

# FIRE-MAKING APPARATUS IN THE UNITED STATES NATIONAL MUSEUM

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## INTRODUCTION

In the ethnological collections of the United States National Museum at the period of 1886 there were many fire sticks, chiefly from the North American Indians, and from the Eskimo, with a few from other parts of the world. Prof. Otis T. Mason, then curator of ethnology in the newly organized Museum, observing the interest of his aide in these curious objects, urged him to take up their study. In this opportune time, 42 years ago, the constant stream of ethnological material flowing into the Museum from expeditions brought with it other fire sticks, until a sufficient basis for their scientific description was assembled. From the first in the National Museum organized by G. Brown Goode on the basis of arts and industries it was regarded as a necessity to practically work out the method by which the aborigine produced the impedimenta which supplied his needs. Thus before the writer could intelligently handle the subject of aboriginal fire making he should be able to make fire by all the methods known to man. This unexpectedly difficult task accomplished, the first practical monograph on the subject appeared.<sup>1</sup> It was found possible in the study to classify the methods and assign them to races and geographic areas and also to give a synopsis of the technical and developmental status of the methods. The widespread interest in this subject was demonstrated by the demand for the paper, which has been placed out of the reach of collectors for many years. The present paper is a revision and extension of the former publication.

The following is a classification of the chief methods of fire making, based upon the presumed order of development:

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<sup>1</sup> Hough, Walter. *Fire-Making Apparatus in the U. S. National Museum*, An. Rep. U. S. Nat. Mus., 1888, pp. 531-587.

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|   | } | 1. <i>Simple two-stick apparatus</i> .—Indians of North, Central, and South America; Ainos, Japan; Somalis, Africa; most Australians, etc. The most widespread method.            |
| I. On wood (reciprocating motion) by-             |   | 2. <i>Four-part apparatus; mouth drill and two-hand drill</i> .—Eskimo, some Indians, Siberians, Hindus, and Dyaks.<br>. <i>Compound, weighted drill</i> .—Iroquois and Chukchis. |
| II. On wood (sawing motion with knife and thong). | } | Malays and Burmese.   |
| III. On wood (plowing or planing motion).         | } | Polynesians; some Australians.  |
| IV. Of minerals and bamboo (percussion).          | } | 1. <i>With pyrites (or stone containing iron) and flint</i> .—Eskimo and Indians of the North (Algonkian and Athapascan stocks).  |
|   |   | 2. <i>Flint and steel</i> .—Modern and disused methods and appliances.  |
|   |   | 3. <i>Flint or other hard substances on bamboo</i> .— <i>Malay</i> .  |
| V. By compressed air.                             |   |   |

Besides the lens, mirror, and aerophore there are pyrophores, the hydrogen lamp, matches, and various chemical and electrical methods.

#### FIRE MAKING BY ARTIFICIAL MEANS

Observations on the customs of the races of mankind, extending in time and area, show that by one or more of several methods all men knew how to make fire artificially. The origin of fire making is evidently lost in the past, but there is no valid reason to put the invention very far back in time. Sound criticism will place it at the period of one of the profound advances marked by new ideas and the beginnings of the great movement of the dissemination of man over the earth. Several deductions are legitimate concerning the nebulous period when the art of fire production was in the making. The first of these is that fire was carefully preserved when no means of lighting it again were at hand and fire occurring in nature from the lightning and volcano was difficult to obtain. Hence the ancients of the early world of man learned all there was to know about the guardianship of fire and were also frugal in the use of this "friend of man."

Another deduction is that there is more or less uncertainty in carrying fire about, especially to any distance, under primitive conditions. If fire was as important to man as has been imagined, he would not for a long time migrate from his primitive seats.

It is not possible to imagine man, undoubtedly a creature of long development and with a long train of acquired experiences, remaining

in one place like other animal groups. With the use of tools, the ownership of fire, organization based primarily on instinct and more importantly on ideas, man presents himself as a candidate for the conquest of the earth. We know that a very long time ago men in the fire-preserving stage spread over large areas in Europe, lived there for millenniums, and passed on. Other areas in western Asia and northern Africa were also found to show evidence of the presence of early man. The continuing thread that runs through this mass of material culture of man is progress. The sum is progress, irrespective of the involved and doubtful questions concerning the time and the man himself. It is not known whether some groups of early man migrated without fire or whether at times fire was lost and became forgotten. Our theories that fire is indispensable to all humankind under all conditions are subject to modification. It is curious that very many fire myths recount a stage of firelessness and a wresting of fire from those having it. Myths are regarded by scientific men as having a substantial basis of fact and it must be concluded that the fire myths indicate that some groups of men were fireless. No such condition of things has ever been observed among the tribes of modern or historical man. The myths, therefore, may be considered as portraying conditions of considerable antiquity.

It may be assumed, therefore, that for a very long period man, possessed of fire and tending it with skill and care, did not know any method of making it at will. How the making of fire artificially came to be developed, for it was a development and not a discovery, can never be known. Which of the methods takes precedence over the others is also uncertain, but from the facts presented it would be argued that wood methods occurred prior to mineral methods.

The first makers of fire may have been confined to a single social group, clan, or tribe. Among observed tribes instances are many where the art of generating fire by wood friction was jealously intrusted to one or a few individuals. Even among the cultured nations of antiquity there is evidence that fire making was never generally practiced by the common people. Tribal possessions of land, minerals, animals, and plants, as well as tribal secrets, form a phase of observed aboriginal life. They are in the class of village industries or the arts and industries of smaller social units possessing workers of skill. Many of these special arts arise on the coalescence of human units into larger social aggregations rather than by derivation by the methods of acculturation as usually understood. In this sense fire making artificially would originate in larger groups where the contact of minds is more stimulating to invention. Such things were at first kept secret under clan custom, dominance of the priesthood, or for other causes, but in the course of time the technical process became



common property and the esoteric sides remained in the care of religious organizations.

The thought on the origin of fire making has tended to vision the human need, and to consider the need supplied by an inventor, much as wonder-working inventions are brought out nowadays. It will be shown that nothing could be farther from the facts. In considering the difficulties which confronted the inventor of the wood-friction fire-making apparatus it is pointed out that the proper wood in proper condition must be found. All advanced Boy Scouts will subscribe to this. Evidently the wood was not selected by the early experimenters before they knew what was to be done with it. Again, the trap for the fire is a slot or channel cut in the horizontal piece, termed the "hearth." This slot is, advisedly, a great discovery. Tinder of a suitable kind in which the spark may be nourished must be found, and this is no small task. Finally the little coal of fire can be brought to a blaze only with great skill and a knowledge of a number of things. These are the chief matters of difficulty connected with the invention of fire making brought out in actual experiment, but there are other minor steps in the process which are seemingly inconsequential yet are vital to efficiency.

It is necessary, then, to vision a long preliminary period during which man gained a growing acquaintance with the properties of various substances which were immediately useful to him in various ways. He knew from the first fire that wood was the fuel which burned on his primitive hearth. He may have thought that fire ate wood, but the chief lesson was that wood burned. Other associations of wood with fire may have come from work with this substance. Friction is a common experience and handling wood or working in wood might give to keen perceptions an odor, a vapor of smoke, suggesting that there was fire present. Unconsciously perhaps these observations led to more knowledge and gradually to an awakening to a combination of these experiences into something useful, and the fire drill, let us say, followed. Why the drill was the form the fire kindler took is not difficult to imagine. The drill is an ancient and primitive tool supplying the need for piercing holes in various materials. It is the result of diverse means employed to pierce holes, such as scraping, punching, grinding, cutting, and breaking, the processes described being variants of the making of holes. From these experiences came finally the drill more especially as a tool for piercing hard substances requiring abrasive processes. Thus when the culmination of the protracted experiments was about to be reached there was a drill which could be adapted to the service of fire making. The Hindu fire-origin myth most practically states that the carpenter with his drill first elicited the divine fire. In its present state the Aryan Hindu myth places the origin of artificial fire making at a

period of social organization in which occupations as of woodworking were followed, indicating a comparatively late event as suggested.

FIRE MAKING WITH THE TWO-PART DRILL

Making fire with the two-part drill is not difficult. The apparatus is designed to render fire making easy, yet with two sticks in hand and no knowledge of the details one is placed practically in the position of primitive man. The drill is a straight, stiff, dry, slender, smooth rod, the diameter of a lead pencil or larger, as shown in the specimens used by various tribes, and up to 20 inches long, but rarely shorter than 12 inches. The hearth admits of far greater variety of form. The large majority, however, are straight-growing sections thicker than the drill and of the same wood. Many of the hearths appear to have been gathered haphazard as a good piece of wood was found, many others are fashioned in a workmanlike manner with flat sides and squared edges, while others are carved and shaped according to the fancy of the native artists.

Having the two essentials and provided with tinder and accompaniments for getting a blaze it is possible to describe in detail the making of fire. We round the lower end of the drill and make a slight holding notch near the border of the hearth in which to start the drill rotating, and we cut a clean, vertical slot from the notch down the edge of the hearth. This slot should be cut deep enough to divide the pit in which the drill operates nearly halfway. Place the hearth on the floor or on firm ground, kneel on one knee, and hold the hearth firmly with the other foot. Take the drill between the extended hands, set the rounded end in the notch, and roll it between the palms, pressing down at the same time. After a few rotations the drill will have bitten into the wood and the dust ground off fallen down the slot, which explains its purpose. Remove the drill and make sure that the slot is central with the hole, also that the drill end is not binding, and if so, whittle it a bit to insure its working freely. Before beginning again it must be understood that the work should be carried on to the finish without displacing the drill from its socket. Also, when rotating the drill the hands will gradually move to the lower part of the shaft. At this juncture grip the drill with one hand, bring the other up to the top, grip the drill with it, and hold it while the other hand can be brought to the first position. By practice this can be done so quickly that no apparent cessation of the drilling is observable.

To resume the effort to make fire it is better to revolve the drill slowly at first, gradually increasing the pressure till the dust darkens somewhat and smoke arises, then quicken the stroke and pressure to the extreme till the carbonized wood dust pushes down the slot in a coherent roll. If a thin vapor arises from the dust the work has been

a success. Shortly a little coal of fire will be seen. To get a blaze from this fragile coal is like Langley's problem in launching the first airplane; the difficult problem which was hardly visioned in the more important effort.

There are, of course, a number of minor variations in the procedure. The coal may be very gently fanned where it lies and finely divided material added in right amount. Generally, softened inner bark strips are previously placed under the hearth and shredded grass or bark with perhaps a bit of tinder placed near the slot. The coal emerges in this material, which is taken up on the strips of bark and gently waved in the air. In a little while a flame bursts forth.

#### FIRE MAKING WITH THE FOUR-PART DRILL OR BOW DRILL

The explanations referring to the hand drill also apply to the bow drill in everything except in the handling of the machine which supplants the bare and often excoriated palms of the would-be primitive fire maker. The aboriginal bow is rigid, straight, or slightly curved and from 10 to 20 inches long. The cord of buckskin or hide is tightly fastened to one end and can be adjusted at the other to take up slack. The drill is usually of larger diameter and shorter than the hand drill, and tapered toward the ends from the middle. The nut is a block of wood, generally carved in form of an animal among the Eskimo, of convenient size for holding in the hand, and set with a piece of soft, easily polished stone such as marble or soapstone in which a cavity has been made. Make one turn of the cord around the drill, leaving the bow to the right, set the drill in the socket of the hearth, and place the nut. Make a few turns to ascertain conditions, especially whether the cord grips the drill sufficiently to not slip when pressure is applied on the nut. The position of the driller is over the drill, the left hand holding the nut being brought around the left flexed knee, which aids pressure on the drill. Begin slowly and increase pressure, nicely balancing the pressure with the grip of the cord. In the concluding rapid work the cord may be tightened by pinching it up between the thumb and first finger of the right hand. When the drill is felt to bite strongly into the wood and throws up a little smoke increase the pressure and rotation until the fire coal is thought to have appeared. Hold the drill in place till this fact is known, as it is much better to continue with a hot drill than a cold one.

With the fire plow we have another idea radically different from the drill. In this case a blunt stick is held between the locked fingers, pressed down firmly, and rubbed back and forward on the flat surface of a horizontal hearth, cutting a groove and forcing the dust into a little heap at the end of the groove, and in which the fire rises. As in the drill, this method requires careful and assured movements, calculated to a nicety lest the accumulation of dust be disturbed. At



the culmination of the effort the rubbing stick is raised to a higher angle so that it will bite more strongly.

The fire saw offers another curious method which is nearer to the fire plow than to the drill. The fire saw is almost invariably of bamboo, to which the method conveniently adapts itself. A bamboo joint is split into halves; from one is fashioned the sawing part in form of a strip with a sharpened edge. In the concave of the other half a few slivers are raised to hold a piece of tinder. This is set on the ground convex side up and the saw is swiftly rubbed across at right angles and over the the cage holding the tinder. The saw soon cuts through the wall of the bamboo and at its hottest comes into contact with the tinder, which is ignited.

A related form is the fire-thong apparatus, which consists of a stick either split and wedged apart, as shown in Plate 9, or having a horizontal slot cut through the middle. A bit of tinder is stuck in the slot; the cord, which is a rattan length, is passed under the stick at the tinder and pulled up and down, shortly igniting the tinder.

#### QUALITIES OF WOOD

It is found by experience that the qualities rendering wood suitable or not for fire making are as follows: Wood with fine grain, or without grain, as in deadwood, and wood decomposed to a certain extent, and stalks of yucca and other vascular flower stalks are to be chosen; new wood, or wood containing certain products of growth, such as gums, resins, starches, sugars, and tannic acid, will not produce a fine, dry, inflammable powder; and, in general, hardwoods are to be rejected.

In selecting wood judgment must be exercised after the manner of aboriginal man, who desired wood that was dry, soft, of proper grain, and inflammable, and as a result his selection was nearly always of deadwood. Some woods, however, thoroughly dried and seasoned, will answer very well. In many cases wood must be tested with the drill and discarded if the dust rubbed between the fingers is gritty. Also, one part only of the chosen wood may be good.

The following American woods are suggested for fire making. Those queried may be valuable if in proper condition as mentioned. Hemlock, willow, elm, soft maple, sycamore, tulip (?), cedar, cottonwood, balsam (?); poplar, silver, Lombardy; white pine (?) and yucca, flowering stalk.

There are introduced here the explanation of two plates of a series exhibited in the United States National Museum illustrating the presumed development of the art of fire making.<sup>2</sup>

<sup>2</sup> Extracted from Proceedings, U. S. Nat. Mus., vol. 60, No. 2404, 1922, pls. 1 and 2.

- No. 1. Volcano in action; lava setting fire to forests. Water-color drawing. 178157.
- No. 2. Lightning setting a forest on fire. Water-color drawing. 178158.
- No. 3. Camp fire; man borrowing fire. Water color drawing. 178159.
- No. 4. Fire saw. Strip of bamboo drawn across a section of bamboo. Dyaks of Borneo and other Malays. 178152.
- No. 5. Fire thong. Rattan thong drawn over a grooved piece of wood. Dyaks of Borneo. 178152.
- No. 6. Fire plow. Blunt stick worked along a groove in a lower stick. Polyne-sians. 178152.
- No. 7. Fire drill. Slender rod twirled between the hands upon a lower stick having a cavity with slot. Indians of the United States and widely diffused in the world. 176353.
- No. 8. Fire drill. Rod held in a socket and gyrated by means of a cord. The lower piece of wood has a cavity with slot opening upon a shelf. Eskimo of Alaska. 127644.
- No. 9. Fire drill. Rod held in a socket and gyrated with a bow and cord. Lower piece with cavities on a central groove. Eskimo of Alaska. 48078.
- No. 10. Fire drill. Pump drill used specially for sacred fire. Iroquois Indians, Canada.
- No. 11. Strike-a-light. Flint and iron pyrites struck together as the ordinary flint and steel. Eskimo of Alaska. 178154.
- No. 12. Strike-a-light. Flint and steel and box for holding flint, steel, and tinder. Sulphur-tipped splint ignited from the tinder. England. 130436.
- No. 13. Strike-a-light. Bamboo tube and striker of pottery used as flint and steel. Two boxes for tinder. Malay.
- No. 14. Tinder pistol. Gunlock adapted for throwing sparks into tinder. Eng-land. 175712.
- No. 15. Strike-a-light. Combination of flint, steel, tinder, and extinguisher for carrying in the pocket. Spain. 178155.
- No. 16. Fire syringe. Cylinder with closely fitting piston bearing tinder. Driv-ing the piston down smartly kindles the tinder. Siamese and Malays. 176091.
- No. 17. Lens. Used for producing fire by focusing sunlight upon tinder. Ancient Greeks. 178151.
- No. 18. Hydrogen lamp. Hydrogen gas is made to play upon spongy platinum, causing it to glow. Germany, 1824. 165440.
- No. 19. Match light box. Bottle of sulphuric acid, into which splints tipped with potassium chlorate and sugar were dipped. Vienna, 1809. 151711.
- No. 20. Matches. Various kinds of phosphorus matches. 178156.
- No. 21. Electric gas lighter. Cylinder containing a small dynamo run by pres-sure of the finger, producing sparks between the points at the upper end of the tube. United States, 1882. 200512.

The means of applying forces for making fire may be classified as below in the order of their utilization:

*Frictional*, drilling, sawing, plowing on woods.

*Percussional*, striking pyrites, flint and pyrites, and flint and steel.

*Physical*, compression of air, platinum sponge, lens, mirror.

*Chemical*, chemical combination as matches, sodium, pyrophores, etc.

*Electrical*, electrical energy, sparking apparatus.



