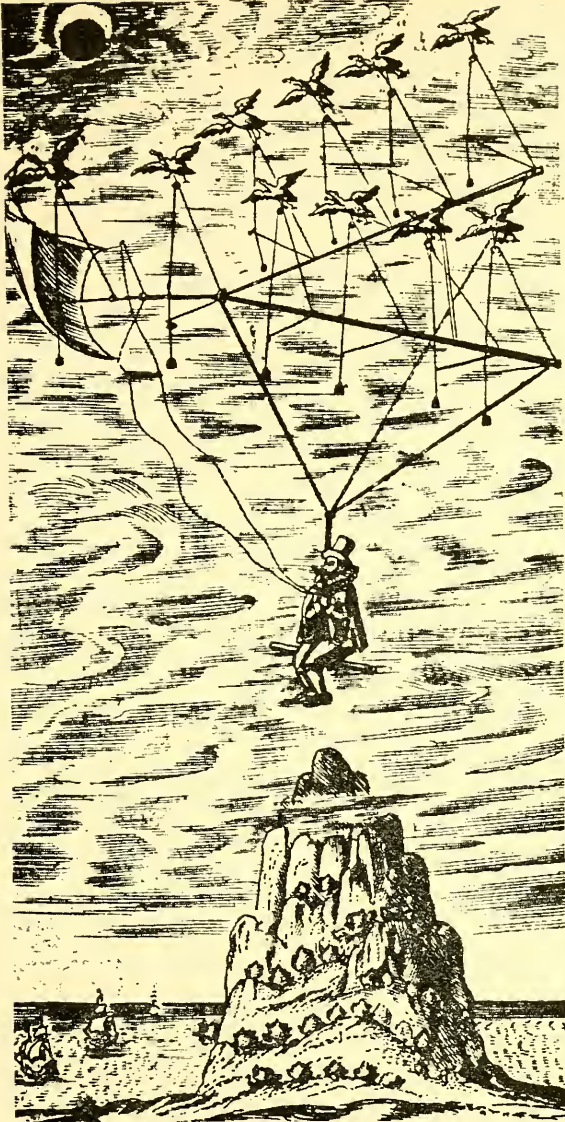
The Daedalus story finds an echo in the Germanic saga of Wayland the Smith, the artificer of marvelous weapons. King Nidung endeavored to keep him in his service by cutting the sinews of his feet, thus laming him forever. Wayland forged a feather robe and revealed his purpose to the king from the tower of the castle and flew home to Seeland.

The most notable of the Greek gods and goddesses who flew through space were Perseus and Hermes with winged helmet and shoes. Fantastic conveyances were used on the Greek stage to give the illusion of persons being lifted upward or descending from the air.

Archytas, a Greek philosopher, mathematician and statesman, who lived in Italy in 428 B.C. attained great skill as a practical mechanic. His flying dove of wood was one of the wonders of antiquity. From the accounts we have, it is not clear just what it was. It is described as being a wooden figure balanced by a weight that was suspended from a pulley. It is said to have soared in the air and been put into motion by a current of air "hidden and enclosed" in its interior. Some scholars incline to the opinion that it was an anticipation of the hot air balloon, others that it was an aerostat or glider, for it is said that it could fly but not rise again after falling. It may also have been on the order of Lu Pan's wooden kite.

Lucian, the delightful satirist and divine liar of the second century of our era, tells of an air voyage where the flyer, Menippus, goes Daedalus one better by refraining from the use of wax. He fastened an eagle's and a vulture's wing to each side by straps with handles for grips. Thus he essayed to fly, at first leaping and flapping, keeping close to the ground as geese do, later becoming bold enough to fly to Olympus, and to the moon. This story gave the impetus to the class of fiction known as "voyages imaginaires."

Such a voyage is described by Francis Godwin in his romance "The Man in the Moone." His hero, Gonzales was abandoned on an uninhabited island, St. Helena. He trained a flock of birds to fly together bearing a burden. Then he devised a mechanism whereby he could distribute his weight at the start of the flight. At first



THE AERIAL VOYAGE OF DOMINGO GONSALES
From F. Godwin's *Man in the Moone*, 1638

Courtesy of Field Museum

he experimented with a lamb, then he was himself carried aloft. "For I hold it far more honor to have been the first flying man than to be another Neptune that first adventured to sail upon the sea." This sentiment, "to be the flying man," finds its earliest expression here.

The Arabs, heirs to Greek philosophy, and science, made considerable progress in mechanical devices. About the year 875, an Arabian, known as the Sage of Spain, who was the first to manufacture glass, invented a contrivance to make his body rise into the air. He made wings, clothed himself with feathers and flew quite a distance, but as he had not considered what would happen during his descent, he fell and injured his buttocks. He was ignorant, the Arabic chronicler adds, that a bird falls only on its rump, and had forgotten to make a tail for himself.

