The ROMANCE OF THE MATCH

Fire Lighting in the Glacial Age

THE ROMANCE *of the* MATCH

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HOW many thousand or hundred thousand years man lived on earth before learning to use fire is unknown. How long he employed fire before being able to create it is uncertain. In just what period and in what way he discovered how to produce it, is problematical. Nevertheless the explorations of the last few decades have gradually unearthed various definite prehistoric facts which enable us to fix the first production of fire before a known epoch, and probably between certain periods.

Fire making has been proved to be older than pottery, older than weaving, and older than agriculture. It goes back before the New Stone Age and well toward the beginning of the Old Stone Age. It was known before the last glacial period, but just how long previously, still remains to be determined.

THE EARLIEST RECORDS

The first systematic working of flint seems to have taken place in what is called the Chellean era, named after Chelles in France, where the first important relics of the sort were discovered. That was almost a tropical epoch, during which man lived and left his remains along the banks of mighty rivers. There is no direct evidence that he then used or produced fire, but in working flints he must have struck sparks, and may have learned to strike a light from them.

The first positive proofs of man's employment of fire are to be found in deposits from early in the Acheulean era, so-called after St. Acheul in France, where many such remains were unearthed.

The climate then was growing colder, because the earth was approaching a glacial age, and men in some places were taking to caves as shelters. These caves were much more likely than the river sides to preserve remains of their inhabitants, and consequently the records of this period become more frequent.

In various places these remains offer proofs of the use of fire.

At Mentone, on the Italian coast, the relics include charred bones of the cave bear, cave lion, rhinoceros, and wild bull. At Taubach, near Weimar, have been found the remains of perhaps fifty elephants and a hundred rhinoceroses of which the teeth especially show signs of fire. In the Grotto of the Rhinoceros near Schwartzfield, were approximately a thousand bones of the cave bear, many of which have been split as if for marrow, and are marked by fire. At St. Brilade and at Sirgenstein, the floors of the caves seem to have been cleaned by sweeping the bones into the fire.

The importance of the use of fire even at that date, can scarcely be overestimated. It was a marvelous protection against savage animals. It not only made cooking possible, but supplied light in the caverns, and warmth against the increasing cold. Pottery and metal working, however, were still in the future.

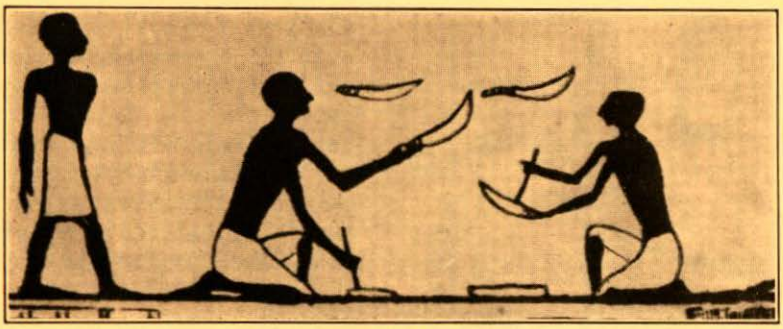
Prehistoric Flint and Pyrites for Striking a Light

How man produced fire at that time, we can only surmise. Probably from flint, which we know he worked regularly and largely. If he made it also by rubbing together two pieces of wood, no evidence of it from that date has been discovered. But a wooden fire stick could scarcely be expected to remain undestroyed through the ages.

In the glacial period which followed, life centered in the caves. Wonderful paintings of animals on walls far from the entrance prove the use of lights, and a few sandstone bowls among the remains indicate the lamp of the period.

That was still the Old Stone Age, before pottery, agriculture, and metals. Proofs of drilling are common, but the drill may have been turned between the hands, an operation which might have been used also for fire making. Nevertheless arrowheads are found, proving that the bow had been invented. Whether it was used not only for shooting, but for drilling and fire making is unknown.

After the Old Stone Age came the New Stone Age, marked by the flints being not merely chipped but polished. The climate became much the same as at present, and agriculture and weaving were first developed. Fire was applied to the making of pottery, and at the end of the age to the working of copper.



Ancient Egyptians Working Flints

THE DAWN OF HISTORY

When the curtain of history rose in Egypt some 6,000 years ago, fire was produced not only from flints but probably by means of the bow drill.

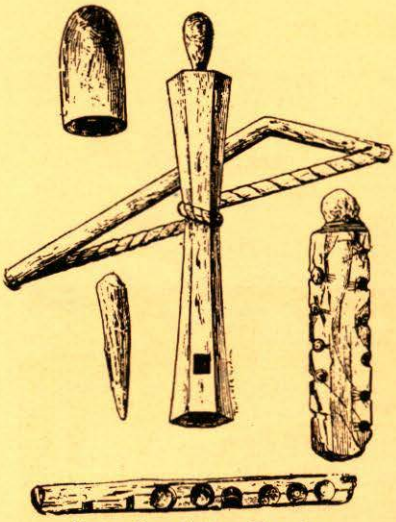
One of the hieroglyphics or written signs of the early dynasties, represents the drill and the stock on which it was turned, but not the bow, indicating that in the beginning it was twirled between the palms of the hands. The bow drill, however, had already been invented and is illustrated in tomb paintings of the Fifth Dynasty. This was a remarkable invention. The bow was wrapped around the drill, which was rotated as the bow was moved to and fro. This was the first known machine for converting reciprocating into circular motion, and was in use for drilling up to the last century.

The parts of a bow drill used in making fire have been found in a tomb of the Twelfth Dynasty at Kahun, while a tomb painting of that period from Beni Hasan shows an Egyptian actually employing a bow drill in fire making.

An Egyptian Using a Bow Drill. The Thong of the Bow Winds Round the Stick of the Drill

Flint tools continued to be used in the early dynasties side by side with copper, and, there is little doubt that the Egyptians continued to use flint in striking a light even after the bow drill was invented.

Fire was used in the Middle Kingdom, about 4,000 years ago, in producing bronze, and, in the New Empire, after the invention of the foot bellows about 1200 B.C., for the smelting of iron. Oil bowls with wicks and rush can-



Parts of an Ancient Egyptian Bow Drill

called the "first born of heaven," and, as fire, was present at every sacrifice.

Whether prehistoric man favored any particular stone with which to strike flint is uncertain, but in some of the barrows or graves of the bronze age, nodules of iron pyrites have been found, some of which plainly show grooves which have been made by the edge of flints. Indeed in a few cases, the flint and the iron pyrites have been found stuck fast together.

The Old Testament has little to say about producing fire. The widow told Elijah that she was "gathering two sticks" to make a fire, but they may have been for fuel. When Maccabeus recaptured the temple, "they made another altar, and striking stones they took fire out of them and offered a sacrifice after two years."

dles were employed as lights, while the Egyptian methods of cooking and baking were numerous.

In Babylonia there is no doubt that in prehistoric times fire was produced by a drill rotated between the hands, for in the name of the Babylonian fire god, Gebil, "Ge" means "stick" and "Bil" denotes "fire." Several statuettes of this god, dating from perhaps 2,000 B.C., represent his hands around a huge fire stick. He was

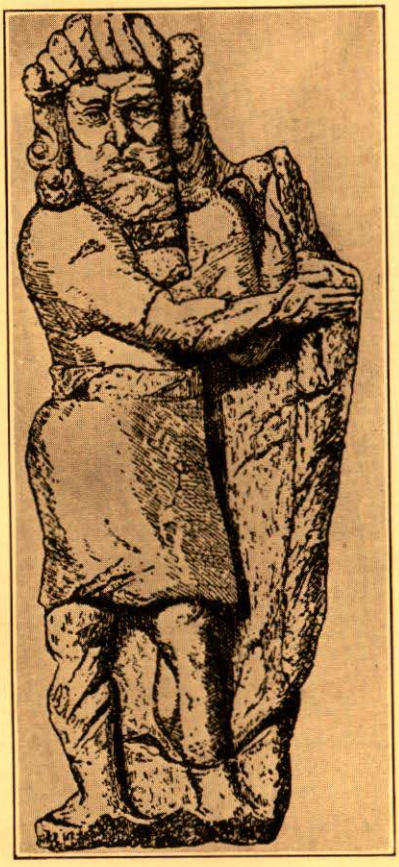
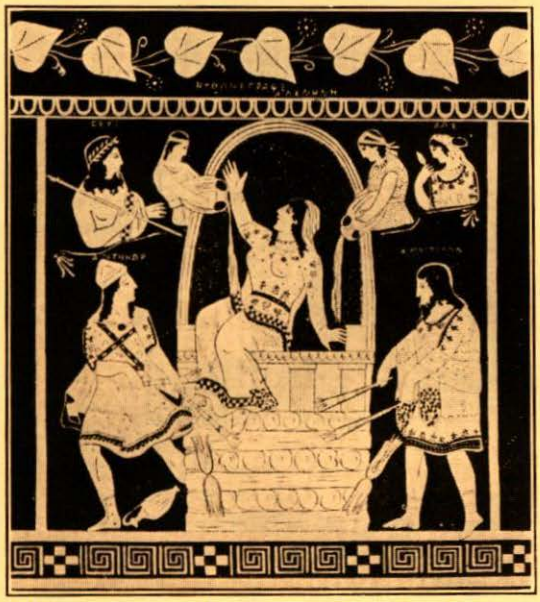


Figure of Assyrian Fire God

IN ANCIENT GREECE

The ancient Greeks had the myth that fire was stolen from heaven by Prometheus, and carried in a hollow tube down to man. For this Zeus chained him to a rock, where an eagle devoured his liver until he was released by Herakles, or Hercules. "Prometheus," it should be noted, means "forethought," which may account for the tradition that he taught writing, metal working, and medicine to man.

The fire on the altar in the home was sacred to Hestia, and if it went out was lighted with newly made fire. When a new colony was formed, the colonists carried fire from the altar of the mother city with them.



Lighting the Fire under Alcmene, Who Is Saved by Zeus

Theophrastus, the successor to Aristotle as head of the Academy, gave the following details concerning sticks for fire making: "Fire sticks are made from many kinds of wood, but best, according to Menestor, from ivy, for that flares up most quickly and freely. The stationary piece should be made of one of these, the drill of bay. They are made in fact of buckthorn, kermes oak, lime, and almost any wood except olive."

He added the rather surprising information that the sticks took fire better in a north wind and in an exposed spot. Possibly the north wind in the peninsula of Greece was less laden with moisture than the others.

That fire could be started by a convex glass or by a concave mirror was known to the Greeks of the classical age. Archimedes, the great philosopher, was credited with setting fire to Roman ships at the siege of Syracuse by means of a mirror in 212 B.C., but the earliest known mention of the deed is by Galen who wrote several centuries later.