## ETHNOGRAPHY OF FIRE-MAKING APPARATUS

## I. FIRE MAKING BY RECIPROCATING MOTION

1. *Simple two-stick apparatus.*—This method may be said to have a world-wide distribution and to have had no narrow range in time. It is a very interesting study to observe the many different practices that have been superadded to the simple task of twirling two sticks with the design of creating fire. It is also instructive to note how fixed have become tribal characters in so small a thing as the shaping of the elements of the fire drill. It has well been said by Doctor Schweinfurth that:

A people, as long as they are on the lowest step of their development, are far better characterized by their industrial products than they are either by their habits, which may be purely local, or by their own representations, which (rendered in their rude and unformed language) are often incorrectly interpreted by ourselves. If we possessed more of these tokens we should be in a position to comprehend better than we do the primitive condition of many a nation that has now reached a high degree of culture.<sup>3</sup>

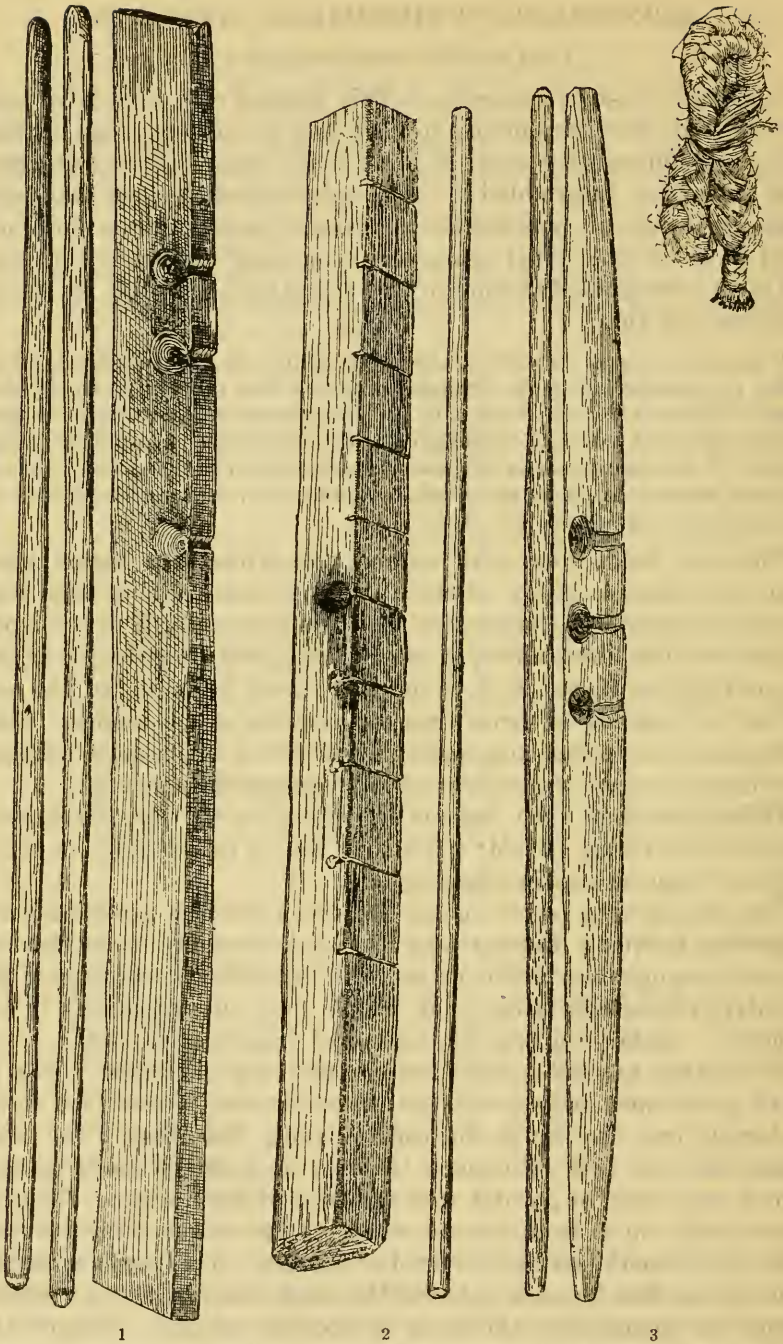
This fact holds good with reference to tribes in a higher plane than the learned writer included in this statement, in this way: There are many little things that have not been subject to the modification of time, intercourse, or environment, but coexist with an art. To particularize: Prof. E. S. Morse has shown the value of the simple act of releasing an arrow from a bowstring as a classifier. Close attention to the minor acts and arts will reveal much more than the nice measurements of man's practically unmodified skeleton.

Differences that have become functional in the arts have come down from an early period; when they can be found they are of the greatest value as aids in ethnology.

The ethnography of the simple fire drill is studied geographically, beginning in North America with the most northerly tribes that use it, and ranging from north to south in the different sections of the country, among the tribes from which there are specimens in the Museum. Other countries are examined from west to east.

The Sitkan fire-drill spindle is unusually long and thick. (Fig. 1.) Both hearth and drills are of the *Thuja gigantea*, a tree that enters so largely into the life of the Indians along this coast. The wood grinds off very well with much friction; at ordinary speed there is soon a small heap of powder at the bottom of the fire slot. The latter is deeply cut in from the side nearly to the center of the fire hole. The whole hearth has been charred at the fire. This repels moisture, and also renders it easier to ignite the wood, charring being a process somewhat analogous to the decay of wood by rotting. If kept carefully in a dry place, this apparatus was perfectly adequate for the

<sup>3</sup>The Heart of Africa. New York, 1874, vol. 1, p.257.



FIGS. 1-3.—1, FIRE-MAKING SET. CAT. NO. 74379, U.S.N.M. TLINGIT INDIANS, SITKA, ALASKA. COLLECTED BY JOHN J. MCLEAN. 2, FIRE-MAKING SET. CAT. NO. 20644, U.S.N.M. BELLA-BELLA, B. C. COLLECTED BY JAMES G. SWAN. 3, FIRE-MAKING SET AND SLOW MATCH, CAT. NO. 127866, U.S.N.M. QUINAIELT INDIANS, QUINAIELT, WASH. COLLECTED BY CHARLES WILLOUGHBY

purpose of the Sitkan, and in his skillful hands would no doubt give the spark in a minute or so. The long drill would indicate that two worked at it consecutively to keep up a continuous motion.

For tinder, the bark of the arbor vitae was used. It is finely frayed, and is much improved by being slightly charred. They also use, preferably, a tinder made from a fungus, because it is "quicker," that is, ignites more readily than the frayed bark.

The hearth is squared and measures 23 inches; the drill is of equal length.

The southern Tlingit drill in the American Museum of Natural History, New York City, has the hearth and drill of equal length. The hearth is a block having the head of a raven at one end and of a bear at the other. The drill is enlarged at the lower end, and the hearth has three fire holes. (Pl. 1, Cat. No. 239100, Alaska; Amer. Mus. Nat. Hist., N. Y.; hearth, 15 inches long (38 cm.); drill, 15.3 inches long (39 cm.).)

Going southward from Sitka the next fire-making set in the series is from Bella-Bella, British Columbia. These Indians are of the Salishan stock, and are called Bilhulas. The horizontal is a piece of cedar wood dressed square on three faces. It is apparently a piece of an oar or spear handle. The fire holes are shallow, and the fire slots are quite narrow. (Fig. 2.) The drills have been scored longitudinally near the rubbing end; this may be a device to cause the wood to wear away more rapidly and furnish fuel to the incipient fire. Fire has evidently been made with this set. Both parts are  $1\frac{1}{2}$  feet long; the drill is much thinner than that of Sitka. The tinder is a braided length of frayed cedar bark.

From a southern family of the Salishan stock, called the Quinaiet Indians, of Washington, the Museum has a complete set collected by the late Charles Willoughby. It consists of a hearth, two drills, and a slow match. The hearth is a rounded piece of cedar wood; opposite the fire holes it is dressed flat, so as to rest firmly on the ground. There are three fire holes with wide notches. The drills taper to each end; that is, are larger in the middle. (Fig. 3.) The powder, a fine brown dust, collects at the junction of the slot and fire hole, and there readily ignites. This side of the hearth is semidecayed. No doubt the slots were cut in that side for the purpose of utilizing this quality. The drills are bulged toward the middle, thereby rendering it possible to give great pressure and at the same time rapid rotation without allowing the hands to slip down too rapidly, a fault in many fire drills. The slow match is of frayed cedar bark, about a yard long, folded squarely together, and used section by section. Mr. Willoughby says:

The stick with three cavities was placed upon the ground, the Indian kneeling and placing a knee upon each end. He placed one end of the smaller stick in one





FIG. 4. — FIRE-MAKING SET. CAT. NO. 24096, U.S.N.M. KLAMATH INDIANS, OREGON. COLLECTED BY L. S. DYAR.

of the cavities, and, holding the other end between the palms of his hands, kept up a rapid half-rotary motion, causing an amount of friction sufficient to produce fire. With this he lighted the end of the braided slow match of cedar bark. This was often carried for weeks thus ignited and held carefully beneath the blanket to protect it from wind and rain.

Fire is easily procured with this set. It takes but a slight effort to cause a wreath of aromatic smoke to curl up, and the friction easily grinds off a dark powder, which collects between the edges of the slot. When this ignites it drops down the slot in a little pellet, and falls upon the tinder placed below to receive it. Both drill and hearth are 18 inches long.

The Klamaths, of Oregon, of the Lutuamian stock, use a fire apparatus that looks very much like that of the Utes. The hearth is a rounded piece of soft-wood thinned down at the ends. (Fig. 4.) The drill is a long, round arrow stick, with a hardwood point set in with resin and served with sinew. (See Ute drill, fig. 7). The holes in this hearth are very small, being less than three-eighths of an inch in diameter. They are in the center, and the fire slot being cut into the rounded edge widens out below, so that the coal can drop down and get draught. The wood is quite soft, apparently being sapwood of yew or cedar, while the drill point is of the hardest wood obtainable. It is probable that sand is used on the drill. The hearth is 13 inches long, and the drill 26.

The Chinooks, a tribe of Indians of a separate stock, called Chinookan, formerly lived about the mouth of the Columbia River, in Oregon, but are now nearly extinct. James G. Swan, the veteran explorer, investigator, and collector among the northwest coast tribes, says that the Chinooks are the best wet-weather fire makers he ever knew.<sup>4</sup>

To kindle a fire the Chinook twirls rapidly between the palms a cedar stick, the point of which is pressed into a small hollow in a flat piece of the same material, the sparks falling on finely frayed bark. Sticks are commonly carried for the purpose, improving with use.<sup>5</sup>

Paul Kane<sup>6</sup> describes the hearth as a "flat piece of dry cedar, in which a small hollow is cut with a channel for the ignited charcoal to run over. In a short time sparks begin to fall through the channel upon

<sup>4</sup> Northwest Coast, p. 248.

<sup>5</sup> Bancroft. Native Races, vol. 1, p. 237.

<sup>6</sup> Wanderings of an Artist Among the Indians. London, 1859.

finely frayed cedar bark placed underneath, which they soon ignite." The Ahts and Haidas also use cedar fire sticks of the usual Indian kind.

The Hupa Indians of California are of the Athapascan stock. Their fire drill is a carefully made piece of apparatus. (Fig. 5.) The hearth is of a reddish, punky piece, made from the roots of a willow (*Salix laevigata*), or of cottonwood roots (*Populus trichocarpus*). The drill is made from the root of the willow mentioned. Fire has been made in one of the holes; the others show the rough, frayed cavities which have been made to start the drill. The notches at each end of the hearth seem to be to facilitate the tying of the pieces together as a precaution to prevent their loss or separation. They are usually intrusted into the hands of the most skillful fire maker, who wraps them up to keep them from becoming damp. The effectiveness of the sticks increases with use and age; a stick and hearth that have been charred by the former making of fire in most cases yields the spark in half the time required for new apparatus. Another advantage is that the drill is softer from incipient decay.

That this set is in the highest degree efficient is shown by the fact that the writer repeatedly got a glowing coal, the size of a pea, from it in less than 20 seconds. The hearth is 18 and the drill 21 inches long.

The Nokum Indians of Lassen County, Calif., use a small hearth with wedge shape end, probably to steady the piece against a support while making fire. Small block hearths like this are customary among the Ute tribes. The drill is a slender rod worked from cedar, as is the hearth. (Cat. No. 131078; Susanville, Calif., L. L. Frost; hearth, 7 inches long (18 cm.); drill, 11 inches long (28 cm.).)

The McCloud River Indians (Copehan stock) make the drill from the buckeye tree.

The Indians of Washoe, Nev., from their language, have been classed by the Bureau of Ethnology as a separate stock, the Washoan. Stephen Powers many years ago collected a rather remarkable hearth from these Indians. It has eight rather small holes, in every one of which fire has been made. The wood is soft, well-seasoned pine. Apparently sand has been made use of to get greater friction, as is the

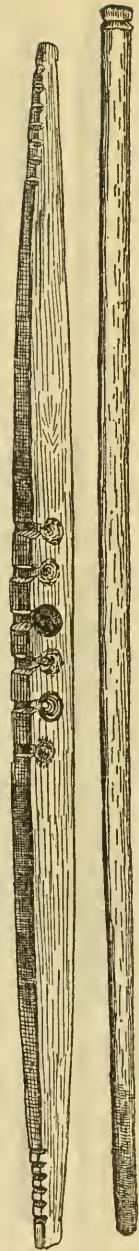


FIG. 5.— FIRE-MAKING SET. CAT. NO. 77193, U. S. N. M. HUPA INDIANS. CALIFORNIA. COLLECTED BY LIEUT. P. H. RAY

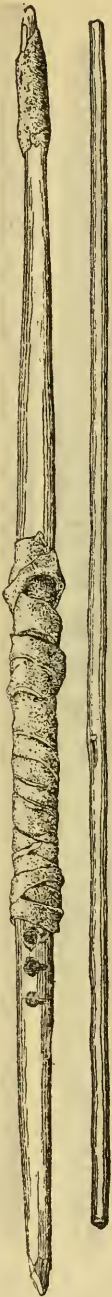


FIG. 6.—FIRE-MAKING SET. CAT. NO. 19840. U.S.N.M. WASHOE INDIANS, NEVADA. COLLECTED BY STEPHEN POWERS

custom of the Zuñis and Apaches. This device, in a measure, obviates the necessity of having tinderlike wood, or wood in a state of partial decay. For the drill any hardwood cylindrical stick might be employed. A strip of buckskin about an inch wide is passed around the hearth over the fireholes to keep them dry. (Fig. 6.)

At the end of the hearth is a mass of cement made of the resin of a pine mixed with sand, apparently, a kind of material used by the Indians over a large area in the Great Basin and southward to fix their arrowheads, pitch the water bottles, and for other purposes. It is quite probable that this stick was the property of an arrow maker whose need of fire to melt the somewhat intractable cement caused him to combine these functions in one tool.

It has a better finish and displays greater skill in its manufacture than the fire tools of the neighboring tribes of Shoshonian (Utes) and Moquelumnian stocks. In fact, it has a close affinity in appearance to those of the very near Athapascan (Hupa, etc.) stock. It is a matter of very great interest to compare with this a stick from the Mackenzie River. (See fig. 26.) The resemblance is striking; it is as though one found a word of familiar sound and import in an unexpected place. The related tribes of the Indians dwelling on the Mackenzie have a wider range than the distance between the localities whence the respective sticks came; in fact, the Athapascans range about 50° in latitude and the southern colonies of this great family are only about 250 miles southeast of the Washoans, while, as has been stated, the Hupas are quite near.

It would be presumptuous to say at present that this tool is a remnant of the influence of the Athapascan wave that swept along the Great Interior Basin, leaving groups here and there in California and other parts to mark its progress, but there is more to its credit than a coincidence of form and function.

The museum is in possession of a complete collection of fire-making material from the tribes of the Shoshonian stock. They were collected by Maj. J. W. Powell. The native name for the Ute fire set is *whu-tu ni-weap*. While the lower member of the set—the



hearth—differs among the several tribes in point of material, shape, etc., the spliced drill is characteristic of the whole stock. It has never been noticed outside of the southern part of the Great Interior Basin but in one instance—among the Klamaths of Oregon. The main part of the drill is either a reed or a straight sprout, usually the former. At one end a short piece of very hard wood—grease-wood, *Sarcobatus vermiculatus*—is set in and lashed with sinew. It resembles the Shoshonian arrows, which are foreshafted in this way. They also use sand in common with other neighboring tribes.

The Pai-Utes, of southern Utah, make their hearths of a short, rounded piece, usually of the sapwood of juniper. It is tied to the drill with a thong of buckskin when not in use. (Fig. 7.) The drill is like the usual one, just described. This is the common form of the Pai-Ute apparatus. The small, two-holed hearth of rounded form and the shortened, spliced drill are for convenience of carrying, this kind being used by hunters while away from the lodges. S. J. Hare says that the men do not usually make the fire except when out on a hunting excursion. At the lodge it is the squaw's duty to make the fire when it is needed.

The Pai-Ute is rarely at a loss to get fire; he is master of various devices. Mr. Hare, who was among the Utes for some time, states that when the Indian is in need of a light he uses either the flint and steel, the drill, or, if these are not at hand, he takes two branches and rubs one up and down on the other, soon getting fire. The Australians are said to have practiced fire making by rubbing in the way mentioned. This is the only observation collected of its occurrence in America. It is, in all probability, a difficult, unusual way, only practiced under pressure of necessity among the Utes. They take great pride in their skill; to be a quick fire maker is to achieve fame in the tribe. They are fond of exhibiting their art to white travelers in the hope of gain.