There is another story of a flying architect from the tenth century, who erected a huge tower for King Shapur I. The king, not wanting anyone else to profit by his genius, left him on the top of the tower. The architect built a pair of wooden wings, fastened them to his body, and driven by the wind, flew to a place of safety. This story bears a remarkable resemblance to the Daedalus story.

In Constantinople, at the festivities held in honor of a visiting Sultan, a Saracen wanted to show his skill in flying. He announced he would fly from the tower of the hippodrome across the race-course. He was clad in white garments, large and wide, braced with rods of willow-wood laid over a framework. He delayed for a long time and the crowd became impatient; but finally, when the wind was favorable, he soared like a bird and seemed to fly in the air.

Oliver of Malmesbury, an English astrologer of the eleventh century, is said to have attached wings to his hands and feet and attempted to fly off from a tower. He attributed his fall to the lack of a tail. This bears a striking resemblance to the Arabic story above mentioned.

John Damion, an Italian by birth and a physician at the court of King James, claimed he could overtake an embassy to France. He fastened wings of bird feathers on himself and hopped off the top of Stirling Castle, but he fell and broke his legs. He blamed his misfortune on the fact that there were some chicken feathers in his wing which showed a natural affinity to return to the barnyard.

Giovanni Battista Danti, a mathematician of Perugia, is said to have attempted winged flights over the lake Trasimeno.

Roger Bacon was to some extent under the influence of Arabic science. He had all the superstitions of his contemporaries in regard to flying. He suggested that flying machines could be made so that a man "seated in the midst of the machine, revolving some sort of device by means of which wings artificially composed may beat the air after the manner of a flying bird." Bacon's place is at the end of the line in the prehistory of aviation. His ideas of flying are the echo of the ancient idea that we have traced from China and India, Persia and Arabia.

The modern history of aviation begins with Leonardo da Vinci.

THE AIR MAIL OF ANCIENT TIMES

Air-mail service was first established in the United States in 1918 when the New York-Washington mail route (218 miles) was established. While our air-mail is an epoch-making innovation and an achievement of modern times, there was also a prehistoric air-mail which is no less admirable, carried on the wings of pigeons. This institution we owe also to the Orient.

The first Chinese who made use of carrier pigeons is Chang Kiu-ling (A.D. 673-740) a statesman and poet, who corresponded with his relatives by means of a flock of carrier pigeons, which he called his flying slaves (*fei nu*). The messages were attached to the feet of the birds who were taught how to deliver them. The government of China never employed pigeons for carrying important messages, but their use remained restricted to private correspondence chiefly for bringing news of the arrival of cargoes and the ruling prices of markets.

In India the use of carrier pigeons goes back to great antiquity and may with certainty be assumed to have been in full swing in the beginning of our era. Kings of India received news about the movement of hostile troops by domesticated pigeons. In Indian stories various kinds of birds appear as harbingers of messages, the white wild goose, for instance, the crow, and frequently parrots.

As regards Persia, many pigeons were kept on their sea going vessels, capable of flying several thousand *li* (Chinese miles). These were released and they returned home bearing tidings as it were

that everything on board was well. In medieval times Persian authors repeatedly refer to the conveyance of letters by pigeon mail. The pigeon also appears in love songs as messenger and bearer of love letters.

The use among the Greeks and Romans of carrier pigeons is restricted to isolated instances where news is carried of victory in the Olympian games or to a besieged city. Since there is no mention made of their being trained for message bearing, it was probably of no great significance among the ancients and probably died out during the days of the decline of the Roman Empire.

Mesopotamia appears to be the home of the domesticated pigeon, and the domestication of the bird was accomplished as early as pre-Semitic times by the Sumerians. Among the Semites, pigeons are closely connected with religious practices. They are sacred to the goddess Ishtar. It is unknown when and where pigeons were first trained for conveying messages. Both in Egypt and Mesopotamia the practice was unknown, but it is improbable that the practice could have developed where clay tablets were the common writing material.

The dove which Noah sent from the ark three times represents an entirely distinct class in the category of land-spying birds which navigators released when they had lost their bearings and were in quest of land. These birds never returned to their ships.

In the 9th century when the Vikings sailed from Norway, they kept birds on board which were set free from time to time amid sea, and with their aid, succeeded in discovering Iceland. Land expeditions would also be accompanied by land-spying birds and would settle in a territory where the birds would descend.

In the present state of our knowledge we can only assert with safety that the highest development in the use of pigeon messengers was reached in the empire of the Caliphs and under the Mohammedan dynasties of Egypt, where the whole business was organized and systematized on a scientific basis, while of course, isolated cases occurred many centuries earlier. Indo-Iranian peoples may very well have given the first impetus to the training of carrier pigeons. Under the Caliph, Nūr-ed-dīn a regular air mail was established. Pigeons were kept in all castles and fortresses of his empire. Under the Caliph Ahmed Naser-lidin-Allah air mail developed into a regular institution. Although many were engaged

in the business of raising pigeons, their prices reached amazing figures. A well trained pair sold as high as 1000 gold pieces. Bagdad was the central station for air-mail until it was conquered by the Mongols in 1258.