IN THE ROMAN EMPIRE

In ancient Italy, the fire on the hearth was sacred to Vesta, who corre-

The Altar and the Flambeaux Used to Light the Fire, from a Graeco-Roman Vase

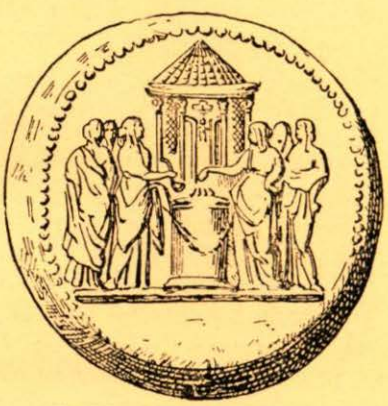
sponded to the Greek Hestia. Priestesses of Vesta are mentioned at Alba Longa before the founding of Rome, as well as in other Latin states. They were early introduced into Rome, and for centuries kept the fire ever burning on the altar of Vesta.

This so-called eternal fire was probably handed down from the days when the tribe gathered round a central fire and there might be great difficulty in rebuilding it. Later, when the tribe scattered to separate homes, it was easier to maintain one central fire than a fire in each home. At all events, the Vestal Virgins early became the most sacred of all Romam priestesses and continued to be so until overthrown by Christianity.

Seneca, the Roman philosopher of the first century A.D., recognized only two important methods of making fire: "Fire is produced by man in two ways," he declared, "either from striking a flint, or by friction of two pieces of wood." The fact that he did not mention burning glasses indicates that they were uncommon.

Pliny in his Natural History wrote that two pieces of wood were rubbed together and the fire caught on fungus or leaves, but favored making fire from flint.

His account of the use of flint is of especial importance: "The stones which have the greatest affinity to fire we distinguish as 'live firestones.' They are the heaviest of all, and are found remarkably useful for advance guards when laying out encampments, for on being struck with a nail or by another stone, they emit a spark, which, received upon sulphur, dried fungus, or



The Vestal Virgins at the Altar

leaves, produces a fire almost sooner than it could be named."

Here we have one historic record of the use of iron in striking flint, and another of employing sulphur to catch the spark.

While this is the oldest known notice of the use of flint and iron in fire making, they may have been so employed long before. Iron was common by 1200 B.C., and even steel is implied in the Odyssey in the lines, "The ax hisses loudly when some smith plunges it into the cold water to temper it, for thence comes the strength of iron."

Fanning the Fire on an Altar of Isis, Roman Period

The application of sulphur to tinder by the Romans is corroborated in the epigrams of Martial, written about 75 A.D. He wrote of poems "which a huckster would not purchase at the price of a sulphur match," and called Caecilius "such a one as barters pale colored sulphur matches for broken glass."

Such so-called matches, it should be stated, would not strike, but were intended to light easily.

IN THE MIDDLE AGES

After the successive waves of barbarians overthrew the Roman Empire, much of the classic civilization was lost, but the more useful knowledge of everyday life was retained. Among this were the striking of fire from flint and the making of fire by the friction of pieces of wood.

A custom of the early Christian church in the north in 752 A.D., according to the Ordo Romanus, included the use of flint and steel: "On Maundy Thursday at the ninth hour a fire is kindled by a flint and steel sufficient to light a candle."

This rite was not observed in Rome, however, for Pope Zacharias wrote to St. Boniface that they had "no tradition of such crystals." Nevertheless Pope Leo IV, in 853 established the custom of striking fresh fire by means of flint and steel on Easter eve.

A few specimens of steel, or at least iron, used for striking flint have been discovered which are assigned to as early a date as the Merovingian kings of France around 700 A.D. Some of them are highly ornamented, as befits their royal ownership and their rarity at the period.

In the time of Charlemagne, steel was used by the knights for swords, and there is little doubt that bits of steel were employed for striking fire.

With the progress of the Middle Ages, the art of steel making greatly improved, and by the time of the Crusades, the smiths were producing steel of marvelous quality. This increased the effectiveness of flint and steel, and in civilized countries they well nigh superseded the friction of two pieces of wood, and even of the bow drill, as a method of producing fire.

IGNITION FOR EARLY FIRE ARMS

When fire arms were invented at the beginning of the 14th Century, they greatly increased the importance of fire lighting apparatus.

According to the journal of the city of Ghent under 1313, "In that year was the first discovery of the use of cannon by a monk in Germany." In the earliest picture of a cannon, it looks like a large vase. The first cannon were lighted by a touch hole, the artilleryman carrying a long slow-burning fuse, called a match, to furnish a ready light.

Hand guns are shown in a painting at Sienna, Italy, dating about 1340. At first they were merely metal tubes fastened to a stick, like a rocket, and the soldier carried a long lighted slow match with which to discharge them.

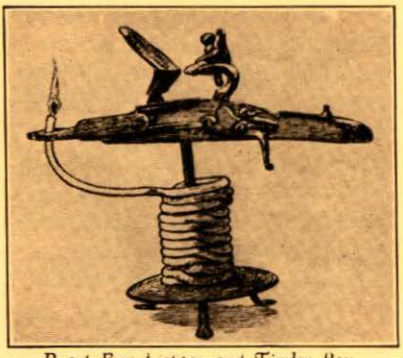
The slow match consisted of a rope of slightly twisted hemp or other material, which would keep lighted but burn very slowly, about a yard in eight hours. In spite of such crude igniting methods, attempts at revolver-like guns, organ-guns, breech loaders, and other rapid fire types, appear in the manuscript pictures of about 1400.

A Slow Match for Discharging a Gun, 1400 A.D.

By 1475 was devised the fire lock or match lock in which the slow-burning match was fastened to a cock, and was brought in contact with the priming when the trigger was pulled.

A more decided improvement, the wheel lock, was invented probably in 1517 at Nuremberg. In this a fire stone was screwed into

the cock and a steel plate or wheel which could be wound up by a key, was fastened to the barrel. When the trigger was pulled, the wheel turned against the firestone and produced a spark to set off the priming. The firestone at first used was not flint but a variety of pyrites or mascarite, which was more easily chipped. This often missed fire, and the soldiers long continued to carry lighted punks.



Pistol Fire Lighter and Tinder Box

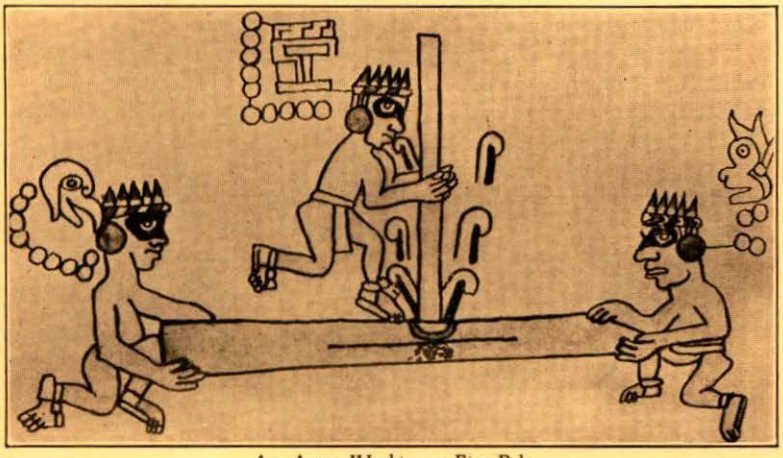
About 1540 the flint lock musket was developed by the Spaniards. In this the hammer struck the flint, the sparks from which fell on the powder in the priming pan. The flint lock became of great importance in war and peace, and continued in use for almost three centuries.

Pistols also were invented about 1540 in Pistoia, Italy, and were discharged by flint locks.

An interesting relative of the pistol was the pistol tinder box. In this a flint lock was used as in a pistol. but the sparks ignited a tape, from which was lighted a candle on the fire lighter.

AMONG THE AMERICAN INDIANS

When America was discovered, the Indians were found to produce fire both by rubbing pieces of wood together, and by flint and pyrites. Copper and gold were worked by the Aztecs and Incas, but they knew nothing of iron.



An Aztec Working a Fire Pole

There are several grotesque miniatures in Aztec manuscripts, depicting gods and priests producing fire. The fire stick is twirled between the hands. In some cases the Aztec is kneeling, as on our cover, while in at least one picture, he is standing and turning a fire pole somewhat as the ancient Babylonian god, Gebil.

A South American Indian Producing Fire

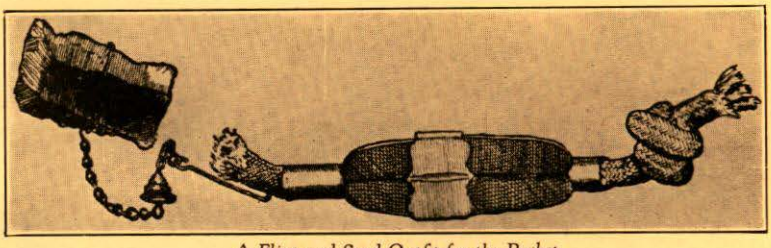
Probably one reason why fire making is depicted in the manuscripts is that the Aztecs let all their fires go out at certain periods and renewed them with new fire.

The South American Indians also used a rod which was held against the breast, sprung into a curve and turned by the hand. In another type, the rod held against the breast was turned by a strap which had been wrapped around it.

The Indians in the present United States employed especially the fire stick which they twirled between the hands. The favorite woods for drilling were cotton wood roots, willow root, and yucca stems. For tinder were employed cedar bark and other fungi.

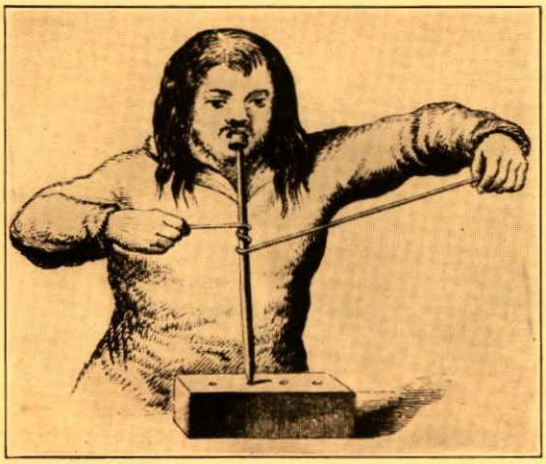
John Sparke, who was on the voyage with John Hawkins in 1565, wrote of the fire making of the Indians in Florida: "There is one thing to be marvelled at, the making of fire, which is made only by two sticks, rubbing them one against another; and this they may do in any place they come, where they find sticks sufficient for the purpose."