Another form of hearth (fig. 8) is made of yucca flower stalk, like those of the Apaches and Navaho. The drill is of tule reed, set with a very hard wood

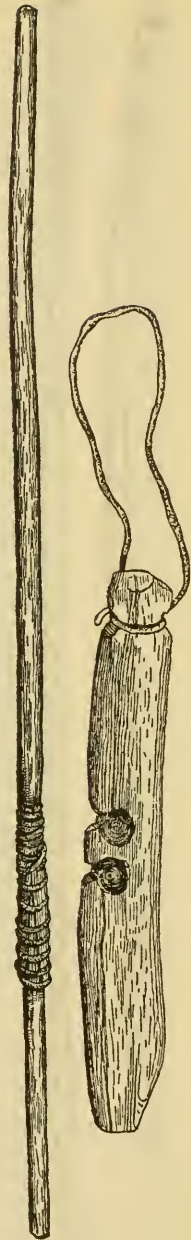


FIG. 7.—FIRE-MAKING SET. CAT. No. 17230, U.S.N.M. PAI-UTE INDIANS, SOUTHERN UTAH. COLLECTED BY J. W. POWELL



FIG. 8.—FIRE-MAK-  
ING SET. CAT.  
No. 11976,  
U.S.N.M. PAI-  
UTE INDIANS.  
SOUTHERN UTAH.  
COLLECTED BY J.  
W. POWELL

head. It is suggested that the reason for splicing the drill is that the hardwood of the kind used for the head (grease-wood) can not be procured in pieces long enough to make the whole drill. This set is apparently one used as a fixture in the Ute domestic economy, the squaws having to light the fire. The duty is mainly relegated to the females in several other Indian tribes and among the Eskimo. Mr. Catlin says that the Sioux objected to letting the squaws have their portraits painted, saying that their women had never taken scalps nor done anything better than make fires and dress skins.<sup>7</sup> The hearth and drill last figured are, respectively, 20 and 23 inches long, while in the hunting set (fig. 8) the length is 7 and 18 inches.

The Wind River Shoshones are also represented. (Fig. 9.) The hearth is of hardwood, rudely hacked out and rounded. Upon the slanting edge are eight holes or shallow depressions, prepared for the drill, with notches cut in to meet them from the sides. The drill is a willow branch, 25 inches long, with a hardwood head mortised in, and served with buckskin. It is most probable that sand was used with this set, because, if the parts are not models, it would be necessary to use it on sticks of equal hardness like these. I am inclined to believe that they are models, from their appearance and from the difficulty of setting up a pyrogenic friction upon them even with sand. They were collected more than 50 years ago by Maj. J. W. Powell.

The Hopi are the most differentiated members of the Shoshonian stock. Mrs. M. C. Stevenson collected the two excellent fire-making sets in the Museum from the Hopi Pueblos. The hearth is a branch of the very best quality of softwood (cottonwood). In one hearth an end has been broken off, but there still remain 18 fire holes, showing that it was in use for a long time and highly prized. (Fig. 10.) The drill is a roughly dressed branch of hardwood. It is comparatively easy to make fire on this apparatus. In the set numbered 126694 these conditions are reversed; the hearth is tolerably hard wood and the drill soft wood.

The Hopi fire tools are used now principally in the estufas to light the sacred fire and the new fire

<sup>7</sup> Smithsonian Report, 1885, pt. 2. p. 723.

as do the Zuñis, and the Aztecs of Mexico did hundreds of years ago. They use tinder of fungus or dried grass rubbed between the hands.

By their language the Zuñi people belong to a distinct stock of Indians. Their fire sticks are of the agave stalk, a soft, pithy wood with harder longitudinal fibers, rendering it a good medium for the purpose of making fire. (Fig. 11.)

As to the plan pursued in grinding out fire, Col. James Stevenson informed the writer that they make a slightly concave place where the burnt holes are seen, cut the notch on the side, sprinkle a little fine sand on the concavity, set the end of the round stick on the sand and roll it rapidly between the palms of the hands, pressing down hard. The "sawdust," Colonel Stevenson called it, oozes out of the notch and forms a small mass, which on blowing slightly becomes a burning coal, and the application of a little tinder creates a blaze. For preserving the fire for any length of time they use a piece of decayed wood. (Fig. 12.)



FIG. 9.—FIRE-MAKING SET. CAT. NO. 22022, U.S.N.M. SHOSHONE INDIANS, WIND RIVER, WYOMING. COLLECTED BY J. W. POWELL

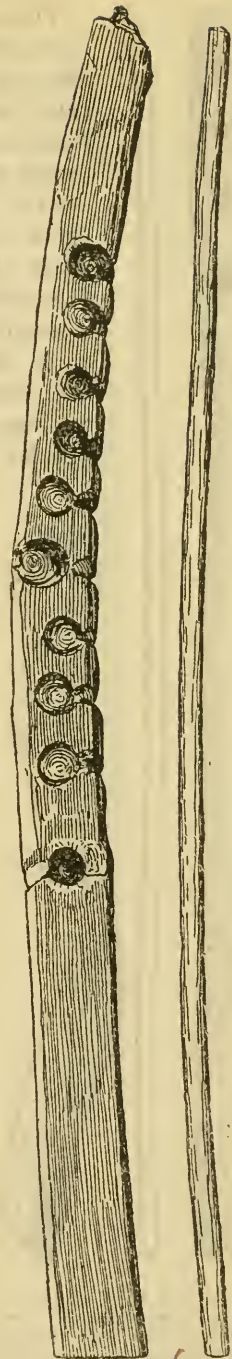
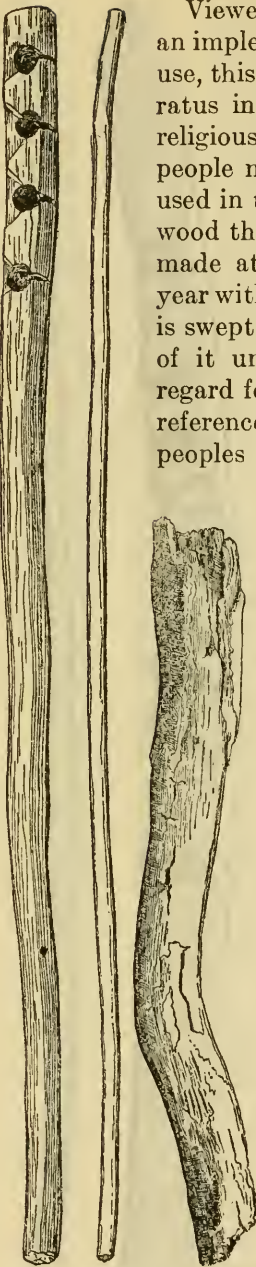


FIG. 10.—FIRE-MAKING SET. CAT. NO. 128694, U.S.N.M. HOPÍ INDIANS, ARIZONA. COLLECTED BY MRS. M. C. STEVENSON





FIGS. 11 AND 12.—FIRE-MAKING SET AND SLOW MATCH. CAT. NOS. 127708 AND 69850 U.S.N.M. ZUNI INDIANS, NEW MEXICO. COLLECTED BY JAMES STEVENSON

Viewed in another aspect than as an implement of necessary or common use, this set is an important cult apparatus in the wonderfully complicated religious worship of the Zuñis. These people make the sacred fire that was used in their ceremonies by friction of wood that has been wet. New fire is made at the beginning of their new year with great ceremony. The house is swept and everything is moved out of it until the fire is made. Their regard for fire and their customs with reference to it add them to the list of peoples who have held it in similar reverence and have practiced similar customs all over the world, ranging widely in time. The wetting of the drill, increasing their labor, may be done to please their gods.

This art must have been practiced for a long time in this region, for Henry Metcalf found a hearth (fig. 13) with three fire holes in a cave dwelling at Silver City, N. Mex. It is apparently very ancient. The wood is much altered and has become heavy by impregnation with some salt, probably niter. Specimens are found during nearly every exploration in the cliff dwellings. They show entire uniformity in all parts of the region.

The Apache and Navaho belong to the great Athapascan stock, that ranges so widely in North America. Capt. John G. Bourke, United States Army, collected the hearth of yucca wood shown (fig. 14), and says:

With the stick you now see, the Apache Indians in my presence made fire in not quite eight seconds by the watch, and one asserted that he could make



FIG. 13.—LOWER STICK OF FIRE-MAKING SET. CAT. No. 35268, U.S.N.M. FROM A CAVE AT SILVER CITY, N. MEX. COLLECTED BY HENRY METCALF

it in a number of motions, which, on the watch, occupied exactly two seconds—that is, under most favorable circumstances. The experiments, made under my own observation, ran all the way from 8 to 47 seconds. Sand is generally used, although not essential to success.

Captain Bourke's observation is very interesting, as it records the fact that the Apache is the most skillful fire maker in the world. Many other tribes can make fire in less than a minute, I think by far the majority of them, but there is no eight-second record, while if he could prove his ability to do it in two seconds he would arrive at the facility of striking a match.

William F. Corbusier has noticed the fire making of the Apache-Yumas of Arizona (Yuman stock).<sup>8</sup> They use a drill about 2 feet long and one-half inch thick, made of o-oh-kad-je, or "fire-stick bush." Its end is dipped in sand and drilled on a soft piece of agave or yucca stalk held down by the feet. They carry a slow torch of dead-wood (spunk) and also use a flint and steel. For tinder they use dry grass or bark fiber. They use also a fungus, some species of *Polyporus*, for the same purpose.

Another reference to the fire making of this stock (Yuman) is found in the translation by the late Dr. Charles Rau of the writings of Father Baegert on the Californian Peninsula.<sup>9</sup> He says:

To light a fire, the Californian makes no use of steel and flint, but obtains it by the friction of two pieces of wood. One of them is cylindrical and pointed at one end, which fits into a round cavity in the other, and by turning the cylindrical piece with great rapidity between their hands, like a twirling stick, they succeed in igniting the lower piece if they continue the process for a sufficient length of time.

The Navaho fire set looks very much like a mere makeshift. The hearth is a piece of yucca stalk and the fire holes have but a shallow side notch. The drill is a broken arrow shaft, to which has been rudely lashed with a cotton rag a smaller piece of yucca wood. (Fig. 15.) This carelessness, which it is rather than lack of skill, is characteristic of the Navaho in their minor implements. They resemble the crude Apache in this.



FIG. 14.—LOWER PIECE OF FIRE-MAKING SET. CAT. No. 130679, U.S.N.M. APACHE INDIANS, ARIZONA. COLLECTED BY CAPT. JOHN G. BOURKE U. S. ARMY

<sup>8</sup> American Antiquarian. Mendon, Ill., vol. 8, September, 1886, p. 283.

<sup>9</sup> Smithsonian Report, 1865, p. 367.



FIG. 15.—FIRE-MAKING  
SET. CAT. NO. 9555,  
U.S.N.M. NAVAHO IN-  
DIANS, NEW MEXICO.  
COLLECTED BY EDWARD  
PALMER

One thinks of the Navaho only with regard to their fine blanket weaving and silver working, so well presented by Dr. Washington Matthews in the reports of the Bureau of Ethnology, and does not consider their arts in other lines.<sup>10</sup>

Thomas C. Battey, a Friend, long missionary among the Indians, kindly gives a description of the Kiowan fire-making process, not now practiced among them but shown to him as a relic of an abandoned art:

A piece of very hard and coarse, rough-grained wood, perhaps 8 inches in length, 2 in width, and three-fourths of an inch in thickness is procured. In one side of this and near one edge several holes are made, about one-half an inch in diameter by five-eighths of an inch in depth, rounded at the bottom, but left somewhat rough or very slightly corrugated. In the edge nearest these holes a corresponding number of smaller and tapering holes are made, opening by a small orifice into the bottom of each of the larger ones. These are made very smooth.

A straight stick, also of hard, rough-grained wood, about 8 or 10 inches in length, about the size they usually make their arrows or larger, is provided. Both ends of this are rounded, but one end is made smooth; the other is left slightly rough. The dried pith of some kind of reed, or more probably of the yucca, some fibers of the same loosely prepared like hackled flax, some powdered charcoal, I think formed by charring the yucca, and a piece of hard, thick leather, similar to sole leather, completes the outfit, which is carried in a leather bag made for the purpose. The first-described piece of wood is placed upon the knees of the operator with a quantity of the fibrous substance beneath it which has been powdered with charcoal dust; some of the latter is put into one of the holes and the rough end of the stick inserted; the other end is put into an indentation of the leather placed under the chin, so that a gentle pressure may be exerted. The spindle is then rapidly revolved by rolling it one way and the other between the hands. The friction thus produced by the rubbing of the roughened surfaces ignites the fine coal dust, which, dropping as sparks of fire through the orifice at the bottom of the hole, falls into the dry fibrous preparation, thus igniting that, then by the breath blowing upon it a flame is produced and communicated to some fine, dry wood and a fire is obtained. The whole operation occupies but a few minutes.

In Mexico a number of the uncivilized tribes of the mountains continued the fire drill into recent times. It is probably used now as in other parts

<sup>10</sup> Doctor Matthews's mountain chant of the Navahos, in the fifth annual report (1883-84) of the Bureau of Ethnology, gives some very striking ceremonial uses of fire. No ethnologist should fail to read this important contribution to science.



of the world in religious rites. There is abundant data in the pictorial writings of the ancient Mexicans as to the form and use of the simple fire drill, especially in the codex discovered by Mrs. Zelia Nuttall. A model of a drill after this codex is shown on Plate 2, figure 2a.

One of the rudest fire-making appliances in the Museum was collected by Prof. W. M. Gabb, at Talamanca, Costa Rica. The hearth is a rude billet of charred, black wood, resembling mahogany. It has central holes, with no gutter usually, though sometimes a shallow notch is cut on both sides of the fire-hole. The drill is a light branch, rather crooked, but dressed down roughly with a knife. Another hearth is of partly decayed, worm-eaten wood; with this a hardwood drill can be used, the hearth wasting away instead of the drill. (Fig. 16.) The absence of any fire slot—that is, the use of the central fire hole—is worthy of notice in this locality. I have only observed its use in various parts of the Eskimo area, from east Greenland to Kodiak; outside of this range I have not noticed it anywhere else among the present tribes of the world. From descriptions given it seems to have been practiced by the Caranchua Indians, a recently extinct tribe in Texas and Mexico.

These specimens from Costa Rica are the crudest fire tools, not to be mere makeshifts, that have come to my notice or have been described in the literature examined. The Costa Rican Indians are very interesting in their preservation of several other arts that may justly be classed among the most ancient. One may be mentioned, that of bark cloth making.

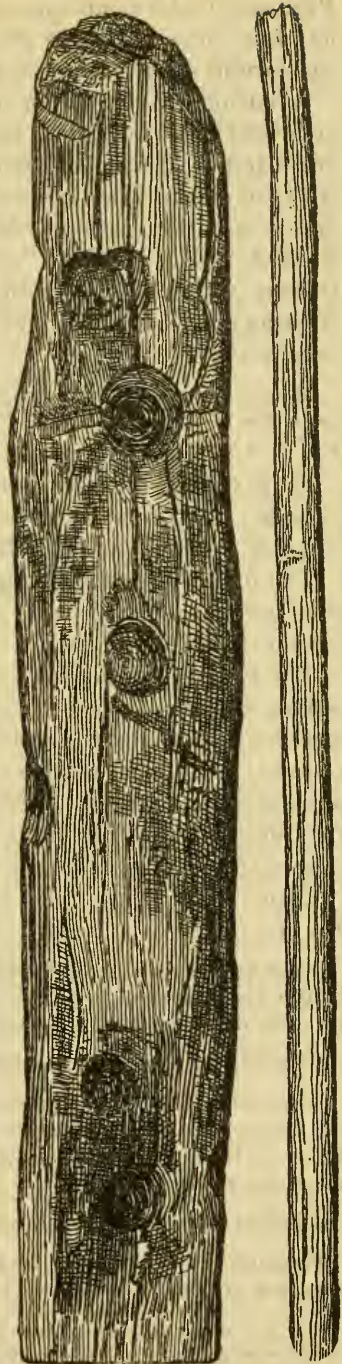


FIG. 16.—FIRE-MAKING SET. CAT. NO. 15396, U.S.N.M. NATIVES OF TALAMANCA, COSTA RICA. COLLECTED BY W. M. GABB

Professor Gabb made quite a collection from Talamanca, but has not left any notes on these remarkable people, who are well worthy of the careful study of ethnologists.

A curious modification of this central-hole plan is figured and described in Oviedo, folio 90, as occurring in Hispaniola—that is, the West Indies, Haiti, San Domingo, etc. He says that “two dry, light sticks of brown wood were tied firmly together, and the point of the drill of a particular hardwood was inserted between the two and then worked.” H. Ling Roth<sup>11</sup> thinks that if one can judge from the illustration (which is a miserable one) in Benzoni’s work, the natives of Nicaragua also used three sticks in making fire. Benzoni, however, says:<sup>12</sup>

All over India they light fire with two pieces of wood; although they had a great deal of wax, they knew no use for it, and produced light from pieces of wild pine wood.

From Oviedo’s description I am inclined to believe that the dust in which the fire starts was allowed to fall below on tinder placed beneath the hearth. (Pl. 2, fig. 2.)

The drill was sufficient for its time for the reason that there was at that period rarely necessity for generating fire; the art of fire preservation was at its height.

The Cherokees, the most southerly of the Iroquois, James Mooney writes, kept fire buried in the mounds upon which the council houses were built, so that if the house was destroyed by enemies the fire would remain there for a year or so. The Cherokees use the simple rotation apparatus, and, as far as Mr. Mooney can ascertain, never used the the pump drill. They have a tradition that fire originally came out of an old hollow sycamore tree (*Platanus occidentalis*).

Capt. John Smith tells how the Indians of Virginia made fire. He says:

Their fire they kindled presently by chafing a dry pointed sticke in a hole of a little square piece of wood, that firing itselfe, will so fire mosse, leaves, or anie such like drie thing that will quickly burn.<sup>13</sup>

Writing in the first quarter of the next century, Beverley says:

They rubbed Fire out of particular sorts of Wood (as the Ancients did out of the Ivy and Bays) by turning the end of a Piece that is soft and dry, like a Spindle on its Inke, by which it heats and at length burns; to this they put sometimes also rotten Wood and dry leaves to hasten the Work.<sup>14</sup>

Loskiel says of the Delawares:

Formerly they kindled fire by turning or twirling a dry stick with great swiftness on a dry board, using both hands.<sup>15</sup>

<sup>11</sup> The Aborigines of Hispaniola, Journ. Anthropol. Inst., Ot. Britain and Ireland, vol. 16, p. 282.