One of the most curious incidents in the history of airmail was when the Caliph Aziz (975-996) had a great desire for a dish of cherries from Balbek. His Vezir caused 600 pigeons to be despatched from Balbek to Cairo each of which carried attached to either leg a small silk bag containing a cherry. This is the first record of parcel post by air-mail.

Stanley Lane Poole, in his "History of Egypt in the Middle-Ages," writes of Beybars (1266-77) "the most famous and energetic of all the Bahri Mamluks, that he established a well-organized system of posts, including the pigeon post. . . . The pigeons were kept in cots in the citadel and at various stages which were farther apart than those of the horses. The bird would stop at the first post-cot where its letter would be attached to the wing of another pigeon for the next stage. The royal pigeons had a distinguishing mark and when one of these arrived at the citadel with a dispatch, none was permitted to detach the parchment save the Sultan himself; and so stringent were the rules that were he dining or sleeping or in the bath, he would nevertheless be informed at once of the arrival and would immediately proceed to disencumber the bird of its message." The letters were written on a fine tissue paper and were fastened beneath the wings and later to the tail feather.

During the middle ages the European nations became acquainted with pigeon air-mail when the cross and the crescent clashed during the Crusades. There are stories on record which depict the wonder and amazement of the Christian soldiers at witnessing this novel experience. They brought carrier pigeons back from the Orient. Medieval knights used them in sending communications from castle to castle. The convents did so also. All pigeons used in medieval Europe for air-mail purposes were of Oriental origin.

The first employment of pigeons for military purposes in Europe was during the siege of Harlem by the Spaniards in 1573. The garrison received advices by pigeon mail announcing the approach of a relief army under the Prince of Orania.

It is said that Rotchschild of London had his agents join Napoleon's army and send him first hand information by air-mail,

whereby he managed his financial speculations. Reuter started his career by organizing a pigeon post from Aix-la-Chapelle to Brussels. A newspaper reporter equipped with a small pigeon cage was not a rare sight. During the siege of Paris in 1870 the only news from the outside world that reached the city was conveyed by the wings of pigeons. In the world war pigeons were extensively utilized and achieved brilliant records of flight under great difficulties.

Pigeons are still bred and kept in large numbers for messenger service and racing. In good weather young birds will fly about 300 miles in seven to nine hours and flights of 600 miles in one day have been accomplished by older birds.



KI-KUNG'S FLYING CHARIOT
Chinese Woodcut from T'u shu tsi ch'eng

Courtesy of Field Museum

For Leaders —

The **JOURNAL OF RELIGION**

To read *The Journal of Religion* is to keep in the vanguard of those who are thinking about the problems of present day religious life.

This non-sectarian periodical provides for its readers an unprejudiced, critical account of modern religious thought. It attempts to reveal the inner reality of religion, rather than to defend a doctrinal system. It consistently avoids cant, dogma, technical abstruseness; and constantly emphasizes the interrelationship of religious life and social environment.

This scholarly journal is indispensable to the serious reader interested in religion as a living, spiritual reality in society, in history, and in individual experience.

The Journal of Religion is edited by Shirley Jackson Case with the cooperation of the Divinity Faculty and Conference of the University of Chicago. It is published quarterly at the subscription price of \$3.00 a year.

If you wish to examine *The Journal of Religion* a sample copy will be mailed you free upon request.

THE UNIVERSITY OF CHICAGO PRESS
5750 ELLIS AVE. . . . CHICAGO, ILLINOIS

THE LOGIC OF DISCOVERY

By

ROBERT D. CARMICHAEL

Head of the Department of Mathematics
University of Illinois

The main aspects of the process of discovery are skillfully discussed in a manner to interest the non-technical reader.

Three of the chapters have previously been published in *The Monist*, *Scientia* and *The Scientific Monthly*.

TABLE OF CONTENTS

Chapter

- I The Logic of Discovery
 - II What is the Place of Postulate Systems in the Further Progress of Thought?
 - III On the Nature of Systems of Postulates
 - IV Concerning the Postulational Treatment of Empirical Truth
 - V The Structure of Exact Thought
 - VI The Notion of Doctrinal Function
 - VII Hypothesis Growing into Veritable Principle
 - VIII What is Reasoning?
 - IX The Larger Human Worth of Mathematics
- Index

Pp. 280, cloth. Price \$2.00

By the same Author

A DEBATE ON THE THEORY OF RELATIVITY with an introduction by William Lowe Bryan, Indiana University.

Favoring the Theory: Robert D. Carmichael, University of Illinois, and Harold T. Davis, Indiana University.

Opposing the Theory: William D. MacMillan, University of Chicago and Mason E. Hufford, Indiana University.

(First Impression in 1925, Second Impression in 1927.)

Cloth, \$2.00

THE OPEN COURT PUBLISHING COMPANY

Chicago

London