This implies merely rubbing the sticks together. The more advanced method of drilling, as in use among the Hurons and Iroquois, was described by Pere Lafiteau in 1724: "They take two pieces of cedar wood, dry and light. They hold one piece firmly down with the knee, and insert



A Flint and Steel Outfit for the Pocket
In Use in the 19th Century

the other piece, which is round and pointed, in a hole which they make with a beaver tooth. . . . . They press down and turn with so much rapidity and violence that the material of the wood, vehemently agitated, falls off in a rain of fire, which passes by means of a crack or little canal from the cavity to a (slow) match. This match catches the sparks which fall, and preserves fire for a long time. From it they can make a large fire by touching it to other dry materials."



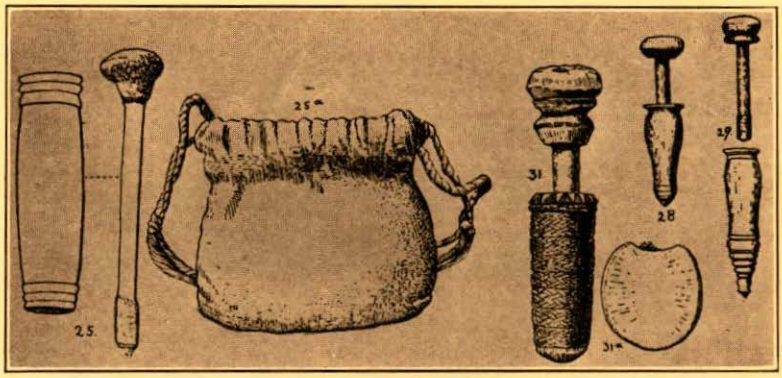
An Early Esquimo Producing Fire with a Strap Drill (Note the Mouth Grip)

Many of the Indians, especially toward the north, employed flint and pyrites. John Brereton in 1602 gave a quaint account of this custom as he saw it among the Indians in the neighborhood of Rhode Island: "They strike fire in this manner: every one carryeth about him in a purse of tewed leather, a Minerall stone (which I take to be their copper), and with a flat Emeric stone (wherewith glasiers cut glasse and Cutlers glase blades), tied fast to the end of a little sticke, gently he striketh upon the Minerall stone, and within a stroke or two, a sparke falleth upon a piece of Touchwood (much like our Spunge in England) and with the least sparke he maketh a fire presently."

Esquimos Producing Fire with a "Strap" Drill. From a Picture of 1756

AMONG OTHER UNCIVILIZED RACES

The increasing use of flint and pyrites among the Indian tribes toward the



Pistons for Producing Fire

pole, suggests that this method may have come to them from the Esquimos of Greenland and northern Europe. Besides flint and pyrites, the Esquimos employed both a bow drill and a strap drill. In using the strap drill, a picture of which dates from 1756, the drill was held in place by a mouthpiece, and turned by drawing to and fro the strap which was wrapped around it. In another type, the drill was held by one person and the strap oscillated by another. These customs are particularly interesting, because it is possible the Esquimos are descended from the men who lived in the caves of Europe during the glacial period.

In place of pyrites, the Esquimos substituted iron when it was introduced and they could get it, but they never produced iron themselves.

As the far parts of the world were explored, various other methods of fire making were found in use by savage tribes.

In New South Wales, the natives, besides drilling with the hands, sawed a stick across a log. In some of the Polynesian islands, the natives ploughed a dry log with a stick. A bamboo thong was sawed across a bamboo rod in Poum and across a piece of wood in Kayan, where the wood was held in place by the feet.

A rather astonishing device for fire making was the piston in use in India and the East Indies, which was probably developed from the bamboo. A piston was fitted to a tube and the end covered with cotton or thread. A bit of dry fungus was placed in a cavity at the opening of the tube. Then the piston was quickly rammed down the tube and withdrawn suddenly, whereupon the heat engendered usually lighted the fungus.

In all probability the fire piston was a comparatively modern invention, not known in ancient or mediaeval times.

IN THE 17TH AND 18TH CENTURIES

Throughout the seventeenth and eighteenth centuries, which cover the Colonial period in America, the main reliance was on some form of

flint and steel, but their varieties were very numerous.

The tinder box to hold them had come in by 1600, for, according to Stow's Annales, when Guy Fawkes, instigator of the Gunpowder Plot, was arrested, "there was found in his pocket a piece of touchwood, a tinder boxe to light the touchwood, and a watch."

The tinder box was of two great types, one to carry on the person, the other to be kept in the home.

The personal tinder holders were as compact as possible, and often took the form of leather pouches to fasten to a belt. But whatever the shape, they had to be waterproof, and hold flint, steel, and a supply of tinder. A favorite tinder was charred linen, but the frontiersmen used fungus and moss.

Flint and steel were particularly suited to the trapper because even the flint would last for months.

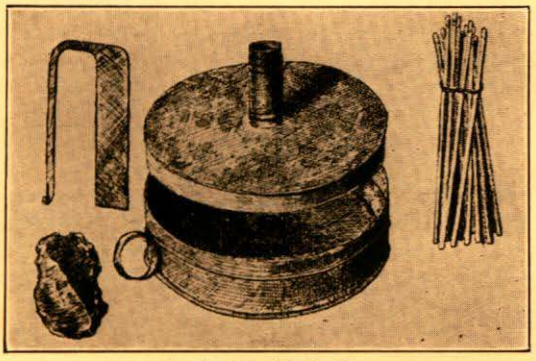
But since every man on the frontier carried his gun with him, it was customary to apply its highly developed flint lock to striking a light. A little powder was put in the pan and tinder ignited from its flash.

Daniel Defoe in 1719 had Robinson Crusoe write in his journal, "Resolved to come again the next day, provided with candles and a tinder box which I had made of the lock of one of the muskets, with some wild fire in the pan."

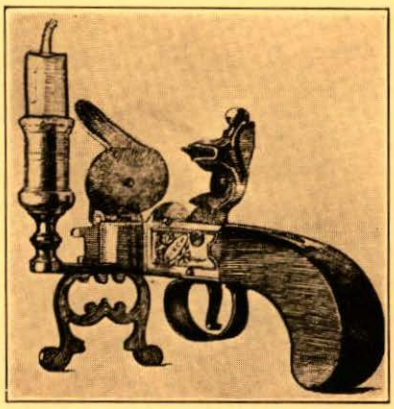
From this it is evident that Crusoe had constructed a fire producer comparable to the pistol fire lighters already mentioned. These in fact are found in various forms throughout the 17th and 18th centuries.

The tinder box for the household was in some cases merely a wooden box, in others a round tin can. As it was in use for two centuries, it is worth while quoting a description of it written by Tomlinson just as it was passing from the scene:

"The tinder box consisted of carbon in a filmy form, procured by burning a piece of rag in a short cylindrical iron box, the loose cover of which being inserted, extinguished the flame of the burning rag and left the carbon. The steel was a strip of hard iron, curved round at the top and bottom, so as to form a handle; this was held in the left hand, and in the right a flint wedge, the sharp edge of which being struck against the steel, chipped off minute fragments. The heat developed by the



An English Tinder Box



Pistol Fire Lighter and Tinder Box with Candle

percussion was sufficient to ignite and even fuse these metallic fragments, which falling down into the easily combustible carbon, ignited it at every point of contact. The operator then blowing upon the tinder to keep up the combustion, applied the point of one of the matches to the incandescent carbon, and with some little contrivance, managed to light the sulphur, which in its turn ignited the wood of the match.

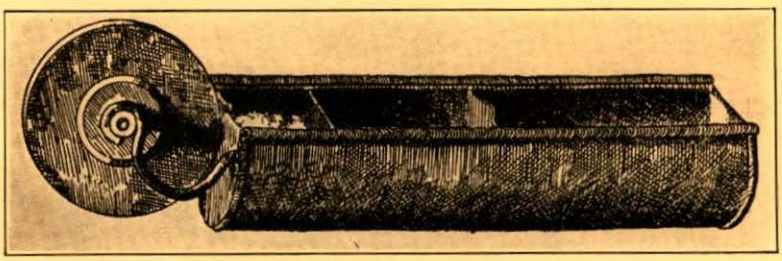
"The cover was then returned to the box, and the weight of the flint and steel pressing it down, extinguished the sparks in the carbon."

But this was the tinder box at its best. At its worst it was almost unbelievably trying.

"The tinder or the matches," Tomlinson wrote, "might be damp; the flint blunt, and the steel worn; or on a cold dark morning, the operator would not infrequently strike his knuckles instead of the steel; a match, too, might be often long in kindling; and it was not pleasant to keep blowing into the tinder box; and on pausing a moment to take breath, to inhale sulphurous acid gas, and a peculiar odor, which the tinder box always exhaled."

Since the usual time in winter for lighting the fireplace was before dawn, the flint and steel were employed under the worst conditions, in the dark and cold, and the clink, clink, clink, of the kitchen maid striving to start the fire was long drawn out. Dickens later wrote that with luck one might get a fire in half an hour, but perhaps he was caricaturing the facts.

A more reliable device, which, in the Southern colonies, was called a mill, was based on the wheel lock as previously used in guns. In this a steel wheel was spun against a flint, which was fixed in a trough full of



A Tinder Box with a Wheel for Striking a Light

An 18th Century Match Girl

tinder. This saved the knuckles and by producing a continuous flow of sparks was more likely to set fire to the tinder. But it was much more expensive than a flint and steel and not at all common.

The colonists must have had a great deal of trouble in making a fire, for it was customary, if the fire went out, to send a boy to a neighbor's, perhaps half a mile away, to bring back coals in a pan or on a shovel.

A London Match Girl a Century ago

AROUND 1800

About 1800 vendors of so-called matches were common in London, and to a lesser extent in American cities. These matches were only splints, the ends of which had been dipped in sulphur. This work was usually done by little manufacturers in the poorer quarters of the city, all the members of the family assisting in the work.

The shopkeepers objected to carrying the splints because of the smell, and they were sold to match girls or boys who cried them on the street. The vendors were sometimes picturesque characters, and are the subject of several paintings and engravings of the period. Probably the best of these is a painting of a match girl by Wheatley, member of the Royal Academy, in 1794.

An engraving published in the Cries of London, 1805, indicates how the match vendors hawked their wares to the cooks in the basement.

The vendor is a woman with two children. One of these, a boy, is kneeling at a grate and peering down into a kitchen, at the same time showing a handful of matches to the cook.

A vendor sometimes had several such assistants who besieged the cook while she besought the passers by. The sale of such matches, however, was still largely a form of begging.

A ditty more or less common among the match girls early in the 19th century is preserved as follows:

"I cry my matches in town and in city,—
I pray you, good mistress, come take some for pity.
I cry my matches as far as the tower,—
I'm hungry and cold in the midst of the shower.
I cry my matches all by the King's Mews,—
Pray, mistress, give me an old pair of shoes.
All you that have money think of me that have none,
Come buy my matches that I may go home."

THE COMING OF THE CHEMICAL MATCH

But a revolution in methods of fire production was approaching. Chemistry had been slowly emerging out of alchemy and was beginning to be applied to practical ends. One of its first triumphs was the creation of fire through chemical energy instead of by physical exertion.