<sup>12</sup> History of the New World, Hakluyt Society, vol. 21, p. 151.

<sup>13</sup> The Natural Inhabitants of Virginia. English Scholars Library, No. 16, p. 68.

<sup>14</sup> History of Virginia, 1722, pp. 197, 198.

<sup>15</sup> History of the Mission of the United Brethren, p. 54. London, 1794.

The Cherokees used for a drill the stalk of a composite plant (*Senecio*) and twirled it on a piece of wood. The art has long been out of common use, but they employed the wooden drill to make fire for the Green Corn Dance into the present century, though flint and steel was then in vogue. Sometimes they passed the bow over the drill. The tinder was of a fungus or dried moss. James Mooney collected this information from some of the older men of the tribe in North Carolina, who have retained the ancient customs and traditions, which the part of the tribe removed to the West has entirely lost.

The Creeks (Muskogean stock) had a regularly authorized fire maker who early in the morning made fire for the Green Corn Dance. The apparatus that he made use of was four sticks placed end to end to form a square cross. This was oriented, and at the junction of the sticks new fire was made by friction.<sup>16</sup>

The Choctaws (also Muskogean) of Mississippi, M. F. Berry writes, make fire in the following way: One stick of dry wood that has a hole in it, with a smaller hole at the bottom going through, is placed between the feet. Another piece made round and about 3 feet long is made to revolve rapidly back and forth between the hands in the hole, and the fire drops through the small hole below. When new fire was wanted for the Green Corn Dance or other purposes three men would place themselves so that each in turn could keep the stick revolving without a stop until fire would drop down through the hole, which was nursed with dry material into a flame.

This form of the fire hearth is not represented in the collections of the Museum; the only other description of a process closely like it was given by Thomas C. Battey, who observed it among the Kiowas. It was shown him at that time as a revival of the ancient method. The pierced fire hearth is somewhat impracticable, except in the Malay sawing method. In the rotary drill the small hole would come over the axis of least friction and heat. Unless provision was made for the dust to fall freely underneath by a double cone perforation worked from both sides the dust is likely to become obstructed and smother the fire. It will be seen, too, that it departs very much from the simplicity of the usual fire drill in the fact that a hole must be made through the piece of wood, a matter of some difficulty before the introduction of iron awls.

The Seminoles of Florida, the most southern Muskoki, have neglected the art of fire making by simple friction, unless at the starting of the sacred fire for the Green Corn Dance, says Clay MacCauley.<sup>17</sup> A fire is now kindled either by the common matches, *ma-tci*, or by steel and flint.

<sup>16</sup> Benjamin Hawkins' Sketch of the Creek Country, 1798-99, pp. 68-72, cited in Pickett's History of Alabama, vol. 1, p. 108.

<sup>17</sup> Fifth Annual Report of the Bureau of Ethnology for 1883-84, p. 518.



Thus it is seen that wherever in the earlier period of the exploration in this country the observation has been made, the Indian, almost without exception, was found to be using the friction apparatus consisting of two sticks of wood. Some tribes had improved on the working of the invention, while a very few others had perhaps arrived at the use of the higher invention of the flint and pyrites.

Returning to the tribes of the wide central plains of our country, we find that the flint and steel soon displaced the fire sticks, except for religious purposes. The Mandans, of the great Siouan stock, were using flint and steel at the time of Mr. Catlin's visit in 1832.<sup>18</sup>

There seems to be a great misapprehension among some of the writers on ethnology as to the general use of the bow drill among the Indians. In mentioning that the Sioux use the bow drill, Schoolcraft is quoted as authority. As a matter of fact the reference is to a "made-up" figure of a bow-drill set, marked "Dacota." On the same plate there is a representation of an Iroquois pump drill that is obviously wrong. The lower part of the plate is taken up by a picture of an Indian woman (presumably Californian) pounding acorns in a mortar. To complete the absurdity the whole plate is entitled "Methods of obtaining fire by percussion," and is placed in the text of a questionnaire on the Californian Indians, opposite a description of the Californian way of making fire by twirling two sticks.<sup>19</sup>

Mr. Schoolcraft is not to blame for this state of affairs. In those days illustrations were not ethnological; they were "padding" gotten up by the artist. Nowhere in his great work does Mr. Schoolcraft describe either the Dakota or Iroquois drill. Among the northern Indians in central and northern Canada, however, the bow is used.

Sir Daniel Wilson, in his work on Prehistoric Man, notes that the Red Indians of Canada use the drill bow. In August, 1888, at the meeting of the American Association for the Advancement of Science, at Toronto, he gave an account of the facility with which these Indians make fire. He said that at Nipissing, on the north shore of Lake Superior, while he was traveling in a pouring rain, and not having the means wherewith to light a fire, an Indian volunteered to light one. He searched around for a pine knot and for tinder, rubbed up the soft inner bark of the birch between the hands, got a stick from a sheltered place, made a socket in the knot and another piece of wood for a rest for the drill, tied a thong to a piece of a branch for a bow. He put the tinder in the hole and rested his breast on the drill and revolved it with the bow and quickly made fire.

<sup>18</sup> The George Catlin Indian Gallery. Smithsonian Report for 1885, vol. 2, p. 456.

<sup>19</sup> Indian Tribes, vol. 3, pl. 28. 1851-1860.

It is perhaps true that some of the Dakotas did use the bow at times, but it is not correct to place it as the customary tool of the whole stock. On the contrary, there is evidence that they used the simple means. Dr. J. Owen Dorsey writes:

I was told in 1879 by the late Joseph La Flèche, that the Omahas, prior to the advent of the white men, made fire by using pieces of the "du-à-du-á-hi," a grass (?) that grows in the Sand Hill region of Nebraska, near the sources of the Elkhorn River. One piece was placed horizontally on the ground, and a slight notch was cut at one end, wherein a few grains of sand were put. The other stick was held between the palms of the hands, with one end in the notch of the horizontal stick, and then rolled first in one direction then in the other till fire was produced. A fresh notch was made in the first stick whenever the old one became useless, and so on until it became necessary to procure a new stick.

In the Green Corn Dance of the Minitaries, another Siouan tribe, the "corn is boiled on the fire, which is then put out by removing it with the ashes and burying them. New fire is made by desperate and painful exertion, by three men seated on the ground facing each other and violently drilling the end of a stick into a hard block of wood by rolling it between the hands, each one catching it in turn from the others without allowing the motion to stop until smoke, and at last a spark of fire is seen and caught in a piece of spunk, when there is great rejoicing in the crowd."<sup>20</sup> The desperate exertion was not necessary, except in imitation of the Zuñi fashion of wetting the drill to create sacred fire.

It will be seen from these references given that the Sioux used the customary Indian method. Later, they may have used the bow to expedite the drill when the wood was intractable. The bow may have been borrowed from more northern tribes, the Algonquians are said to use it;<sup>21</sup> Thomas C. Battey says that the Sac-Fox Indians (Algonquian stock) used a soft-wood drill and a hard-wood hearth. "The drill was worked by a bow and the fire caught on the end of the drill and touched to tinder."

Throughout South America the art of fire making with two sticks of wood is found to be as thoroughly diffused as it is in North America. Many of the tribes still use it; we may say that in all tribes the use of flint and steel was preceded by that of the sticks of wood.

From Carib-Arawak tribes of British Guiana come simple jungle-fire drills consisting of peeled and dressed rods of soft-yellow wood. A bit of the black bark is left at the upper end of the drill as an ornament. The hearth has a fire pit near the end or in the smaller hearths near the middle. (Pl. 2, figs. 1, 1a, Cat. No. 210445, British Guiana, coll. by J. J. Quelch, received from the Field Museum of

<sup>20</sup> Smithsonian Report, vol. 2, p. 315, 1885.

<sup>21</sup> Sir Daniel Wilson. Prehistoric Man, vol. 2, p. 375.

Natural History, Chicago; drills 15-19 inches long (38-48.3 cm.); hearths 5.5-7 inches long (14-17.7 cm.).)

The Guanchos, a mixed tribe of herders on the pampas of Venezuela, practice a peculiar way of fire getting. They select a pliant rod, place one end against the breast and the other against the block forming the hearth, held on a line with the breast. By pressing against the rod it is bent and turned rapidly around like an auger. This impracticable and no doubt very local method is described by Prof. E. B. Tylor.<sup>22</sup>

In Brazil, in the province of Goyaz, the Chavantes, Cayapós, and Angaytés, use the simple fire drill.<sup>23</sup> The Angaytés drill figured looks somewhat like that of the Hopis. It is usually 28 cm. long for the hearth, and for the drill 20 cm. They use the throat skin of the nandu, *Rhea americana*, for a tinder sack. The Lenguas of the same Province use a strike-a-light consisting of a tinder horn, flint, and steel, which is also figured in the cited report. This set is very interesting, because from it we can say with certainty where the Lengua got it. The steel is the English "flourish" and the flint is the oval, old English shape, probably broken somewhat by blows. The Lenguas, being on the line of travel, have adopted the method from English traders. In Rio de Janeiro the Indians had an angular recess at the back of their snuff mills for the purpose of making fire by friction.<sup>24</sup>

The Ainos of Japan formerly used fire sticks, and are said even yet to resort to this method when they have no other means of getting fire. They use also flint and steel, adopted from the Japanese. A specimen (22257) is in the Collections of the Museum.

The Japanese formerly used the simple drill; a few are yet preserved and used in the temples on special occasions. A specimen is exhibited in the Imperial Museum at Tokio. Several years ago Mr. Stewart Culin, after difficult negotiations through Mr. Tsuda of the Tokio Museum, secured a specimen for the Smithsonian Institution from Baron Menge of the Idzumo shrine. The specimen is like that in the Imperial Tokio Museum from the Oyashiro Temple at Idzumo. It is a smooth, most accurately dressed plank 35.5 inches long (90.5 cm.), 4.75 inches wide (12 cm.), and 1.2 inches thick (3 cm.), of *Chamaecyparis obtusa* wood. There are 42 fire pits on the two edges, generally 1 inch between centers. The holes are drilled deeply and several calibers of drill have been used. The drill is a stem of *Deutzia scabra* with strong walls and large pith. In many of the holes a core is produced as in the tubular drill. This fire drill was used in the Harvest Festival. The inscription in well written characters is, in

<sup>22</sup> Darwin. Narrative of the Voyage of the *Beagle*. Vol. 3, p. 458. Cited in Early History of Mankind, p. 241.

<sup>23</sup> Dr. Emil Hassler. In Jahrbuch Mittelschweiz. Commercial. Gesellsch. Arau, 1888, vol. 2, pp. 114-115.

<sup>24</sup> Harper's Monthly Magazine, vol. 7, p. 745. November, 1853.



part, "fire cuts wood Meiji 35 years November 27," the probable date of the Harvest Festival of thanksgiving and production of new fire. (Pl. 3, Figs. 1, 2.)

In the Transactions of the Asiatic Society of Japan for 1876 (vol. 2, p. 223) a sacred fire hearth is described as having a step as observed in some Eskimo forms. This feature has been taken to be a usage required by the environment of the high north. In Japan, however, it may refer to the collecting and saving of the ground-off dust for healing or other esoteric purposes.

In reference to the use of the sacred fire drill, the following data have been supplied by Romyn Hitchcock:

The fire drill is used at the festivals of the Oyashiro to produce fire for use in cooking the food offered to the gods. Until the temple was examined officially in 1872 the head priest used it for preparing his private meals at all times. Since then it has been used only at festivals and in the head priest's house on the eve of festivals, when he purifies himself for their celebration in the *Imbidous*, or room for preparing holy fire, where he makes the fire and prepares the food.

The art of fire making by sticks of wood by the method of rotation is, or has been, as far as we know, universal on the African Continent as it was in the two Americas at the time of the discovery. It is presumable that the ancient Egyptians who had the bow drill used this implement and previous to its invention used the simple drill.

The Somalis are a pastoral people of Arab extraction, inhabiting a large maritime country south of the Gulf of Aden. Their fire sticks (fig. 17) are pieces of branches of brownish wood of equal texture, in fact the hearth has formerly been used as a drill, as may be seen by its regularly formed and charred end. This is another proof that it is not necessary that the sticks should be of different degrees of hardness. The grain of the wood, that of the drill being against and the hearth with the grain, in effect accomplishes what the use of wood of different qualities results in. The hearth and drill are in the neighborhood of 12 inches long, the former with a diameter of three-eighths of an inch and the latter one-fourth of an inch. They were collected by Dr. Charles Pickering in 1843.

It is possible that the Somalis may have carried this method with them from Arabia. They



FIG. 17.—FIRE-MAKING SET. CAT. No. 129971, U.S.N.M. SOMALIS, EAST AFRICA. COLLECTED BY DR. CHARLES PICKERING. LENT BY PEABODY MUSEUM THROUGH F. W. PUTNAM

conquered this coast, driving back the earlier tribes inhabiting the country in the early part of the fifteenth century. Long since that time, and even now, some Arab tribes practice the drilling of wooden sticks to produce fire.

In eastern equatorial Africa the Wataveita, says H. H. Johnston, generate fire in the common African way by rapidly drilling a hard-pointed stick into a small hole in a flat piece of wood. An interesting bit of custom comes out in connection with this art among the people. "It is the exclusive privilege of the men, and the secret is handed down from father to son, and never under any conditions (as they say) revealed to women." I asked one man why that was. "Oh," he said, "if women knew how to make fire they would become our masters."<sup>25</sup> The figure (fig. 18) shows how this people of the great Bantu stock make fire; this tribe visited by Mr. Johnston lives on the slopes of the beautiful Kilimanjaro Mountain.



FIG. 18.—TAVEITA AFRICANS MAKING FIRE. AFTER H. H. JOHNSTON.  
(SEE JOUR. SOC. ARTS, JUNE 24, 1887)

Fire-drill survivals in Asia are now difficult to find. In the ancient writings of India there are many references to the use of the two-stick apparatus. The collection contains a specimen from the Bhilis of the Rajputana, India. It consists of a hearth made from half of a split branch, while the drill is a slender shoot with bark left on. The specimen was collected by Captain Lovett, of the English Army. (Pl. 4, fig. 1, 1a, Cat. No. 167334; Edward Lovett; hearth, 18 inches long (45.7 cm.); drill, 20.5 inches long (51 cm.).)

There was presented to the United States National Museum by the Natural History Museum of Oxford, England, through Henry Balfour, a replica of a Hindu sacred fire making set. This consists of a squared

<sup>25</sup> Journ. Anthrop. Inst., Great Britain and Ireland, vol. 15, p. 10, 1885.

block of wood  $2\frac{1}{2}$  inches thick, a drill in the cutting end of which can be set a cylindrical piece of superior wood or bitt and another piece supplied when it is worn down, a supply of such pieces sawed in a block of wood, a nut to be held with two hands and having an inset of stone, and a cord for rotating the drill. These parts are named, respectively, "adhararani"; the lower, "arani"; "mantha," the spindle drill; "sauku," set or bitt; and "uttarani," wood for the bitt. In respect to remarks on the necessity of a slot for collecting the fire dust, it may be said that this drill is an exception, as it is found that a drill spindle of unusual diameter obviates the necessity of a slot, the tendency of the movement on a large periphery being to roll off masses of the dust which ignite at one or more places. (India, Cat. No. 150887, Natural History Museum, Oxford, England; length of spindle with bitt, 20 inches (51 cm.). (Pl. 5, figs. 1-4.)) The elaborateness of this fire-making set is an example of the tendency to complexity in cult apparatus.

The turned drill and hand rest, the nut of iron, the iron pin, and bands on the drill naturally mark this set as modern in construction. This sacred fire drill is a model of the apparatus used in Brahmanic India by the fire priest, "agnihotrin," for the daily sacrifices of milk and butter according to the Vedic rituals. The apparatus is set up on an antelope skin.

Dr. W. L. Abbott brought from the Jakuns of the Endau River, Johore, a fire-drill set which, on account of the inaccessibility of these natives and the little known of them till lately, may be considered rare. The equipment as carried by the Jakuns consists of a bundle of little rods of about the same diameter, any one of which may be used as a drill or hearth at choice. There is no separation of hearth and drill. This feature is noticed also among the South American jungle tribes. It will be seen that in this case there is no need for a slot, as the working of the drill upon a hearth of equal caliber cuts a slot in the wall of the hearth automatically. (Cat. No. 213441; Dr. W. L. Abbott; 12-20 inches long (31-54 cm.).) Another bundle of fire sticks, native name, "kooshuk," from the Jakuns of the Rumpin River, Pahang, consists of rude rods, but having the same features mentioned in the Johore set except that the hearth pieces are slightly larger. (Cat. No. 219931; Dr. W. L. Abbott; hearth, 10 inches long (25 cm.); drill, 15 inches long (38 cm.).)

The Malays of the islands of Nias, Pagi, and Simalur, East Indies, have the cord drill. Dr. W. L. Abbott procured several sets from these islands described as follows:

The specimen from Sibabo Bay, Simalur Island, consists of a square piece of light yellow wood with used fire cavity in the middle, and adjoining a place with channel down the side of the block for a new working of the drill. The latter is a short, cylindrical, tapering



piece of the same wood. The cord is twisted brown fiber. The top of the drill is smoothed off by wear against the nut, which was a piece of coconut shell. This set is small and compact for carrying on the person. (Pl. 6, fig. 4, 4a, Cat. No. 216340; Dr. W. L. Abbott; 5.5 inches long (14 cm.).)

The apparatus from Pulo Simalur is larger than the set described above, and the drill is rotated with a strip of rattan. The wood is yellow, quite firm, and not hard. The hearth is squared and the drill is tapering as in the Pagi specimen. The native name of the fire set is "ludang." (Pl. 6, fig. 3, 3a, Cat. No. 221833; Dr. W. L. Abbott; hearth and drill 13 inches long (33 cm.).)

A general similarity with the Pagi and Simalur fire sticks is observed in the Nias specimens. It will be seen from the above that the fringe of islands off the south coast of Sumatra may be characterized as an area in which the cord drill is used. The specimens brought by Doctor Abbott have been chopped out of light-yellow wood, often showing worm holes. The cord is twisted brown bark. (Pl. 6, fig. 1, 1a, Cat. No. 221831, Lafau, Nias; Dr. W. L. Abbott; hearth, 15 inches long (38 cm.); drill, 11 inches (28 cm.).)

The north Pagi specimen is cut from very light wood, the hearth is squared and grooves cut in the regular way, and the drill appears to have been used in the hands. (Pl. 6, fig. 2, 2a. Cat. No. 221830; Dr. W. L. Abbott; drill, 10 inches (25.5 cm.); hearth 12 inches (30.5 cm.).)

Dr. Jesse R. Harris, United States Army, collected a fire hearth from the river district up the Rio Grande de Mindanao, P. I., presumably of Mandayan origin. Doctor Harris says: "The fire drill works with a bow and is a good one." The hearth is of soft worm-eaten wood and has three rather large cavities with slots. It is like the Malay drills of Simalur, Pagi, and Nias, and much extends the range of the machine drills in these regions. The native name is *Col-in-sung-an*. (Cat. No. 247525; 12 inches long (30.5 cm.).)

The Museum collection has a specimen from the Battaks of Palawan, P. I., which consists of a cleft stick held open at one end by a small stone and deeply sawed where fire has been made. The thong is of rattan one-eighth inch in diameter formed by spiral turns into a ring which is worn as a bracelet by the Battaks when it is not needed for fire making. (Pl. 9, fig. 2, Cat. No. 326012, collected by Mrs. E. Y. Miller.)

Mr. R. W. Felkin,<sup>26</sup> in a study of the Maidu or Moru negroes of Central Africa, 5° north latitude, 30° 20' east longitude, describes the fire making of that tribe. He says that one piece of wood about the size and shape of a large pencil is rotated in a hole in a flat piece of hard wood. One man holds the wood steady whilst two others take

<sup>26</sup> Proc. Royal Soc. Edinburgh. Session of 1883-84, p. 309.

it in turn to rotate the stick. This article of Mr. Felkin's is commended to ethnologists as a model ethnologic study in method and research.

That veteran and renowned explorer, Doctor Schweinfurth, gives the following:

The method of obtaining fire, practiced alike by the natives of the Nile lands and of the adjacent country in the Welle system, consists simply in rubbing together two hard sticks at right angles to one another till a spark is emitted. The hard twigs of the *Anona senegalensis* are usually selected for the purpose. Underneath them is placed either a stone or something upon which a little pile of embers has been laid; the friction of the upper piece of wood wears a hole in the lower, and soon a spark is caught by the ashes and is fanned into a flame with dry grass, which is swung to and fro to cause a draught, the whole proceeding being a marvel which might well nigh eclipse the magic of my lucifer matches.<sup>27</sup>

The Gaboon negro fire set is one of the few observed having no dust channel cut on the hearth. The wood, however, is light and apparently first class for fire making with least effort. It resembles the hibiscus wood used by the Hawaiians and other Polynesians, a most admirable material in which fire could be raised without the presence of the usual slot. The hearth is a peeled stem 1 inch in diameter, with large cavity midway. The drills are smaller stems pared down at the end, as is usual. (Pl. 7, Fig. 1, 1a, Cat. No. 164671; Gaboon River, West Africa; A. C. Good; hearth 23 inches long (58.5 cm.), drills, 21.5 and 24.5 inches long (55 cm. and 62 cm.).)

Dr. W. L. Abbott collected specimens from the Wa Chaga negroes, Mount Kilimanjaro, East Africa, years ago. The hearth is a small worked-out block carefully shaped or rough, as shown in the figures. The hearth has a cord at one end for tying to the drill for convenience in carrying. The drill is a straight, slender rod, with neatly cut hole at top for the hearth string. (Pl. 7, fig. 4, Cat. No. 161824, Dr. W. L. Abbott; drill, 20.5 inches long (52 cm.); hearth, 5 inches long (13 cm.).)

The use of worm-eaten wood is shown in the Wa Chaga hearth (pl. 7, fig. 2) and is evidence that wood is often conditioned for fire making by insects and fungi. Wa Chaga tinder is macerated bark. (Fig. 2b.) The drill is a peeled branch. (Fig. 2a, Cat. No. 151823.) Collected by Dr. W. L. Abbott in 1891.

The Somali drill is a workmanlike tool consisting of two smoothed rods of equal length, the drill hole at one end of the rod of larger diameter. It will be noticed that the cut of the drill opens the rod into two V-shape cuts, insuring the perfect collection of dust. The owner of the set pierced the two rods and drew through a slender leather thong to bind them together when not in use. (Pl. 7, Fig. 3;

<sup>27</sup> The Heart of Africa, vol. 1, pp. 531, 532. New York, 1874.

Cat. No. 167094, Somalis, East Africa; William Astor Chanler;  $24\frac{1}{4}$  inches long (61.5 cm.).)

It is an anomaly that the African, to light the fire to smelt the iron out of which he forges his remarkable weapons, should use sticks of wood.

An Australian fire set from New South Wales, collected in 1890 by William Villiers Brown, is an example of the careful manner with which the natives prepared and conserved their fire tools. The hearth is cut from soft, worm-eaten wood in a presumably human outline. Three sticks with vascular pith are tied to the hearth. The cut of such sticks leaves a core in the center of the drilled cavity. (Pl. 4, fig. 2, Cat. No. 168116; hearth,  $14\frac{1}{2}$  inches long, drills, 21 inches long.)

2. *Eskimo four-part apparatus*.—The arts of the Eskimo yield more satisfactory results to students of comparative ethnology than those of any other people.

In all their range the culture is uniform; one finds this fact forced upon his observation who has examined the series of specimens in the National Museum, where they are arranged in order by localities from Labrador to southern Alaska. Prof. Otis T. Mason's paper on Eskimo throwing sticks<sup>28</sup> gave a new interpretation to this fact and powerfully forwarded the study of ethnology by showing the classificatory value of the distribution of an art.

Professor Mason points out that though the Eskimo culture is uniform in general, in particular the arts show the modification wrought by surroundings and isolation—tribal individuality, it may be called—and admit of the arrangement of this people into a number of groups that have been subjected to these influences.

The Eskimo fire-making tools in the Museum admit of an ethnographic arrangement, but in this paper it is not found necessary to make a close study of this kind. From every locality whence the Museum possesses a complete typical set it has been figured and described.

The Eskimo are not singular in using a four-part apparatus, but are singular in the method of using it. The mouthpiece is the peculiar feature that is found nowhere else.

The drilling and fire-making set consists of four parts, as follows:

The mouthpiece, sometimes a mere block of wood, ivory, or even the simple concave vertebra of a fish or the astragalus of a caribou. More often, they show great skill and care in their workmanship, being carved with truth to resemble bear, seals, whales, and walrus. The seal is the most common subject. The upper part is almost always worked out into a block, forming a grip for the teeth. The extent to which some of these are chewed attests the power of the Eskimo jaw.

<sup>28</sup> Throwing sticks in the National Museum. Smithsonian Report, vol. 2, p. 279, 1884.



Frequently the piece is intended to be held in the hand, or in both hands, hence it has no teeth grip. In the under part is set a piece of stone, in which is hollowed out a cup-shaped cavity to hold the head of the drill. These stones seem to be selected as much for their appearance as for their antifriction qualities. They use beautifully mottled stone, marble, obsidian, and ringed concretions.

The drill is always a short spindle, thicker than any other drill in the world. It is frequently of the same kind of wood as the hearth.

The thong is the usual accompaniment of the fire drill. It is rawhide of seal or other animals. The handles have a primitive appearance; they are nearly always made of bears' teeth, hollow bones, or bits of wood. Sometimes handles are dispensed with. Warren K. Moorhead found some perforated teeth in an Ohio mound that in every respect resemble the Eskimo cord handles. They have also been found in caves in Europe decorated with concentric circles like those on the Eskimo specimens.

The bows are among the most striking specimens from this people. They are pared down with great waste from the tusks of the walrus, taking the graceful curve of the tusk. The Museum possesses one  $24\frac{1}{2}$  inches long. It is on their decoration that the Eskimo lavishes his utmost art. The bow does not lend itself well to sculpture as does the mouthpiece, so he covers the smooth ivory with the most graphic and truthful engravings of scenes in the active hunting life in the Arctic, or he tallies on it the pictures of the reindeer, whales, seals and other animals that he has killed.

Professor Baird was interested more with these bows than with any other Eskimo products, and desired to have them figured and studied.

The distribution of the bow is remarkable. It is not found south of Norton Sound, but extends north and east as far as the Eskimo range. The Chukchis use it,<sup>29</sup> but the Ostyaks use the ancient breast drill.<sup>30</sup>

The bow is used by individuals in boring holes. It is presumed that its use as a fire-making tool is secondary, the cord and handles being the older. The difficulty of making fire is greatly increased when one man attempts to make it with the compound drill; at the critical moment the dust will fail to ignite; besides, there is no need of one man making fire; a thing that is for the common good will be shared by all. Hence the cord with handles, which usually requires that two men should work at the drill, is as a rule used by the Eskimo.

Though the Sioux, and some other North American tribes, made use of the bow to increase the speed of the drill, they did not use the thong with handles, nor was the bow common even in tribes of the

<sup>29</sup> Nordenskiöld. *Voyage of the Vega*, vol. 2, p. 121, London, 1881.

<sup>30</sup> Seeböhm. *Siberia in Asia*, p. 109.

Siouan stock that had attained to its use. (See remarks, p. 25.) The bow may be termed a more advanced invention, allowing one man with ease to bore holes.

The hearth is made of any suitable wood. It is commonly stepped and has slots. The central hole with groove is also found. These hearths are preserved carefully, and fire has been made on some of them many times.

The distribution of the central-hole hearth (see fig. 19) and the slot-and-step hearth (see fig. 32) is rather striking. The central holes are found in the specimens observed from the north coast of Alaska, insular British America, and Greenland, exclusively. The stepped hearth with edge holes and slots is by far the more common in western Alaska, though the other method crops out occasionally; both ways are sometimes used in the same tribe. More often the central holes are bored on a groove (fig. 30), which collects the ground-off particles and facilitates ignition. Rarely fire is made by working the drill on a plane surface, in single, nonconnecting holes.

The difference between these features is that it is found to be more difficult to get fire by a single hole without groove or slot than when the latter features are added. The powder forms a ring around the edge of the hole, is liable to be dispersed, and does not get together in sufficient amount to reach the requisite heat for ignition. Of course this is obviated when a second hole is bored connecting with the first, when the latter becomes a receptacle for the powder.

It is found that these different ways are due to environmental modification, showing itself as remarkably in fire making as in any other Eskimo art. Both the stepped and central-hole hearth are different devices for the same end. The step on the hearth is to keep the pellet of glowing powder from falling off into the snow, so universal in Eskimo land; hence, the simple hearth of primitive times and peoples of warmer climates has received this addition. The same reason caused the Eskimo to bore the holes in the middle of the block.

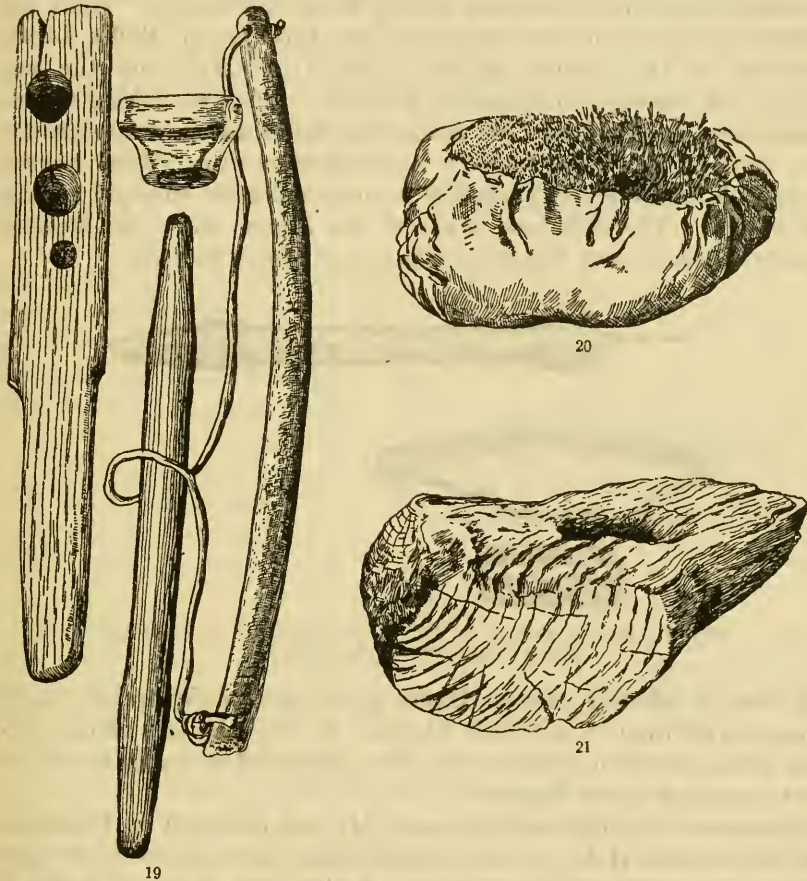
By following the distribution of the center-hole method a clew may perhaps be gotten to the migrations of the Eskimo.

From Labrador to Norton Sound, by the collections in the Museum, the center hole is alone used; south of Norton Sound both methods prevail, with a preponderance of the stepped-hearth species. The step seems to be an addition to the Indian hearth; the center is an independent invention.

The operation of the drill is well told in the oft-quoted description by Sir E. Belcher. The writer can attest to the additional statement that the teeth of civilized man can scarcely stand the shock. He says:

The thong of the drill bow being passed twice around the drill, the upper end is steadied by a mouthpiece of wood, having a piece of the same stone embedded, with a countersunk cavity. This, held firmly between the teeth, directs the tool. Any workman would be astonished at the performance of this tool on ivory; but having once tried it myself, I found the jar or vibration on the jaws, head, and brain quite enough to prevent my repeating it.<sup>31</sup>

The ethnographical study of the Eskimo fire drill begins with Labrador, including Greenland and following the distribution of the



FIGS. 19-21.—FIRE-MAKING SET AND EXTRA HEARTH. CAT. NO. 10258, U.S.N.M. FROBISHER BAY. COLLECTED BY C. F. HALL. 20, MOSS IN A LEATHER CASE. CAT. NO. 10191, U.S.N.M. COLLECTED BY C. F. HALL

people among the islands and around the North American coast to Kodiak Island and the Aleutian chain. The following is an interesting account from Labrador, showing what a man would do in the exigency:

He cut a stout stick from a neighboring larch, and taking out the leather thong with which his moccasins were tied, made a short bow and strung it. He then

<sup>31</sup> Trans. Ethnol. Soc., p. 140, London, 1861.



searched for a piece of dry wood, and having found it, cut it into shape, sharpened both ends, and twisted it once around the bowstring; he then took a bit of fungus from his pocket and put it into a little hole which he made in another dry piece of wood with the point of the knife. A third piece of dry wood was fashioned into a handle for his drill.<sup>32</sup>

Eskimo in other localities often use such makeshifts. Cup cavities are often observed in the handles of knives and other bone and ivory tools where they have used them for heads of the fire drill.

Cumberland Gulf is the next locality to the northward. There are several specimens in the collection from this part of Baffin Land, procured by the famous explorer, Capt. C. F. Hall, and the less known, but equally indefatigable Kumlein. The fire-making implements from Cumberland Gulf have a markedly different appearance from those of any other locality in the Eskimo area. They have a crude look, and there is a paucity of ornamentation unusual among this people. The drill bow is one of the things which the Eskimo usually decorates, but these bows have not even a scratch.

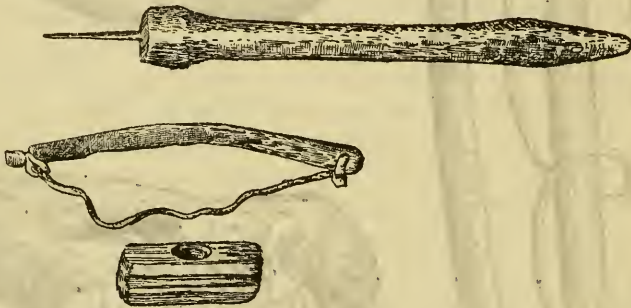


FIG. 22.—BORING SET. CAT. No. 34114, U.S.N.M. CUMBERLAND GULF. COLLECTED BY L. KUMLEIN

It can be inferred that in Baffin Land more unfavorable conditions prevail than in southern Alaska. It must be this cause, coupled with poor food supply, that have conspired to make them the most wretched of the Eskimo.

The hearth (fig. 19) is of drift oak. It was collected at Frobisher Bay by Captain Hall. It has central holes, and appears to be very unfavorable wood for fire making. A skin bag of moss (fig. 20) is for starting the fire. The block hearth is also from Frobisher Bay. (Fig. 21.) It is an old piece of hemlock, with two central communicating holes. The mouthpiece is a block of ivory. Another mouthpiece is a bit of hardwood soaked in oil; it was used with a bone drill having an iron point. A very small, rude bow goes with this set. (Fig. 22.)

<sup>32</sup> Hind. Labrador, vol. 1, p. 149.

Our knowledge of eastern Greenland has been very much increased by the explorations of Holm and Garde, who reached a village on the east coast never before visited by a white man. Extensive collections were made, both of information and specimens. In reference to fire making, Mr. Holm reports :

They make fire by turning a hard stick, of which the socket end is dipped in train oil, very rapidly around by means of a sealskin thong with handles. This stick is fixed at one end into a head set with bone, and the other end is pressed down into a cavity on the lower piece of wood. (Fig. 23.) Therefore there must be two persons in order to make a fire. One turns the drill with the cord while the other presses it down on the hearth; both support the block with their feet. As soon as the dust begins to burn they fan it with the hand. When it is ignited they take it and put it into dried moss (*sphagnum*); blow it, and soon get a blaze. In this way they make a fire in an incredibly short time.<sup>33</sup>

In the preliminary report, Mr. Holm gives the time at almost less than half a minute. It was made by the Eskimo, Illinguaki, and his wife, who, on being presented with a box of matches, gave up their drill, saying that they had no further use for it.