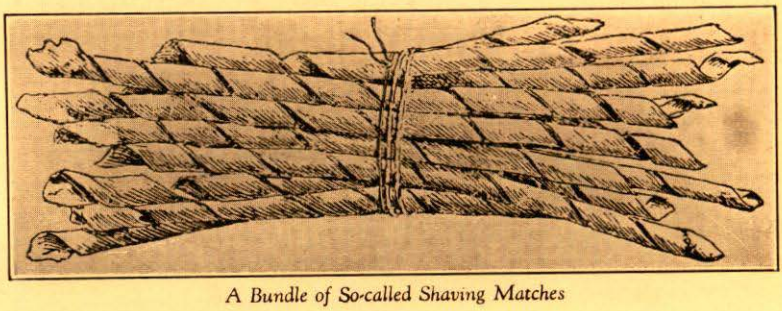
This revolution in fire making was of the greatest importance. It reduced the time required to get a light from five or ten minutes to perhaps a second, or to a third or a sixth of one percent of the previous time.

More than this, the change from muscular effort to chemical action was symbolical of the substitution of science for brute strength which has marked the progress of the modern world. The new science proved itself in the friction match in a practical way that could be appreciated by all, and the chemical match had an appreciable influence in opening the eyes of the public to scientific possibilities.

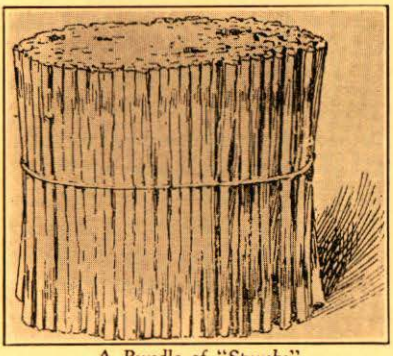
But the change was by no means a sudden one. Like most important inventions it was the culmination of many preliminary advances.

The first step was taken long before. Sulphured splints were used, as we have seen, in ancient Rome and were sold on the streets of London in early modern times.

The next step, the discovery of phosphorus, was probably made by an Arabian alchemist in the eighth century. The new product was one of the wonders of alchemy but was not put to practical use and did not make its way into western Europe. In 1669 it was discovered anew by Brand of Hamburg, who obtained it by evaporating wine to dryness and dis-



A Bundle of So-called Shaving Matches



A Bundle of "Spunks"

tilling the residue. He sold the secret to Krafft, who in 1677 exhibited its marvelously inflammable properties in London, where they created an immense sensation.

Only three years later, or in 1680, Robert Boyle and Godfrey Haukwitz discovered that if matches, as sulphured splints were then called, were dipped in a combination of phosphorus and sulphur, they would ignite by friction. This was the theoretical basis of the chemical match, but the direct mixture of the two chemicals was too inflammable for practical use, and it was a century and a half before the invention of the friction match.

In the meantime a greater supply of phosphorus was made possible when Scheele in 1775 devised a process of preparing it from bones.

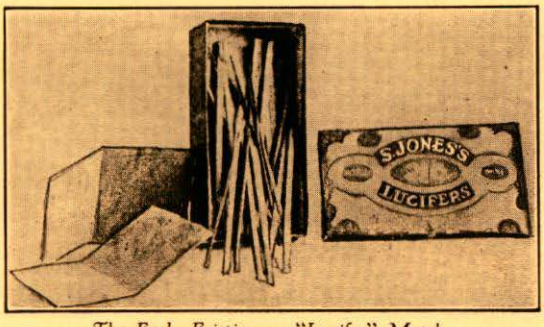
The advance of chemistry gave rise, at the beginning of the nineteenth century, to a number of curious attempts to solve the problem of a chemical fire producer.

In 1804 a mixture of phosphorus, wax, and oil was placed in a corked bottle, and, when a light was wanted, the cork was wet with the mixture, and then rubbed with a sulphured splint.

Another fire bottle was devised by Chancel of Paris in 1805. In it was placed asbestos saturated with sulphuric acid. The sulphured splints were tipped with a gum containing chlorate of potash and powdered loaf sugar. To secure a light, the tip of the splint was dipped in the sulphuric acid. This was the beginning of the oxymuriatic match.

Chancel's apparatus was introduced into Vienna by 1812, and into other countries under various names, such as "Briquets Phosphoriques," "Tunkfeuerzeugen," and "Light Boxes." It at first sold for fifteen shillings, but gradually dropped to two shillings and a half, and was more widely sold in Europe than any other chemical light producer up to 1834.

In 1807 a fire producing syringe was invented by Lorentz on the same principle as the fire



The Early Friction or "Lucifer" Match

piston already described as in use in the East Indies. Whether they were independent inventions is not as yet decided.

A scientifically interesting self-lighting lamp was originated by Döbereiner of Jena in 1823. In this, hydrogen was generated by the action of acidulated water on zinc, and then passed over very porous platinum. This brought the platinum to a glow, which in turn ignited the hydrogen.

Such inventions were rather chemical experiments than matches, and the first real friction matches were made by John Walker, a druggist of Stockton-on-Tees, in 1827. They were inspired by the rocket invented by Sir William Congreve. For some years Walker had made and sold a percussion powder consisting of antimony sulphide and potassium chlorate. In 1827 he tipped sulphured splints with this powder mixed with gum, and started selling them under the name of "congreves."

While considered the first friction matches, they went off with an explosion and spluttered like a Roman candle.

Another chemical device was the "Promethean" patented by Samuel Jones of London in 1830. A thin glass tube containing sulphuric acid was covered at one end with a mixture of chlorate of potash and sugar, and the whole enclosed in a paper tube. To get a light, the end of the glass tube was broken by pinching it, and the acid acting on the mixture produced fire. This, it will be seen, was a precursor of the oxymuriatic match.

The first phosphorus friction match was probably invented by Dr. Charles Sauria, while a student at the College d'Arc Dole (Jura) in 1831, but, left unpatented, it was pirated by unscrupulous persons. His claims were investigated, fifty years later, by the French government, and in 1884 he was granted a "bureau de tabac" as a reward for his invention. Twelve years later the Academie Nationale Agricole presented him with a medal as the discoverer.

Cutting Splints for Matches, 1860

Phosphorus friction matches were introduced between 1831 and 1833 by various concerns, including Römer and Preschel in Vienna and Moldenhauer of Darmstadt. The "lucifer" match was at first an imitation of the congreve, but later was made with yellow

phosphorus.

In 1832 the Vesta match, in which a wax taper was used instead of the wooden splint, was invented, and, soon afterward, its manufacture was begun in France.

The first United States patent for phosphorus friction matches was granted to Alonzo D. Phillips of Springfield, Massachusetts, in 1836. He used a mixture of phosphorus, sulphur and chalk, held together by glue.

Sulphuring Matches, 1860

THE BEGINNING OF MATCH MACHINERY

In addition to the chemical problem of finding a suitable composition for matches, there was the mechanical problem of manufacture. The first friction matches sold for a shilling a hundred, or only four for a cent. They were hand cut and it was a tremendous task to cut them in any quantity. Hence there were early attempts to invent machines to do this work.

Dipping Matches in Phosphorus by Hand, 1860

The first machines to be invented scored the block of wood and sliced the splints off square, but in 1842 Reuben Partridge invented his machine to make round splints by driving a perforated plate through the block. Nevertheless the hand method continued largely in use for many years.

A SANITARY PROBLEM

In the meantime a

Placing Matches in a Frame for Dipping

serious sanitary problem developed, for it was discovered that workmen exposed to phosphorus vapors were subject to necrosis of the jaw-bone.

The first effort to obviate this danger was through the use of non-poisonous or amorphous red phosphorus, which was patented by Pasch in Sweden in 1844. By 1850 matches of red phosphorus were being manufactured in England, Germany, and Austria, and the next year, were made in France.

In 1852, J. E. Lundström of Jönköping, Sweden, employed red phosphorus in making "safety matches," so-called because they would, in general, strike only on a prepared box. For this purpose the matches were tipped with chlorate of potash and the red phosphorus placed on the box.

But while non-poisonous, red phosphorus was otherwise far from a satisfactory substitute for white or yellow phosphorus in the production of a match.

EARLY CONDITIONS

Before 1860 strike-anywhere matches had been made so imperfectly in the United States that the railroads refused to carry them. This gave rise to a number of local companies, whose products were sold from house to house, somewhat as the sulphured splints had been hawked in London. But by 1860 matches had been improved to a point where the railroads considered them safe and began to accept them for shipment. At that period, however, match manufacture was still very crude. Much of the splint making was still done by hand, though machines were in use which would produce a million square splints in a day.

Dipping Matches in a Frame in Phosphorus

The splints were gathered and tied into bundles by hand. The

Match Makers at the East End of London, 1871

sulphur was melted in an iron pot on the stove. Both ends of the bundle of splints were dipped in the sulphur by hand and the bundle then sawed through across the middle to produce the match lengths. In some factories each bundle was dipped in the phosphorus composition, in other factories children arranged the matches in a frame, about 1,200 to a frame, as preparatory to dipping. In each case the dipping in the phosphorus composition was done by hand.

The phosphorus employed, at least in England and the United States, was the white or yellow, and necrosis was only too frequent.

The mixers of the composition, the dippers, the boys who carried the frames to the drying room, and even the girls who picked up the matches from the frames and filled the boxes were exposed to the fumes. In fact the fumes penetrated the whole factory and no one was immune to their effects.

The results of using white phosphorus were so serious that in 1875 Denmark prohibited its employment in making matches, and in 1879 Switzerland followed suit.

In the United States, in the lack of any government supervision, many of the match makers used all sorts of injurious ingredients, yet the factories were so inefficient that an execrable product sold for three times what an excellent one does to-day. Working conditions were bad, and wages poor, while most of the manufacturers were struggling to exist.

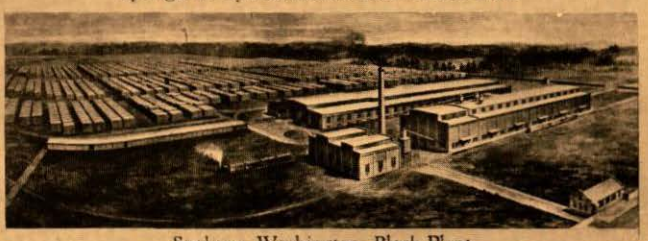
FIVE DIAMOND MATCH PLANTS

Barberton, Ohio, Match Plant

Oswego, New York, Match Plant

Chico, California, Match Plant

Springfield, Massachusetts, Book Match Plant



Spokane, Washington, Block Plant

THE DIAMOND MATCH COMPANY

In 1880 The Diamond Match Company of Connecticut was formed and began to bring order out of chaos. Inventors were encouraged to perfect machinery, and both manufacturing and selling methods were improved. The output was increased 400%, the working conditions bettered, wages raised, and prices cut in half or less.