In the same report Mr. Holm gives an interesting note. He says:

This fire apparatus is certainly better developed than that which has been described and drawn by Nordenskiöld from the Chukchis.<sup>34</sup> The principle is the same as the Greenlander's drill, which they employ for making holes in wood and bone, and which is furnished with a bow and mouthpiece.<sup>35</sup> (Fig. 24.)

The central holes of this hearth are worthy of note, occurring in the farthest eastern locality of the Eskimo, and in Labrador.

*Western Greenland.*—The material in the Museum from western Greenland is very scanty. The southern coast has been settled for so long a time that the Eskimo and many of their arts have almost become extinct. No view of fire making in Greenland would be complete without Davis's quaint description of it, made 300 years ago, but it was the upper end of the spindle that was wet in trane. A Greenlander "begaune to kindle a fire in this manner: He tooke a

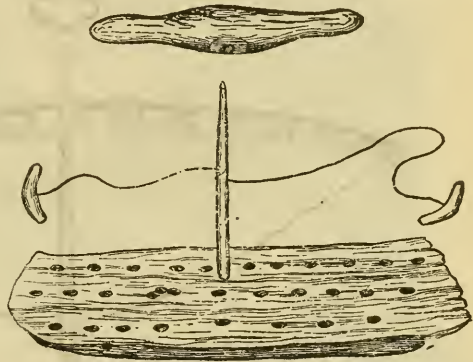


FIG. 23.—FIRE-MAKING SET. ANGMAGSALIK ESKIMO, EASTERN GREENLAND. COPIED FROM G. HOLM'S ETHNOLOGISK AF ANGMAGSALIKERNE, 1837

<sup>33</sup> Danish Umiak Expedition to Eastern Greenland, 1833, p. 28. Pl. 14 contains the figure.

<sup>34</sup> Voyage of the *Vega*, vol. 2, p. 126.

<sup>35</sup> Danish Umiak Expedition. Preliminary Report, p. 208. This seems scarcely what would be inferred from the development of these inventions.

piece of board wherein was a hole half thorow; into that hole he puts the end of a round sticke like unto a bedstaffe, wetting the end thereof in Trane, and in a fashion of a turner with a piece of lether, by his violent motion doeth very speedily produce fire."<sup>36</sup>

Eskimo graves and village sites yield evidence also that the fire-making tools were not different from those at present used higher north along the coast and on the east coast.

Doctor Bessels, speaking of Itah Eskimo of Foulke Fiord in Smith Sound, says: "The catkins of the Arctic willow are used as tinder to catch the sparks produced by grinding two pieces of stone. Also the widely diffused 'fire-drill' is found here; the spindle is held between a piece of bone and a fragment of semi-decayed wood, and is set in

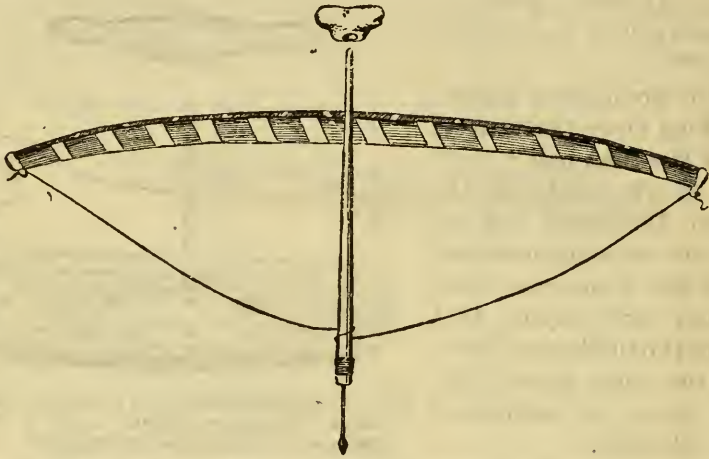


FIG. 24.—BORING SET. (ANGMAGSALIK ESKIMO, EASTERN GREENLAND. G. HOLM'S ETHNOLOGICK OF ANGMAGSALIKERNE)

motion by the well-known bow, and is turned until the wood begins to ignite."<sup>37</sup>

The "fire bag" is an accompaniment to all sorts of fire-making apparatus. The fire bag shown (fig. 25) was collected by Captain Hall, at Holsteinberg, western Greenland in 1860. It is made of sealskin, and is a good specimen of the excellent needlework of these Eskimo. It was used to carry, more especially, the fire drill and tinder which require to be kept very dry.

There is a wide gap in the collections of the Museum between the locality of the specimen just mentioned and the fire hearth from the Mackenzie River. (Fig. 26.) This specimen is from Fort Simpson presumably, where B. R. Ross collected. It is said to be difficult to discriminate the Eskimo from the Indian on the lower Mackenzie. This hearth may be Indian, as it has that appearance; besides, no

<sup>36</sup> Hakluyt Society, vol. 3, p. 104.

<sup>37</sup> Die amerikanische Nordpol-Expedition, p. 358, Leipzig.



Eskimo hearth yet observed has side holes and slots like this without the step. The Indians of this region are of the great Athapascan stock of the North. The close resemblance of this stick to the one from the Washoans of Nevada has been commented upon. (See fig. 6, p. 14.)

There is a very fine old central-hole hearth from the Mackenzie River, collected also by Mr. Ross. It is a rough billet of branch wood, cut apparently with an ax, or hatchet. (Fig. 27.) It is semi-decayed and worm eaten. It has 10 central holes where fire has

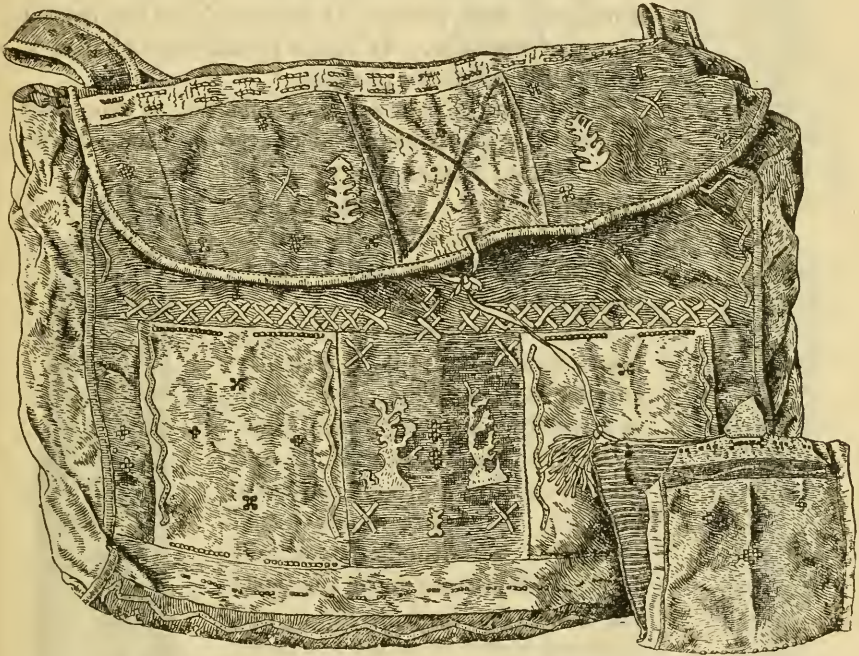


FIG. 25.—FIRE BAG. CAT. No. 10128, U.S.N.M. ESKIMO OF HOLSTEINBERG, WEST GREENLAND. COLLECTED BY CAPT. C. F. HALL

been made; they are quite deep, forming a gutter in the middle of the hearth. There is, as can be seen, no need of a groove, as the dust falls over into the next hole, collects in a mass, and ignites.

The Anderson River set is a very complete and interesting outfit. It was collected many years ago by C. P. Gaudet. The parts are small for convenience of carrying. It is the custom of those who live in snow-covered regions to wrap the drill and hearth together very carefully to keep them dry, as these are the essential parts of the apparatus. It does not matter about the mouth-piece or bow. In this example there is a groove cut along the bottom of the hearth in order to facilitate tying the drill and hearth securely together. The



FIG. 26.—LOWER PART OF FIRE-MAKING SET (ON ONE END IS GUM FOR CEMENT). CAT. No. 1978, U.S.N.M. MACKENZIE RIVER, BRITISH COLUMBIA. COLLECTED BY B. R. ROSS

hearth is a square block of soft wood with three central holes. (Fig. 28.)

The other parts of this set are also worthy of consideration. The mouthpiece is set with a square piece of black stone. The part held in the mouth is very much chewed. One of the wings has a hole for tying, as has the hearth.

This is an unusual Eskimo precaution to prevent small objects from being lost in the snow. The drill is short, being only 7 inches long. The bow is the fibula of a deer, pierced at each end for the frayed thong of sealskin. It has a primitive look, but it admirably serves its purpose.

The Point Barrow set was collected by the most successful expedition under charge of Lieut. P. H. Ray, United States Army. The knucklebone of a deer serves as a mouthpiece, the cup cavity and its general shape fitting it for the purpose admirably.

The drill is regularly made of light pine wood; it is slightly smaller in the middle. The hearth is a rudely rounded piece of pine. A fragment has been split off, and on this surface a groove has been cut and three fire holes bored along it. The thong is without handles; it is used to tie the parts together when they are not in use. A bunch of willow twigs, the down of which is used as tinder, is also shown. (Fig. 29.)

This set is especially interesting, because it shows the degeneration of an art. The fire drill is so rarely used at Point Barrow, John Murdoch says, that it was not possible to get a full set devoted to that purpose. Those here shown are a makeshift. The method only survives by the conservatism of a few old men of the tribe, who still cling to old usages. One of these made the drill for Lieutenant Ray, telling him that it was the kind used in



FIG. 27.—LOWER PART OF FIRE-MAKING SET. CAT. No. 1963, U.S.N.M. ESKIMO OF MACKENZIE RIVER, BRITISH COLUMBIA. COLLECTED BY B. R. ROSS



old times. It seems primitive enough; the knucklebone might well have been the first mouthpiece. The Eskimo farther east sometimes use a fish vertebra for the same purpose; one from the Anderson River has this. The cord without handles is undoubtedly the earliest form also.

The small wooden and bone mouthpieces of the Eskimo east of Point Barrow to Cumberland Gulf seems to be copies of the deer knucklebone. Another primitive adaptation is found in an Anderson River bow, which is made of the fibula of a deer. (See fig. 28.)

The fire-making drill collected from the Chukchis by the *Vega* expedition in the Cape Wankarem region, in northeastern Siberia, about the same latitude as Point Barrow, is figured in Nordenskiöld's report.<sup>38</sup> It is worked by a bow, and the drill turns in a mouthpiece of a deer astragalus like the Point Barrow specimen. The block has central holes, with short grooves running into each one.

Nordenskiöld's description of the manner of making fires is very detailed. He records that the "women appear to be more accustomed than the men to the use of this implement."

He gives also a most interesting observation on the use of a weighted pump drill among the Chukchis. The Chukchis also use flint and steel.<sup>39</sup>

The drilling set from Point Barrow shows the appearance of the parts of the fire drill if we substitute the round stick for the flint drill. Some of the old drill stocks are pointed, with finely chipped flint heads. The length of these points varies from 2 to 4 inches;

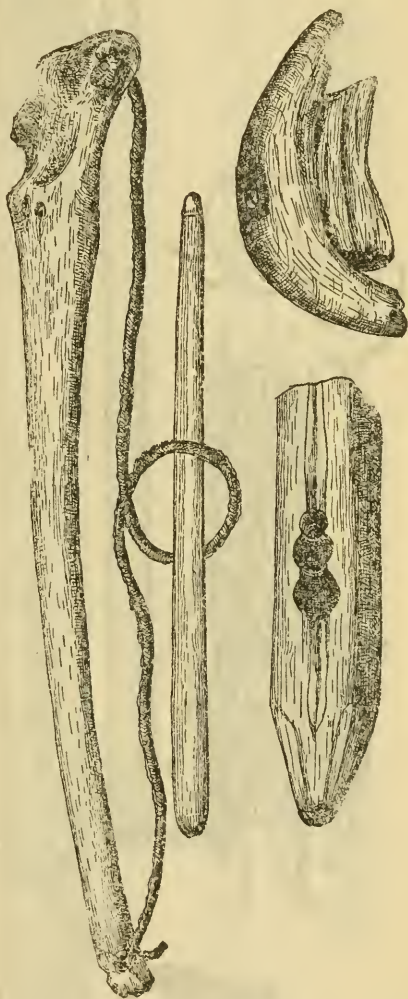


FIG. 28.—FIRE-MAKING SET. CAT. NO. 1327, U.S.N.M. ESKIMO OF ANDERSON RIVER, BRITISH COLUMBIA. COLLECTED BY C. P. GAUDET

<sup>38</sup> Voyage of the *Vega*, London, 1881, vol. 2, pp. 121, 122.

<sup>39</sup> *Idem*, vol. 2, pp. 120, 121.



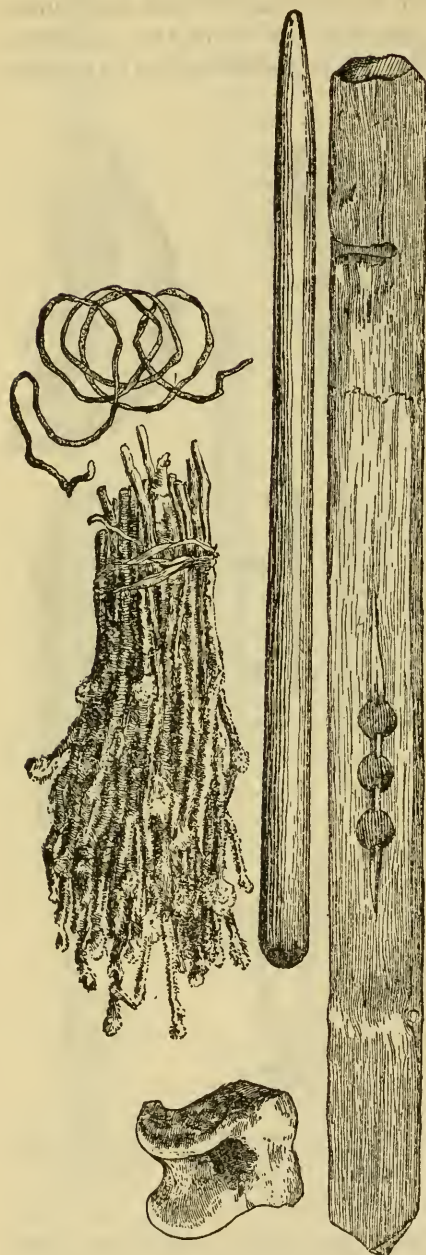


FIG. 29.—FIRE-MAKING SET (WITH MOUTHPIECE OF DEER'S KNUCKLEBONE, THONG, AND TINDER OF WILLOW CATRIN). CAT. NO. 89822, U.S.N.M. ESKIMO POINT BARROW, ALASKA. COLLECTED BY P. H. BAY

the transverse section of one would be a parabola. They are in general more finely wrought than any of the prehistoric drills found in various localities all over the world. Prehistoric man was an adept in the art of drilling stone, bone, and shell; the stone tubes, some of them 18 inches long, bored very truly, are triumphs of the American Indians. Without doubt the prehistoric drill points were mounted like the Eskimo specimen, and were, perhaps, twirled between the hands, the almost universal method of using the fire drill. Japanese carpenters drill holes in this way.

The winged mouthpiece is also a good example of workmanship. It is set with a mottled, homogeneous stone that is tolerably soft, which gives a minimum friction. This stone is much affected by the tribes over quite an extent of coast for labrets, etc. It is probably an article of trade as are flints. The bow is of walrus tusk, accurately made, but poorly engraved in comparison with the life-like art work of the southern Eskimo.

Another drilling set is from Sledge Island. The Museum has no fire-making specimen from this locality. The drill stock is set with a point of jadeite lashed in with sinew cord. The bow is of walrus ivory; it is rounded on the belly and flat on the back. All Eskimo bows of ivory have a like curve, no doubt determined by the shape

of the walrus tusk. In another, the most common form of the bow, its section is nearly an isosceles triangle, one angle coming in the center of the belly of the bow. The head is intended to be held in one or both hands; it agrees in form with the rude St. Lawrence Island heads.

Dr. E. W. Nelson collected at Unalakleet, in Norton Sound, a fire drill, and the native names of the parts. The name of the set is "öð-jöð-gütat"; the mouthpiece, "nä-ghöð-tuk"; the drill, "öð-jöð-ga-tuk"; the hearth of tinder wood, "athl-uk"; the bow, "arshu-löw-shuk-pish-ik-sin-uk."

This is a complete set (fig. 30) in first-rate order. The hearth has central holes along a deep median groove. Its bottom is flat, and it is rounded off on the sides and ends. All the parts are of pine wood, decorated in places with red paint. The drill is quite long, much longer than in any Eskimo set observed. It resembles more the Indian drill for rubbing between the hands. The bow is of wood, which also is quite the exception in other Eskimo regions, where it is of ivory. There are many bows of antler from Norton Sound in the Museum, some of them skillfully and truthfully engraved. The mouthpiece is plain; not very well made. It is set with a square block of marble. It has the usual hole in one of the wings for the passage of a thong.