The more modern plants of the company were built in the west, and chiefly for that reason The Diamond Match Company of Illinois was incorporated in 1889, superseding that of Connecticut.

Meanwhile efforts to find a satisfactory substitute for white phosphorus continued. G. Lemoine of Germany developed sesqui-sulphide of phosphorus in 1864, but for several decades little attention was paid to it. In 1898, however, it was successfully introduced into match manufacture by H. Sévéne and E. D. Cahen in Paris, and officially adopted by the French government for "strike-anywhere" matches. A United States patent was issued to Cahen and Sévéne in 1898, and in 1900 purchased by The Diamond Match Company.

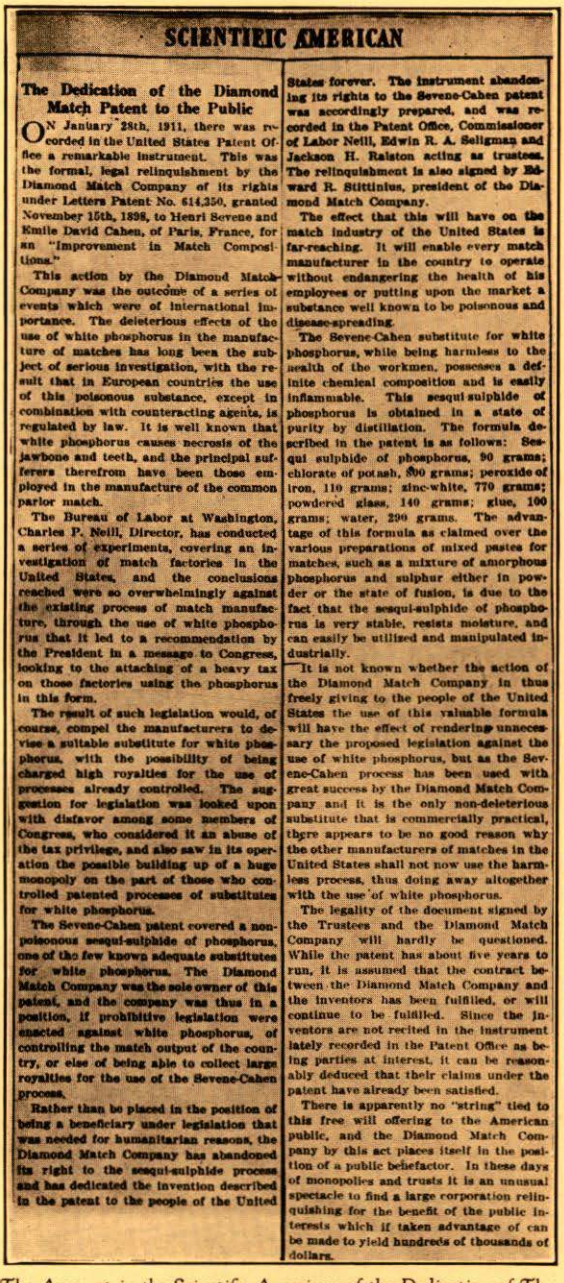
Then followed earnest attempts to use the patent and manufacture non-poisonous matches in the United States, but atmospheric, climatic and physical conditions were so different and difficult, that processes and formulæ effective in Europe failed dismally when applied to match-making in the United States. Experts from the Continent, one after another, tackled the problem of substituting sesqui for white phosphorus in American match-making, but all failed, and the relatively few salable non-poisonous matches made by The Diamond Match Company during its efforts in the years 1901 to 1903 to produce and distribute them commercially would not be accepted by either the trade or the consuming public.

After spending about a quarter of a million dollars in the purchase of the patent and in experimental development work, The Diamond Match Company was compelled to abandon its efforts and the Sévéne-Cahen sesqui patent lay virtually forgotten in the Company's archives for several years.

Meanwhile the movement against poisonous phosphorus gathered force abroad. In 1906 the International Conference at Berne, in order to prevent the use of white phosphorus in match making, proposed a treaty which was signed by Switzerland, Luxemburg, the Netherlands, Germany, France, Austria, and Spain, to go into effect in 1912.

In 1908 a law against the use of white phosphorus was passed also by Great Britain.

In 1909, Mr. W. A. Fairburn, a trained mechanical and chemical engineer, as well as an experienced executive, became associated with The Diamond Match Company, and, studying conditions, became convinced that the match of the future would be a safe and reliable double-dipped non-poisonous one. After applying himself, personally, to imme-



SCIENTIFIC AMERICAN

The Dedication of the Diamond Match Patent to the Public

ON January 28th, 1911, there was recorded in the United States Patent Office a remarkable instrument. This was the formal, legal relinquishment by the Diamond Match Company of its rights under Letters Patent No. 614,350, granted November 15th, 1898, to Henri Sevene and Emile David Cahen, of Paris, France, for an "Improvement in Match Compositions."

This action by the Diamond Match Company was the outcome of a series of events which were of international importance. The deleterious effects of the use of white phosphorus in the manufacture of matches has long been the subject of serious investigation, with the result that in European countries the use of this poisonous substance, except in combination with counteracting agents, is regulated by law. It is well known that white phosphorus causes necrosis of the jawbone and teeth, and the principal sufferers therefrom have been those employed in the manufacture of the common parlor match.

The Bureau of Labor at Washington, Charles P. Neill, Director, has conducted a series of experiments, covering an investigation of match factories in the United States, and the conclusions reached were so overwhelmingly against the existing process of match manufacture, through the use of white phosphorus that it led to a recommendation by the President in a message to Congress, looking to the attaching of a heavy tax on those factories using the phosphorus in this form.

The result of such legislation would, of course, compel the manufacturers to devise a suitable substitute for white phosphorus, with the possibility of being charged high royalties for the use of processes already controlled. The suggestion for legislation was looked upon with disfavor among some members of Congress, who considered it an abuse of the tax privilege, and also saw in its operation the possible building up of a huge monopoly on the part of those who controlled patented processes of substitutes for white phosphorus.

The Sevene-Cahen patent covered a non-poisonous sesqui-sulphide of phosphorus, one of the few known adequate substitutes for white phosphorus. The Diamond Match Company was the sole owner of this patent, and the company was thus in a position, if prohibitive legislation were enacted against white phosphorus, of controlling the match output of the country, or else of being able to collect large royalties for the use of the Sevene-Cahen process.

Rather than be placed in the position of being a beneficiary under legislation that was needed for humanitarian reasons, the Diamond Match Company has abandoned its right to the sesqui-sulphide process and has dedicated the invention described in the patent to the people of the United States forever. The instrument abandoning its rights to the Sevene-Cahen patent was accordingly prepared, and was recorded in the Patent Office, Commissioner of Labor Neill, Edwin R. A. Seligman and Jackson H. Ralston acting as trustees. The relinquishment is also signed by Edward R. Stittinius, president of the Diamond Match Company.

The effect that this will have on the match industry of the United States is far-reaching. It will enable every match manufacturer in the country to operate without endangering the health of his employees or putting upon the market a substance well known to be poisonous and disease-spreading.

The Sevene-Cahen substitute for white phosphorus, while being harmless to the health of the workmen, possesses a definite chemical composition and is easily inflammable. This sesqui sulphide of phosphorus is obtained in a state of purity by distillation. The formula described in the patent is as follows: Sesqui sulphide of phosphorus, 90 grams; chlorate of potash, 800 grams; peroxide of iron, 110 grams; zinc-white, 770 grams; powdered glass, 140 grams; glue, 100 grams; water, 290 grams. The advantage of this formula as claimed over the various preparations of mixed pastes for matches, such as a mixture of amorphous phosphorus and sulphur either in powder or the state of fusion, is due to the fact that the sesqui-sulphide of phosphorus is very stable, resists moisture, and can easily be utilized and manipulated industrially.

It is not known whether the action of the Diamond Match Company in thus freely giving to the people of the United States the use of this valuable formula will have the effect of rendering unnecessary the proposed legislation against the use of white phosphorus, but as the Sevene-Cahen process has been used with great success by the Diamond Match Company and it is the only non-deleterious substitute that is commercially practical, there appears to be no good reason why the other manufacturers of matches in the United States shall not now use the harmless process, thus doing away altogether with the use of white phosphorus.

The legality of the document signed by the Trustees and the Diamond Match Company will hardly be questioned. While the patent has about five years to run, it is assumed that the contract between the Diamond Match Company and the inventors has been fulfilled, or will continue to be fulfilled. Since the inventors are not recited in the instrument lately recorded in the Patent Office as being parties at interest, it can be reasonably deduced that their claims under the patent have already been satisfied.

There is apparently no "string" tied to this free will offering to the American public, and the Diamond Match Company by this act places itself in the position of a public benefactor. In these days of monopolies and trusts it is an unusual spectacle to find a large corporation relinquishing for the benefit of the public interests which if taken advantage of can be made to yield hundreds of thousands of dollars.

The Account in the Scientific American of the Dedication of The Diamond Match Patent to the Public

diate problems, in which he succeeded in producing uniform, safe, and non-explosive phosphorus matches that could be manufactured under all atmospheric conditions, he discovered the discarded sesqui patent and promptly sensed its great inherent value. Undertaking original research work, by intelligent and earnest application to the problem, he succeeded in solving production difficulties in a few months' time, and, early in 1911, announced his ability to revolutionize American match-making, and this without any changes in match machinery and without any perceptible increase in production costs.

By this time congress, state legislatures, and insurance companies were becoming aroused against the use of poisonous phosphorus, and the Esch Bill was introduced taxing white phosphorus matches out of existence. This brought out the fact that The Diamond Match Company owned the patent covering the only satisfactory substitute for white phosphorus, and alone had the knowledge and ability to use the patent successfully.

To meet the situation, the company in 1911, at the suggestion of President Taft, though it had spent a great deal of money on the process, turned over to the people of the United States, without charge, the patent covering the manufacture of non-poisonous matches, and also gave its competitors its secret and extremely valuable technical processes and formulæ for using these patents in this country.

This action was considered so important that the Scientific American devoted almost two columns to it. What that magazine thought of the gift may be judged from the following extracts:

"On January 28, 1911, there was recorded in the United States Patent Office a remarkable instrument. This was the formal legal relinquishment by The Diamond Match Company of its rights . . . . This action by The Diamond Match Company was the outcome of a series of events which were of international importance. The deleterious effects of the use of white phosphorus in the manufacture of matches has long been the subject of serious investigations, with the result that in European countries the use of this poisonous substance . . . . . has been regulated by law. . . .

"It led to a recommendation by the President in a message to Congress looking to the attaching of a heavy tax on those factories using the phosphorus in this form. . . . .