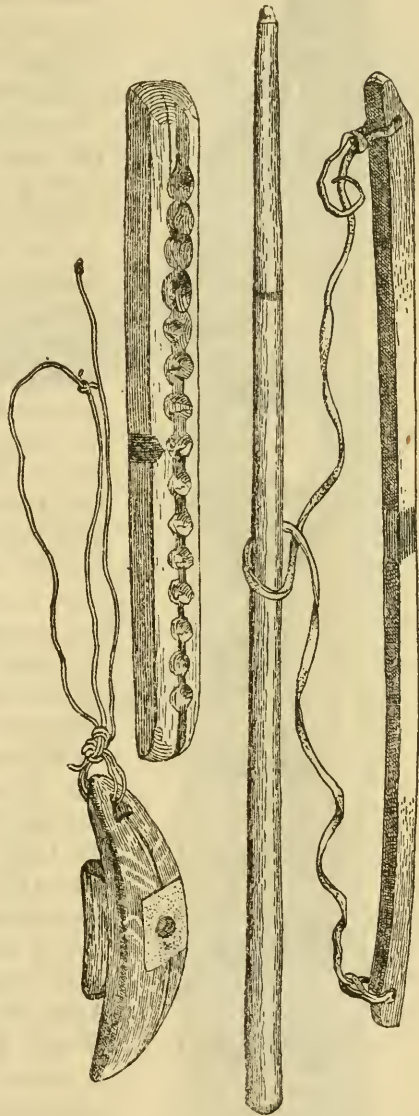


FIG. 30.—FIRE-MAKING SET (HEARTH SHOWING MEDIAN GROOVE). CAT. NO. 33166, U.S.N.M. ESKIMO OF NORTON SOUND, ALASKA. COLLECTED BY E. W. NELSON



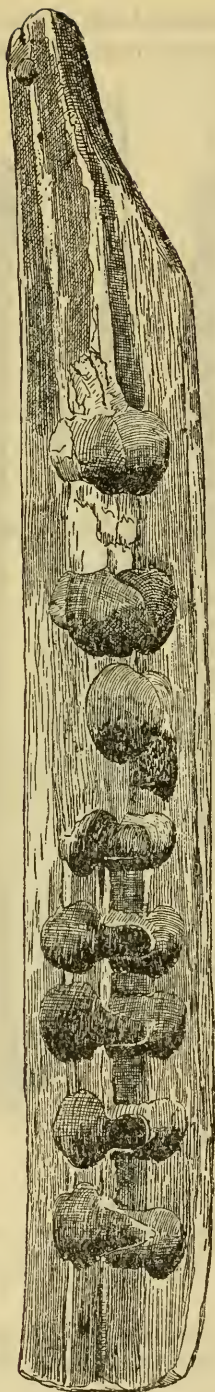


FIG. 31.—LOWER PIECE OF FIRE-MAKING SET (HEARTH). CAT. No. 39601, U.S.N.M. ESKIMO OF CAPE VANCOUVER, ALASKA. COLLECTED BY E. W. NELSON

Cape Vancouver is represented by a fine old hearth. This object has evidently been prized by its owner; it has had two rows of fire holes (fig. 31), one row bored on the step in front of the first holes made; some of the holes are bored clear through. The reason why this was valued is because the wood is so tindery that it is easy to make fire upon it.

Chalitmute, in the Kuskokwim region, on the northern side of the bay of that name, opposite Nunivak Island, is the next locality southward to be considered. The parts of this set are exceptionally well finished. The hearth (fig. 32) is stepped. It has four holes prepared for use; on one, fire has been made. The drill is unusually thick. The mouthpiece has no teeth grip, and there is no evidence that it was ever held in the mouth. It is intended to be held in the hand. This mouthpiece is set with an oval socket stone of black obsidian, ground down into facets and polished. The cord handles are fine, large teeth of the sea lion. The centers of the circles so characteristic of Eskimo art are inlaid with wood. The holes for the drill cord are narrow; they must have been dug through with a sharp, narrow instrument. As before remarked, this is the region where the hand rest is more used than the mouthpiece, and the bow is not used at all.

The fire-making set from the Togiak River was collected in 1886 by Sergt. I. Applegate, of the United States Signal Corps. Kassianamute, from which village it comes, is in the Bristol Bay region, but this set has a different appearance from the former outfits. (Fig. 33.) The hearth is a block of wood worked out at one end into a handle. It is remarkable in having central holes not connecting, and with no connecting grooves. In this it closely resembles the block from east Greenland. (Fig. 23.) This hearth is of soft, tindery wood, and doubtless when the holes became too deep to allow the powder to mass



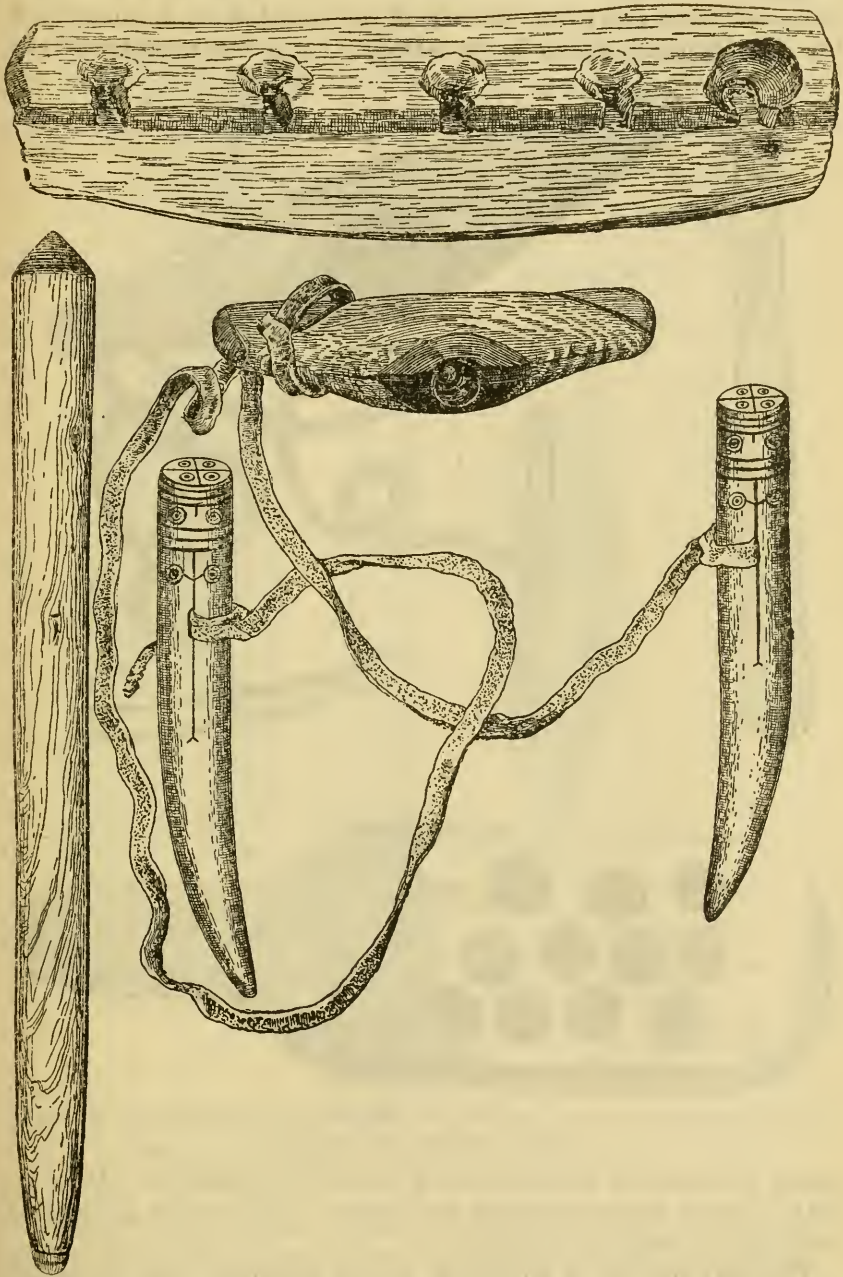


FIG. 32.—FIRE-MAKING SET. CAT. NOS. 36325 AND 37961. ESKIMO OF CHALITMUTE, KUSKOKWIM REGION, ALASKA. COLLECTED BY E. W. NELSON

around the edge the upper part of hearth was scraped down. The mouthpiece is large and is in the form of a seal. It has only a shallow, crescentic teeth grip; from the size of the mouthpiece, its shape, and the absence of a block to fasten between the teeth it must have been

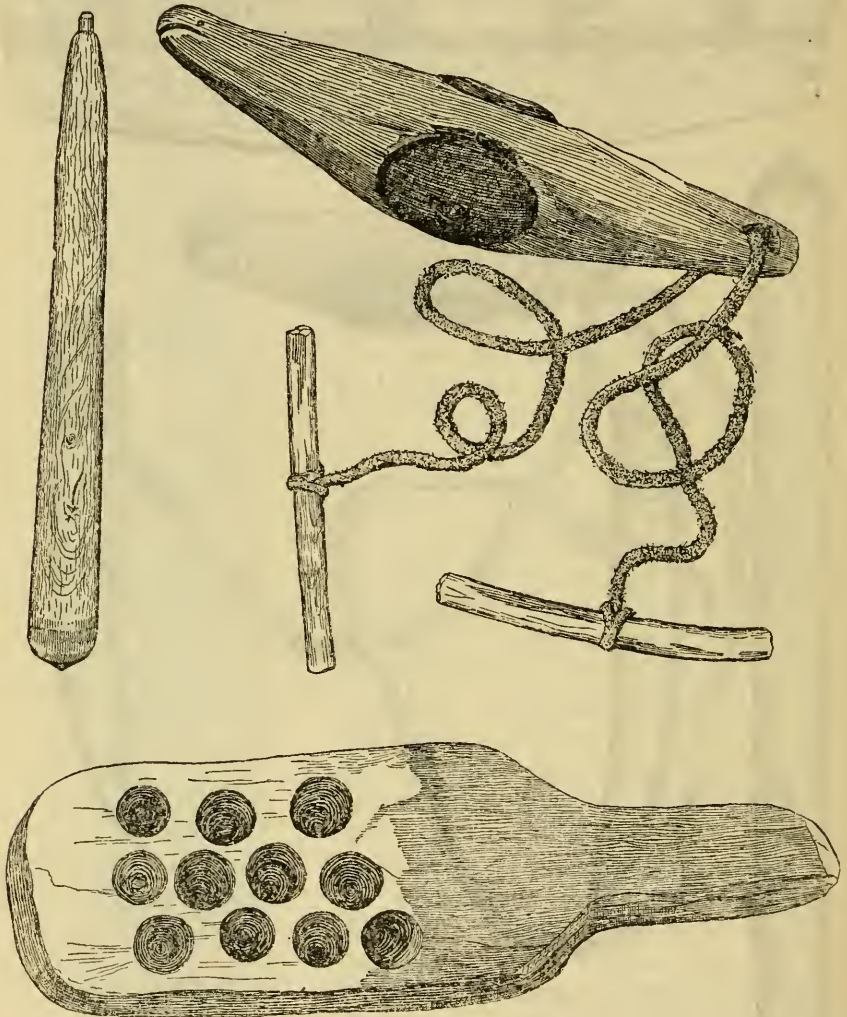


FIG. 33.—FIRE-MAKING SET. CAT. No. 12750, U.S.N.M. ESKIMO OF KASSIANAMUTE, TOGIAK REGION, ALASKA. COLLECTED BY I. APFLEGATE

nearly always held in the hand of one of the operators. It is set with a round pebble, mottled with green. The cord is a thong of rawhide with handles of wood.

The next locality is Koggiung, on the southern shore of Bristol Bay, near its head. Two sets are shown from this locality. From the hearths it will be seen that both fire slots on the side and

center holes are used here. These sets are called "nū-tshūn." (Fig. 34.) The apparatus shown in Figure 34 has the stepped hearth.

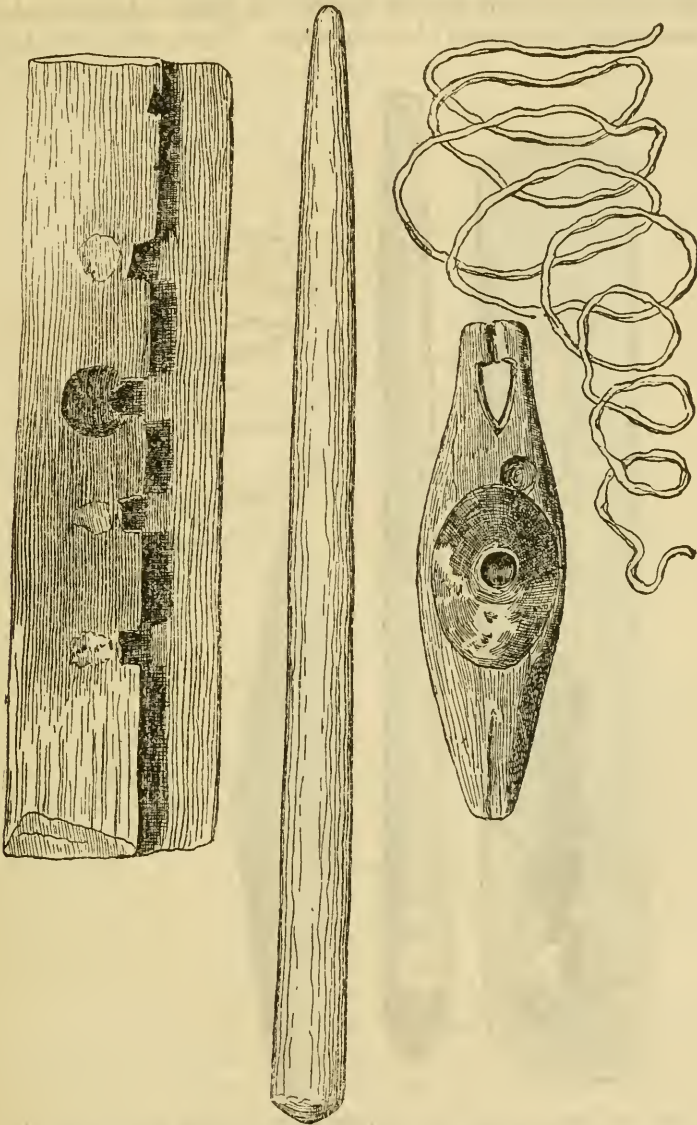


FIG. 34.—FIRE-MAKING SET (HEARTH WITH STEP AND FIVE SLOTS). CAT. NO. 127819A, U.S.N.M. KOGGIUNG, BRISTOL BAY, ALASKA. COLLECTED BY W. J. FISHER

Both drill and hearth apparently have been made for sale. The mouth-piece is a good one, set with a large socket piece of a black stone with green mottlings. This stone is tolerably soft. It is much used by the Bristol Bay Eskimo for making labrets, etc. The teeth grip is



very shallow. The hearth (fig. 35) is of a very peculiar shape; only one other has been noticed like it. The wood is of the best kind, and fire has been made on it a number of times. In several places the holes have been bored clear through. The mouthpiece bears no

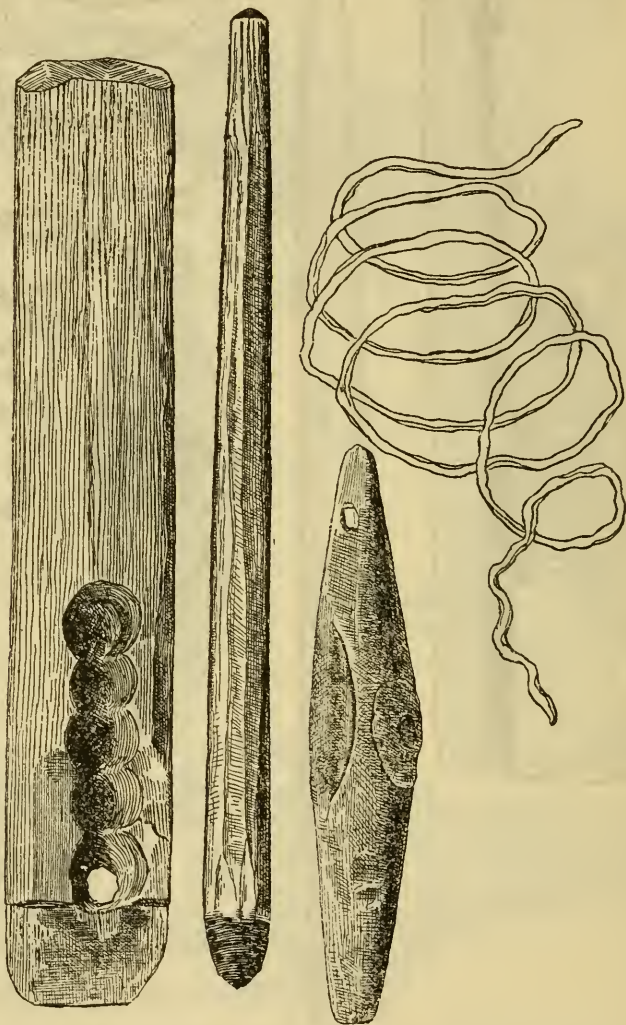


FIG. 35.—FIRE-MAKING SET (HEARTH WITH CENTRAL HOLES AND END STEP). CAT. NO. 127819B, U.S.N.M. KOGGIUNG, BRISTOL BAY, ALASKA. COLLECTED BY W. J. FISHER

evidence that it has been held between the teeth. It is highly probable that fire was made on these outfits more often by two persons, one holding the mouthpiece, or rest, and fanning the flame, the other pulling the cord. This must be the method in Bristol Bay. Neither

the true mouthpiece nor any bow has been procured by the Museum from this interesting region, from whence there are copious collections of ethnological objects. The cords without handles are worthy of notice.

Another set from Bristol Bay is said by its collector, Charles McKay, to be used by both Eskimo and Indians. It is a very valuable outfit because of its completeness. (Fig. 36.) The hearth is a rounded piece of wood with four large holes opening by slots onto the step. The drill is a thick, tolerably hard piece of close-grained wood like the hearth. The mouthpiece has no regular block for the teeth grip, but has a crescentic gash on each side instead. It is set with a socket of a rock resembling marble. Nearly all the mouthpieces south of Norton Sound are in the shape of seals or other long animals. Cord handles are used attached to a thick thong of buckskin. Fungus is used for tinder and a blaze is started with cones of the larch. These are kept in the box, the lid of which is tied on with a thong.