"Rather than be placed in the position of a beneficiary under legislation that was needed for humanitarian reasons, The Diamond Match Company has abandoned its right to the sesqui-sulphide process, and has dedicated the invention described in the patent to the people of the United States for ever. . . . . .

"The effect that this will have on the match industry of the United States is far reaching. It will enable every match manufacturer in the country to operate without endangering the health of his employees, or putting upon the market a substance well known to be poisonous and disease-spreading. . . . .

The Louis Livingston Seaman Medal

"There is apparently no string tied to this free will offering to the American public, and The Diamond Match Company by this act places itself in the position of a public benefactor."

Mr. Fairburn had charge of changing the domestic-made matches from the poisonous white phosphorus to the non-poisonous sesqui type and the improvement in the general quality of American matches made after his original formulæ and processes was amazing. The old parlor "fire cracker" match and the evil-smelling sulphur match were displaced by safe, sane and sure matches that became a delight to both housewife and smoker.

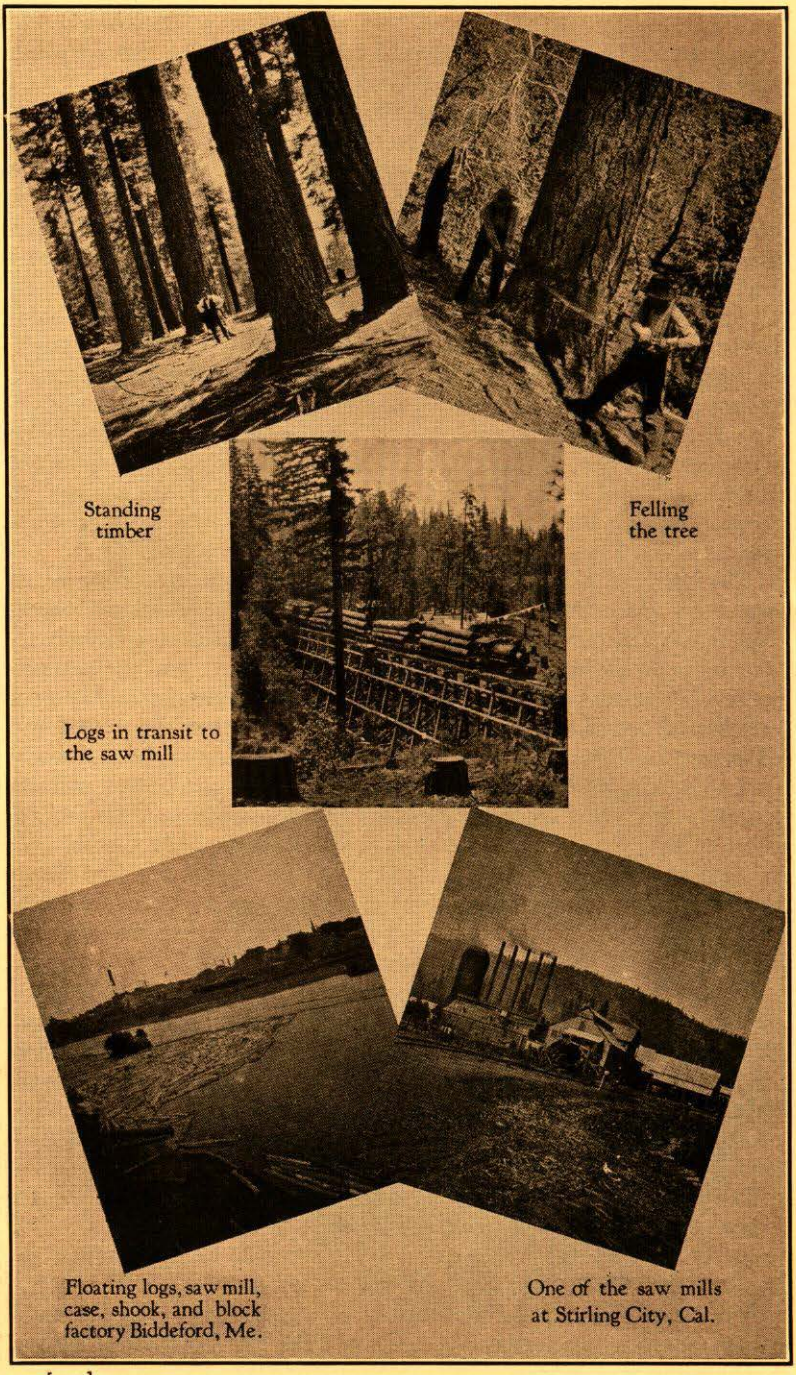
Acknowledgment of Mr. Fairburn's achievements as a public benefactor in removing a readily accessible poison from the American home, in safeguarding lives and property, and in eliminating the occupational disease in an important industry, was definitely made by the award to The Diamond Match Company and William Armstrong Fairburn, its President, in 1915, of the Louis Livingston Seaman Medal—a sort of American Nobel Prize. The previous year this had been given to Surgeon-general William C. Gorgas, U. S. A., for the sanitary work which rendered possible the building of the Panama Canal.

The Diamond Match Company is the originator of automatic match machinery and is the admitted pioneer in every phase of modern match-making,—mechanical and chemical. The great advances in relatively recent years, in addition to the double-dip match (1905), and the non-poisonous, strike-anywhere, safety match (1911) are the impregnating of matches on continuous machines to prevent after-glow, originated and developed by Mr. Fairburn, and the air-conditioning of factory work-rooms and the proximity of match machines. This guarantees uniform atmospheric conditions, making possible an absolutely uniform and reliable product for 12 months in the year, whereas before Mr. Fairburn developed this method, match factories were compelled to close down throughout the summer, discontinue manufacturing when the humidity was low, and turn out very small and erratic product when the humidity was relatively high.

In 1903 the Company's Safe Home matches were accepted and passed by the Underwriters' Laboratories of Chicago, and the new brand placed on the market. It was shown at the Exposition of Safety and Sanitation in 1914 that the ignition temperature of the "Safe Home" match was about twice as high as that of the old white phosphorus match, that spontaneous combustion was impossible, that there was no after-glow, and that the charred part did not fall.

In 1913, also, it was proved by many actual tests by Mr. F. V. D. Cruser, the Company's chemist, and by the Underwriters' Laboratories, that rats and mice if left alone without food would eat one another, or starve, rather than nibble any type of Diamond match.

Because of the demonstrated safety of its products, The Diamond Match Company was awarded the Grand Prize and Gold Medal by the



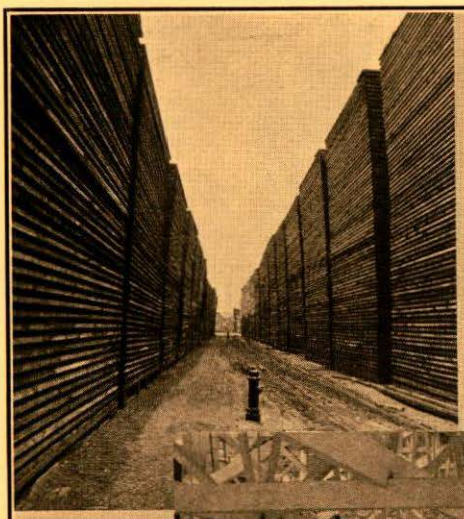
Standing timber

Felling the tree

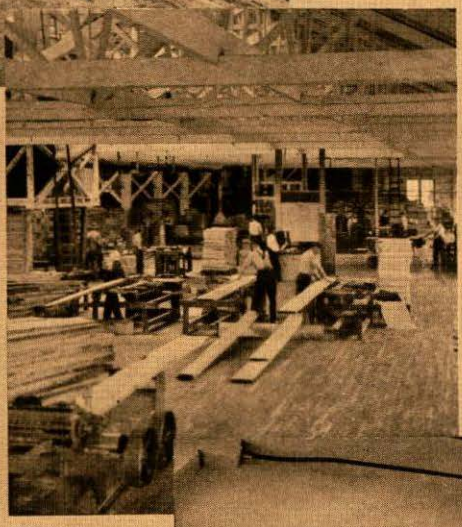
Logs in transit to the saw mill

Floating logs, saw mill, case, shook, and block factory Biddeford, Me.

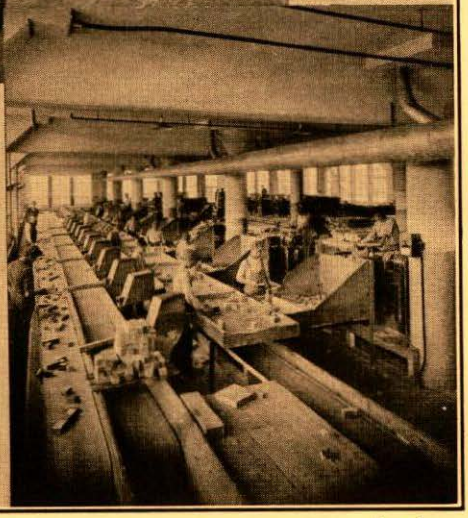
One of the saw mills at Stirling City, Cal.



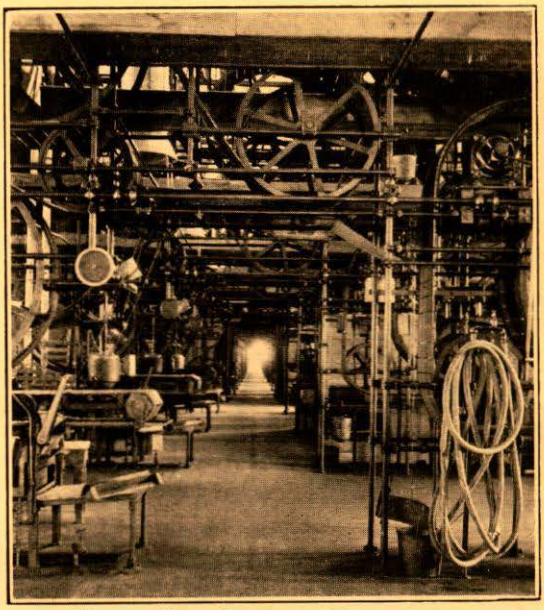
Lumber seasoning in yards



Preparing the lumber



Sawing and sorting match blocks

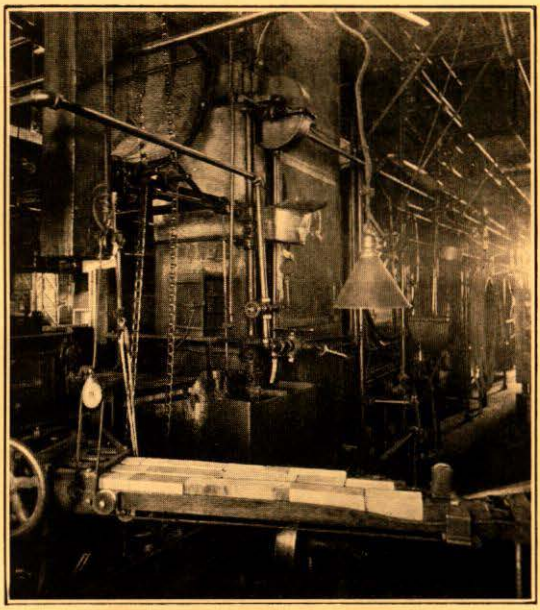


View in Room Containing Match Machines

American Museum of Safety in 1914 and again in 1916, while Mr. Fairburn for his original work has been the recipient of many medals and honors. Certainly no other match company in the United States, and no other manufacturer and technical executive, has received such testimonials.

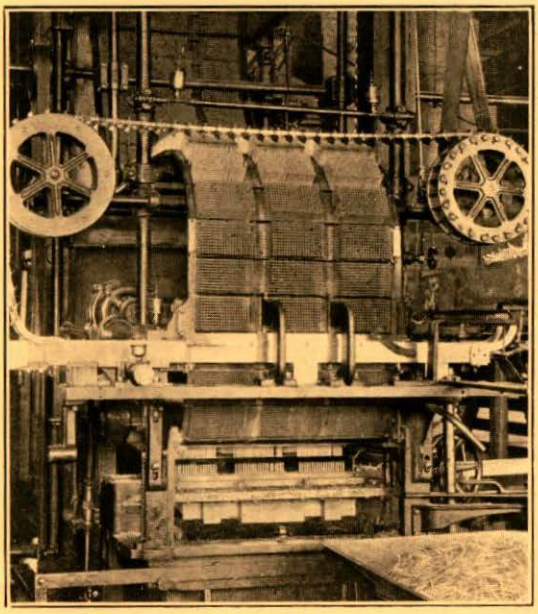
THE PRESENT PROCESS

How matches can be made and sold at the infinitesimal price which they bring is a miracle of modern industry and a mystery to the uninitiated. It is possible only through the most wonderful machinery and well nigh automatic processes, but the production of the match is far from automatic and requires the most scientific knowledge, the highest skill, long experience, and the greatest care.



Feeding Blocks to Match Machines

To insure a supply of timber, The Diamond Match Com-



Cutting and Setting Matches in Plates of Automatic Match Machines

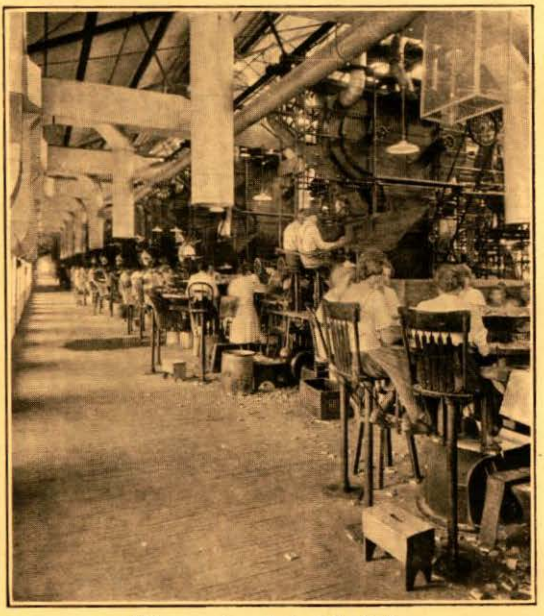
pany has purchased great tracts of white pine. In these, suitable trees are selected, felled, and sawed into logs and lumber. The planks are piled to season for two years, during which they are repiled, inspected, and what are unsuitable are discarded.

The acceptable planks which have been sent to the match factory are sawed into blocks the length of a match, and the suitable blocks placed in storage bins to cure.

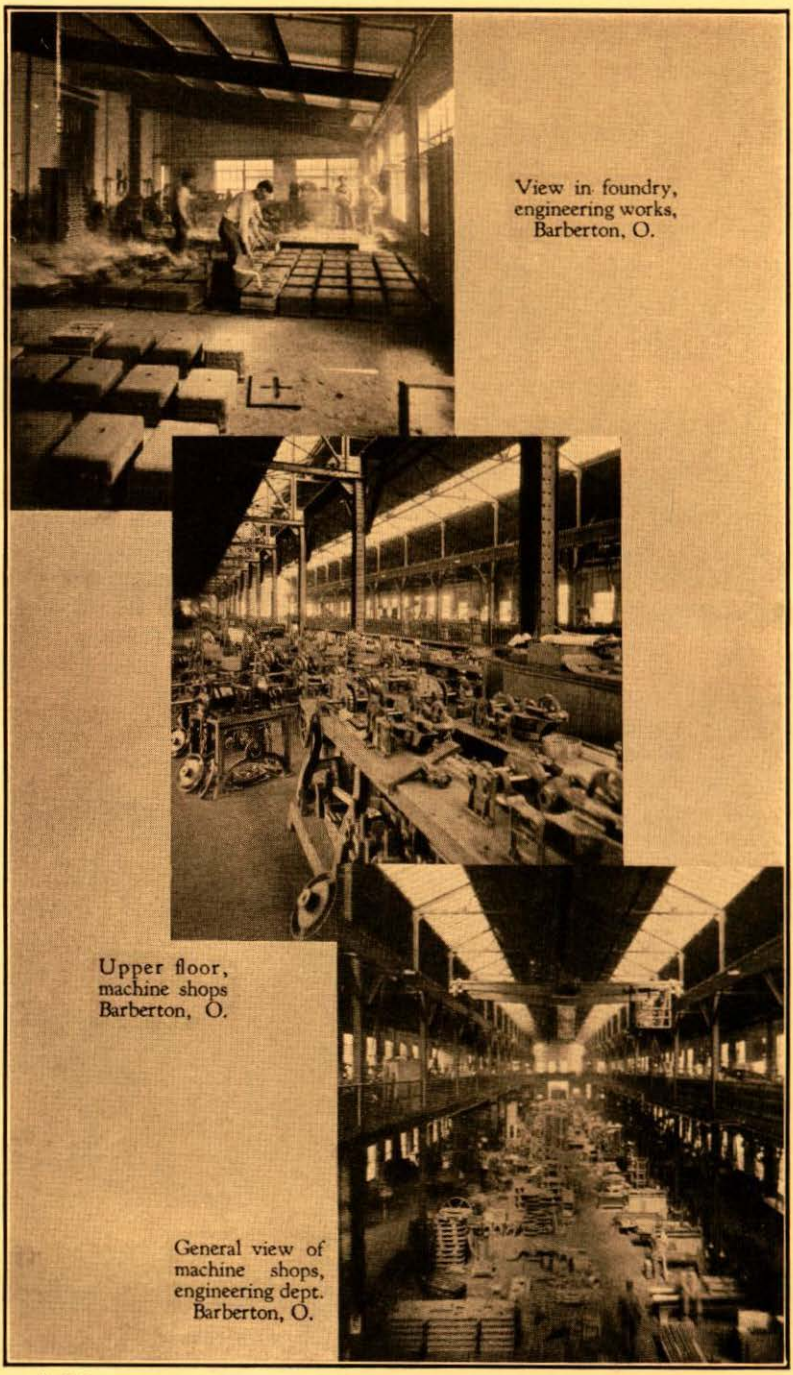
Only blocks passing rigid examination are fed to the match machine. In this a hollow die operating from above stamps out the splints and sets them into perforated steel plates.

These plates hold the matches firmly in position and carry them along endless chains from one process to another.

First they are passed through an impregnating bath, a chemical solution



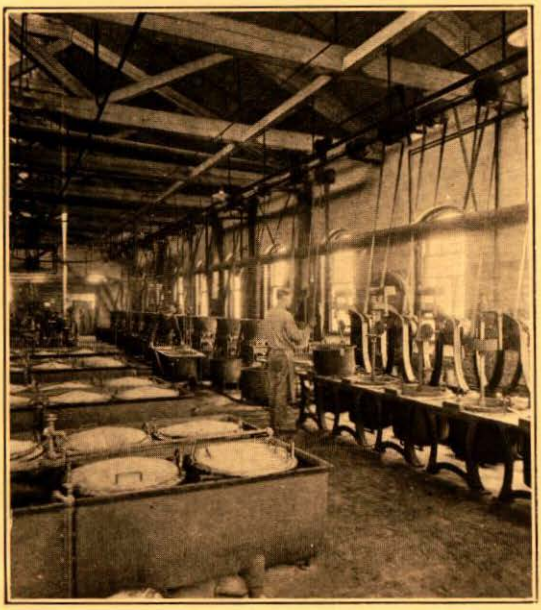
View in One of the Match Rooms



View in foundry, engineering works, Barberton, O.

Upper floor, machine shops Barberton, O.

General view of machine shops, engineering dept. Barberton, O.



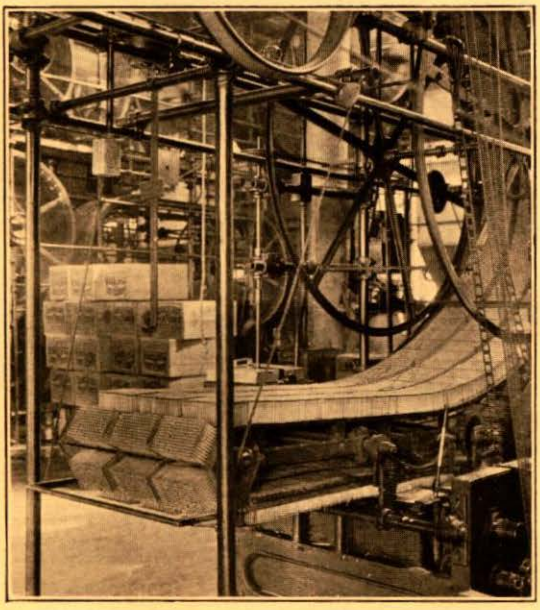
Preparing the Composition for the Head

mere sticks of wood into matches.

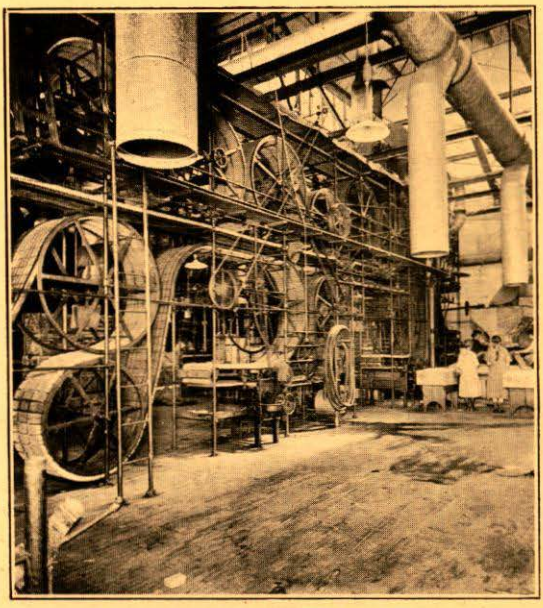
The making of this composition is an extremely intricate and complex process, requiring highly expert and technical skill. The composition contains about one hundred ingredients. Large mechanical mills grind the materials, which must be thoroughly compounded under the careful supervision of experts. Many special appliances are employed in the process, at high temperature, the object of which is to prevent an after-glow when the flame of the match has been blown out.

Then they are carried by the plates through a drying chamber to drive off the surplus moisture and firmly fix the chemicals in the splint.

From here the splints pass through hot paraffine wax, after which they are tipped by the machine with the composition, which changes them from



Putting the Tip on the Match



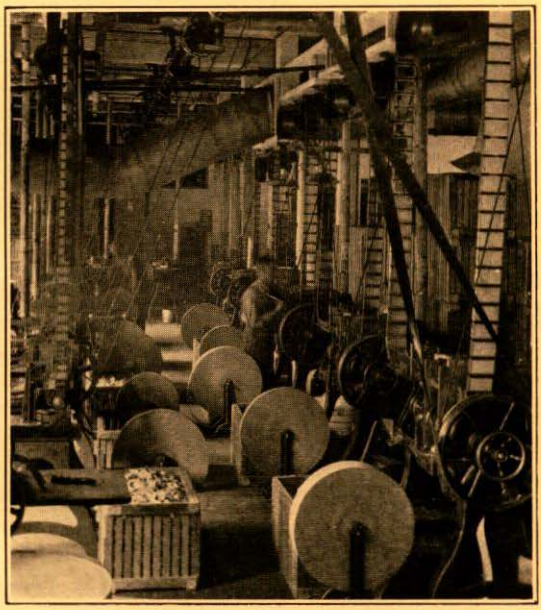
Drying the Matches on Endless Chains

which requires several hours to complete.

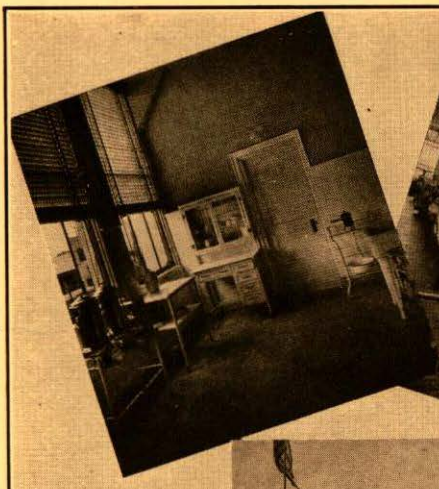
After this composition has been applied, the matches, still in the steel plates, follow a winding course through blasts of air which sets and dries the composition.

This brings the matches back to the starting point, where they are automatically expelled from the plates and packed into boxes by automatic machinery.

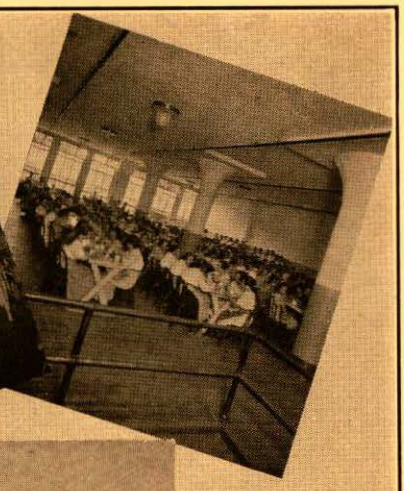
The boxes are packed to contain no more air than necessary and to be almost air tight for a definite reason. To accomplish this, half of the matches in an individual box are laid one way, and half the other. The boxes are placed in cartons, the ends of which are carefully glued. The cartons are packed in cases, the joints of which are glued. The result is that even if a case be dropped ten or fifteen feet on



Making the Inner Boxes

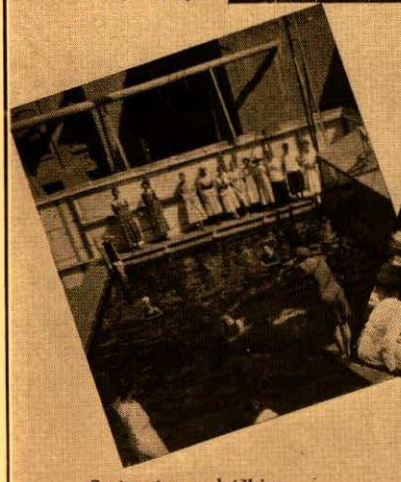


First-aid room

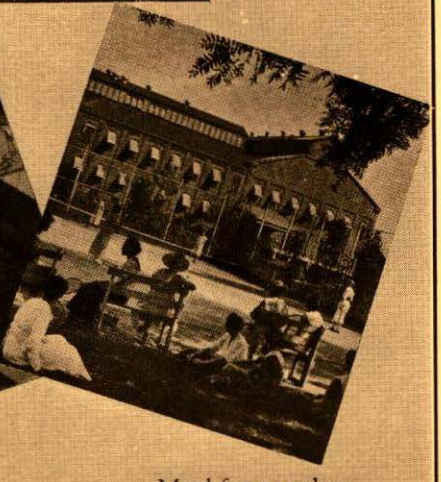


Employees' dining-room

Employees in grounds surrounding Chico, Cal., factory

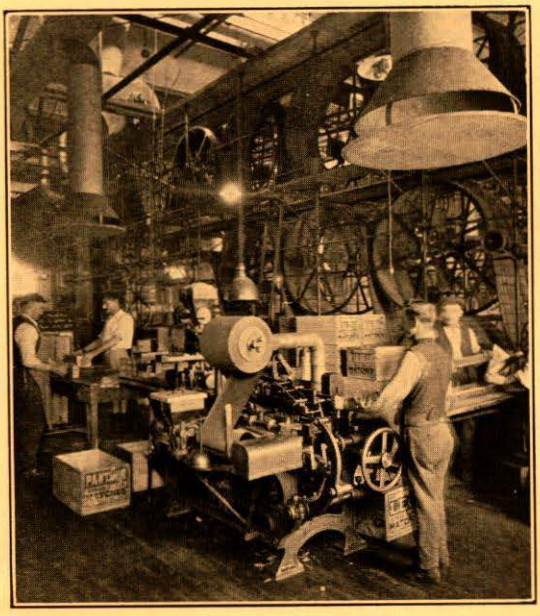


Swimming pool, Chico, Cal.



Match factory and employees, Chico, Cal.

Leading DIAMOND MATCH Brands



Wrapping Match Boxes in Packages

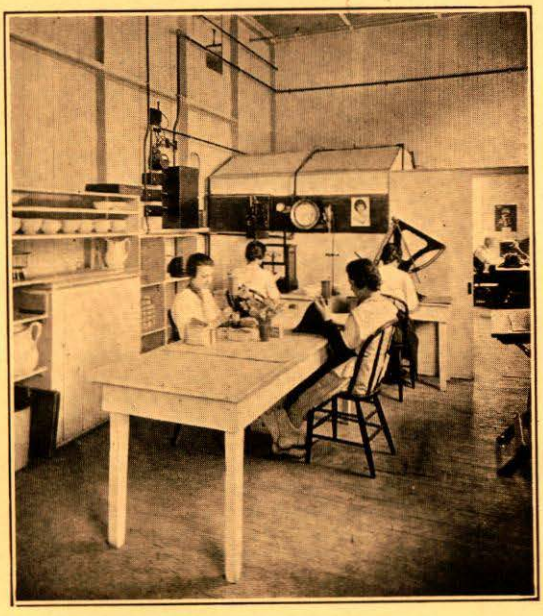
a hard pavement, usually only half the matches in one small box will light. These exhaust the supply of oxygen and the fire dies out.

Cases of the Company's matches have actually been placed in a fire for five minutes with the same result.

The sum of it all is that everything which modern science has made possible and technical skill can offer has gone into Diamond Matches to make them efficient, dependable and safe.

IN CONCLUSION

The Diamond Match Company, it will be noted, has had a history of approximately half a century. In order to endure over this long period, it must have met the conditions. It must have made the right matches at the right prices and by the right processes. If it had not, it would have been evolved out of existence long ago.



Testing the Finished Product

But it has done even more than this. It has revolutionized the manufacture of matches by the introduction of scientific machinery, processes, methods and formulæ.

It has transformed match-making from a poisonous and dangerous to a healthful and safe process.

It has saved the lives of the match-makers, not only in its own plants, but throughout the whole industry, and has eliminated a readily accessible poison from the American home.

It has created for the public a safe, non-poisonous, reliable and uniform "quality" match at a fraction of the price which prevailed decades ago for the former deadly and dangerous product.

The Spirit of Diamond Men

THERE is no glory of achievement in doing what everyone else can do. It does not require a very efficient organization to function automatically along lines well charted on level, non-resisting stretches. Ordinary men, workers of mediocre ability and of passive, or even negative, mental characteristics, drift. They do today what the world did yesterday and the day before. A crowd of men working together and doing thoughtlessly the same old thing in the same old way, day after day, degenerate to a human mass of non-thinking, devitalized tissue, animated perhaps physically, but mentally and psychically dead.

¶ An organization is a living thing. It must be organic—alive all through. There are aggregations of men posing as organizations that are dead. The members move, function, perform tasks, receive their pay, do everything but think and use their inherent mental faculties. A true worker must be a thinker. A true organization is an aggregate of thinking workers, acting in harmonious concert; being alive, it moves, not as a dead thing drifting in the current of time, but as an energetic power struggling to overcome obstacles and to wrestle knowledge from nature. Thus workers subjugate the world's forces for the benefit of mankind.

¶ The Diamond spirit is the spirit of progress. It is the determination to achieve success; to win, no matter how apparently hopeless the path or insurmountable and baffling the resistance may appear. The Diamond spirit is not the spirit of yesterday or of today; it is the spirit of the future. It looks ever forward, not backward; outward, not inward. Its vision reaches beyond the dark, enveloping clouds of discouragement and sees past the obstructions ahead. If a thing can be done, Diamond men will do it. If a problem must be solved, Diamond men will solve it. Diamond men lead, others may trail; they endeavor to prepare and equip themselves to meet difficulties before others can see even the shadow of approaching obstacles.

¶ Diamond men have for years led the world in the art of match-making; today they lead in the science of progressive invention, in the art of efficient production and distribution, in the inestimable virtues of brotherhood, equity and undying good-fellowship, and in the courage and energy that knows no failure and that acknowledges no defeat.

¶ The solution of all harassing problems will be accomplished by this splendid spirit of Diamond men. It couples together the ability of all into one inspired collective genius. This welded unit of brain power is the fruit of purposeful enthusiasm expressed in persistent endeavor; every effort accomplishes something definite, and thus a victorious future is positively assured.

W. A. F.

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