Kodiak, the lowest limit of the western Eskimo, is as far south as the four-part fire drill extends by specimens in the Museum. (Fig. 37.) The hearth is of cedar wood with three central holes with a connecting groove. It is neatly finished. The drill is also of cedar and bears the marks of the use of a thong; the top has also been used in the socket of a rest. The drill approaches in length those used for twirling between the hands by the Indians.

While the Aleutians use flint and steel, or a stone containing quartz and pyrites, struck against another stone, they still make use of the four-part drill at certain times. Hunting parties, says L. M. Turner, carry the drill to use when their matches run out. It takes two men to work it, one holding the hand rest and the other pulling the thong. The spindle is made of harder wood, so as to wear the light dust which ignites, from the hearth. A moment only is necessary to get fire; this is fed with tinder made of willow catkins and powdered charcoal. Sometimes, in order to get fire, they hold tinder at the mouth of a gun and ignite it by firing off a light charge of loose powder.

Possessed of four methods of getting fire, the Aleutian is superior to more fortunately situated people who depend wholly on matches.

*Pump drill.*—It appears probable that the pump drill is of Asiatic origin as there are frequent occurrences of this implement in Asia. There is also a pretty uniform distribution of the pump drill across Siberia. Some western Eskimo and Indians use the pump drill for fire making, and it is possible that it was disseminated in Nearctic Canada and the United States at an early period and surviving now in only a few places, as among the Iroquois.

The Iroquois are unique in the United States in making fire with the pump drill. It is well known that several American tribes used the pump drill for drilling beads and for other light, fine work

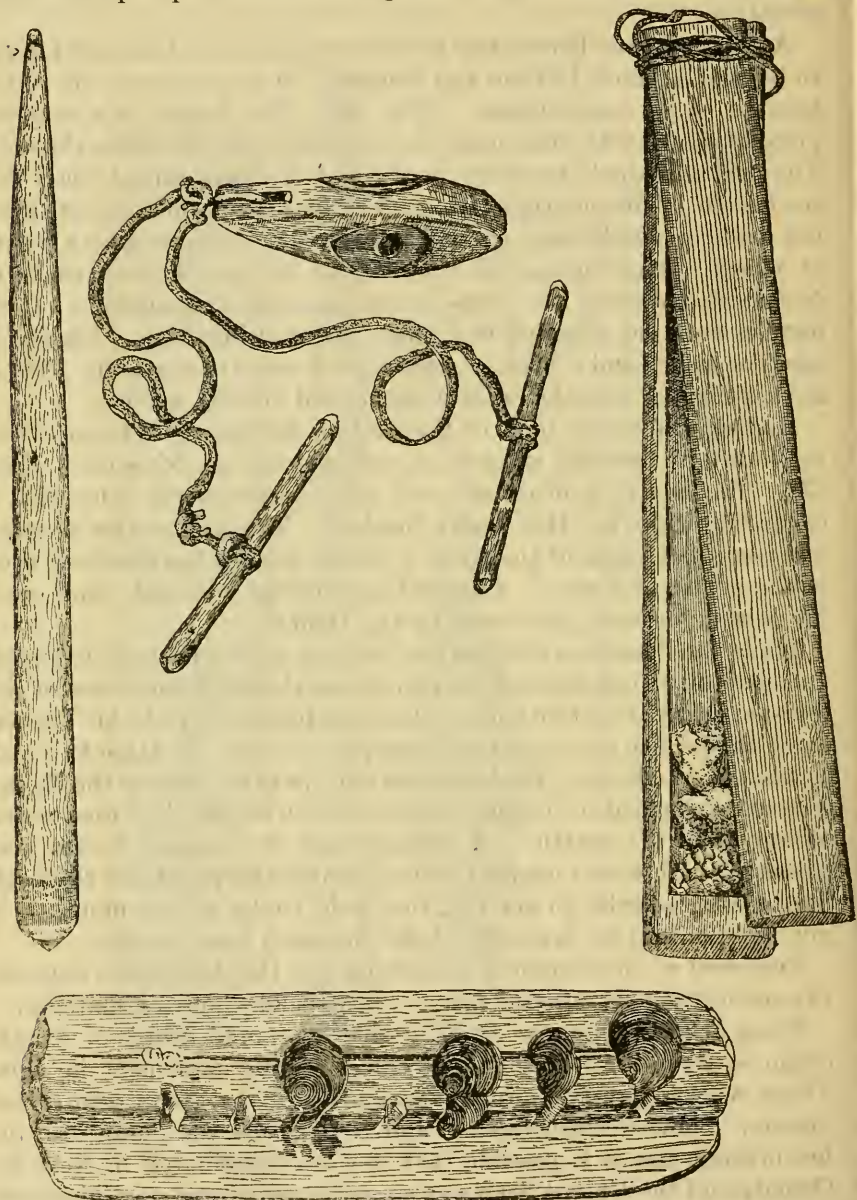


FIG. 36.—FIRE-MAKING SET. CAT. No. 55938, U.S.N.M. ESKIMO OF BRISTOL BAY, ALASKA. COLLECTED BY CHARLES MCKAY

requiring little friction and pressure. To render the pump drill effective for fire making it was necessary to increase the size and add a heaver balance wheel. Even then the pump drill is a clumsy fire



producer and hardly a practical tool for the purpose.

How long the Iroquois have had the fire drill is conjectural, but observers as early as 1724 do not mention its use, speaking only of the simple two-stick drill.

#### II. FIRE MAKING BY SAWING

Prof. Alfred Russell Wallace in his work entitled "The Malay Archipelago," (p. 332) has noted the method by sawing two pieces of bamboo; a sharp-edge piece like a knife is rubbed across a convex piece in which a notch is cut, nearly severing the bamboo (fig. 38); after sawing across for awhile the bamboo is pierced, and the heated particles fall below and ignite. The Ternate Malays and the Tugaras of British North Borneo<sup>40</sup> have improved upon this by striking a piece of china with tinder held with it against the outside of a piece of bamboo, the siliceous coating of the latter yielding a spark like flint. Both of the methods mentioned are in use at different points in the area affected by Malay influence.

The Chittagong hill tribes, on the eastern frontier of British India, use sand on the sawing knife to increase the friction.<sup>41</sup>

The Karens of Burma, Dr. R. M. Luther informs the writer, hollow out a branch of the *Dipterocarpus* tree like the lower piece of bamboo spoken of, cut a transverse notch, and saw across in it with a rubber of ironwood. The wood fibers ground off form the tinder; the coal is wrapped up in a dry leaf and swung around the head till it blazes. It takes only two or three minutes to get a blaze this way.

Bearing upon the origin of this method of sawing in these localities, nature is

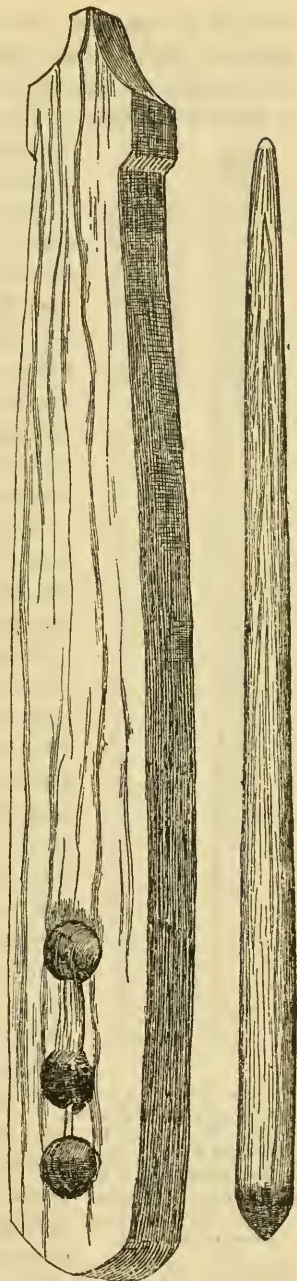


FIG. 37.—LOWER PIECE AND SPINDLE OF FIRE-MAKING SET. CAT. NO. 72514, U. S. N. M. ESKIMO OF KODIAK ISLAND, ALASKA. COLLECTED BY W. J. FISHER

<sup>40</sup> D. D. Daly. Proc. Roy. Geog. Soc., p. 10, 1838.

<sup>41</sup> Capt. T. H. Lewis. Hill tribes of Chittagong, p. 83. Calcutta, 1869.

alleged to suggest the way and to repeat the process that would give to fireless man the hint. Dr. W. T. Hornaday relates that many fires are started in the jungle by bamboo rubbing together in a high windstorm. The creaking is indiscribable; the noise of the rasping and grinding of the horny stems is almost unendurable.

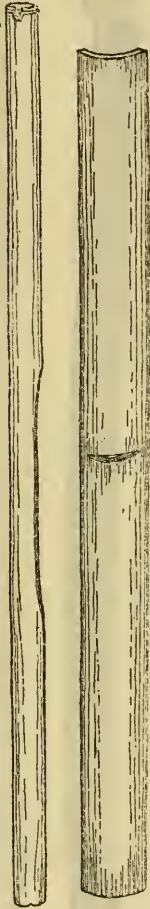


FIG. 38.—MALAY FIRE STICKS. CAT. No. 129775, U.S.N.M. MODELS IN BAMBOO MADE BY DOCTOR HOUGH AFTER A. R. WALLACE'S DESCRIPTION. THE MALAY ARCHIPELAGO, P. 332.

In many tribes it is found that often there is more than one method of fire-making practiced. For instance, in Borneo, as we have seen, the Tungaras use the sawing method, the Saribus Dyaks the "besiapi," or fire syringe, a most interesting fact,<sup>42</sup> other Dyaks the rotary drill,<sup>43</sup> while the Rev. Dr. Taylor says that the Dyaks are acquainted with the use of the bow and string and the upright stick and cord (pump drill). In connection with all these methods probably flint and steel were used.

So in Australia, while the rotary drill is the usual way, some tribes have acquired the art of producing fire with knife or rubber—that is, the sawing method presumably under foreign influence.<sup>44</sup>

The specimens of fire saws in the Museum come from the Philippines, collected 25 years ago. They indicate that a node of bamboo from 13 to 15 inches long was sectioned longitudinally for the lower piece and the saw made by splitting off a narrower piece and sharpening one or both edges. In the middle of the hollow of the lower piece fibers are torn up, forming a groove which reduces the thickness of the wall of the bamboo, allowing the saw to cut through to the tinder affixed in the groove and held in place by loose fibers. The saw is worked across the bow of the bamboo hearth at right angles over the spot where the tinder had been previously located. Sometimes this is reversed by holding the saw firmly edge up and rubbing the hearth on it. The use of the fire saw was quite general in the Philippines among all the tribes, while the hand drill or or plow were not used so far is known in the entire archipelago. The specimens shown are from Mindanao and Luzon. (Pl. 8, figs., 1, 1a, 2, 2a, Cat. No. 216,716; Col. F. F. Hilder; 13.5 inches long and 15 inches long (34.5 cm. and 38 cm.).

<sup>42</sup> The American Anthropologist, vol. 1, No. 3, p. 294. Washington, 1888.

<sup>43</sup> J. G. Wood. The Natural History of Man, vol. 2, p. 502.

<sup>44</sup> R. Brough Smyth. The Aborigines of Victoria, vol. 1, p. 393. London, 1878.

## III. FIRE MAKING BY PLOWING

One of the most marked of fire-making methods in its distribution is that pursued by the Pacific Islanders, confined almost entirely to the Polynesian cultural area. It has spread to other islands, however, being met with among the Negritos of New Britain:

They rub a sharpened piece of hard stick against the inside of a piece of dried split bamboo. This has a natural dust that soon ignites. They use softwood when no bamboo can be procured, but it takes longer to ignite. The flame is fed with grass.<sup>45</sup>

There is a close connection between the Malay sawing method and this, as there is a decided Malay preponderance in the make-up of the population of the islands.

The fire sticks shown (fig. 39) were procured by Harold M. Sewall, at Samoa, and deposited in the Museum by him.

The wood is a light corky variety, characteristic of the *Parite tiliaceum*, which is used for this purpose at Tahiti and many other islands. The rubber may be of some hardwood, although fire may be made by means of a rubber of the same kind of wood as that of the hearth, though no doubt it requires a longer time to make fire if this is done. In the Sandwich Islands, Franklin Hale Austin, secretary of the King at that period, says that the rubber is of "koh" or "ohia"—that is, hardwood—and the hearth of "koh," or softwood; and the friction is always in softwoods; this is true, I believe, everywhere this method is practiced, is in spite of the fact that a soft rubber on hardwood will answer as well.

Lieut. William I. Moore, United States Navy, gave the writer a complete description of the manipulation of the Samoan fire-getting apparatus.

The blunt-pointed stick is taken between the clasped hands, somewhat as one takes a pen, and projected forward from the body along the groove at the greatest frictional angle consistent with the forward motion which has been found to be from  $40^{\circ}$  to  $45^{\circ}$ . Kneeling on the stick the man forces the rubber forward, slowly at first, with a range of perhaps 6 inches, till the wood begins to be ground off and made to go into a little heap at the end of the groove; then he gradually accelerates the speed and moves with a shorter range until, when he pushes the stick with great velocity, the



FIG. 39.—FIRE-MAKING STICKS (a SHOWING GROOVE). CAT. No. 130675, U.S.N.M. SOMOA. DEPOSITED BY HAROLD M. SEWALL

<sup>45</sup> W. Powell. Wanderings in a Wild Country, p. 206.



brown dust ignites. This is allowed to glow and if it is required to be transferred to dry leaves or chips of wood it is done by means of a tinder made of frayed or worn tapa cloth.

The groove (fig. 39*a*) is the most characteristic feature of this apparatus, there being apparently no definite form of implements for this purpose. Fire is made on any billet of dry wood that is available. It is not necessary to cut a slot, or even a groove; the hardwood rubber will form one, so that there is no more need of apparatus than among the Navahos, where two bits of yucca stalk collected near by form the fire tools.

That making fire by this way is difficult to those inexperienced in it is not strange. Mr. Darwin found it quite so, but at last succeeded. The Samoan gets fire in 40 seconds, and so great is the friction and the wood so well adapted that Mr. Austin, before quoted, says it sometimes actually bursts into flame.

The Australians in some parts use a method very much like the one described. They rub a knife of wood along <sup>46</sup> a groove made in another stick previously filled with tinder.<sup>47</sup>

*Fire thong.*—While there is no apparent connection between the fire drill and the fire saw, plow, and thong, there is an approximation in method of operation among the three latter—that is, the fire saw and thong are in close relationship, the plow is related but stands farther away, while the drill is unrelated.

Henry Balfour has most successfully monographed the fire thong.<sup>48</sup> The method has been found in use in southeastern Asia and the Asiatic islands; in New Guinea; West Africa, and western Europe.

At first sight it would seem necessary to limit the fire thong method to the area of the distribution of the rattan, whose strong texture admits of the hard usage required in making fire. This is generally the case, as it is difficult in other parts of the world to supply the thong material. Some thongs of bark, however, or strips of flexible bamboo, are used in areas where the rattan does not occur.

Matthew W. Stirling, on his expedition to Central New Guinea in conjunction with the Dutch Government, found the fire thong in use among the Pygmies and the fringing Pygmy-Papuan tribes. Curiously enough he found the method employed in sawing down trees. This is quite suggestive of a way by which the fire thong may have been discovered.

The Battaks of the island of Palawan in the Philippines use the thong fire kindler. The thong of rattan is wound into a wristlet and worn till needed. The stick is cleft and held open by a bit of stone. M. W. Stirling brought from the hitherto unvisited Pygmies of New

<sup>46</sup> This is perhaps across the groove.

<sup>47</sup> R. Brough Smyth. *The Aborigines of Victoria*, vol. 1, p. 394. London, 1878.

<sup>48</sup> Frictional fire making with a flexible sawing thong. *Journ. Roy. Anthropol. Inst.*, vol. 44, January-June, 1914, pp. 32-64.

Guinea specimens of the thong apparatus identical with the Palawan set described and showing an interesting connection-survival. (Pl. 9, fig. 2, Cat. No. 326012; Mrs. E. Y. Miller; 11.5 in. (29.5 cm.).)

#### IV. PERCUSSION

1. *Flint and pyrites*.—The art of fire making by striking two stony substances together was begun in the far past, having originated in experiences connected with the working of stone. Since by striking flint against flint no live spark can be gotten to start a fire, it is necessary to infer that by striking two pieces of pyrites together or substituting for one piece a flint, a rather hot spark would be observed to follow the impact. The pyrites strike-a-light was found in use in a number of localities, which seems to indicate a survival of former usage, while in other localities pyrites was used with flint, this arrangement being more workmanlike, obviating the breaking of the fragile pyrites. This ancestor of the flint and steel was in use in the European neolithic age and remained current far into the iron age, being used on guns after the invention of gunpowder.

Presumably the neolithic equipment was a flint scraper, a lump of iron pyrites, tinder, and a bag to contain them. Many of the scrapers of the sort believed to have been those used in fire making are found in European neolithic deposits, but pyrites rarely, as it tends to decay rapidly. (Fig. 40a.)

The working of the flint and pyrites in fire making was different from that pursued with the flint and steel. The steel is struck on the edge of the flint with a sharp scraping blow, while the neolithic scraper was chopped on the surface of the pyrites somewhat as a scraper is ordinarily used, shown in Figure 40. The pyrites lump, therefore, being scraped around the sides assumed a cylindrical form. (See fig. 42.)

Dr. Thomas Wilson calls my attention to a discovery of a pyrites nodule by M. Gaillard, in a flint workshop on the island of Guiberon in Brittany. The piece bore traces of use. Doctor Wilson thinks that the curved flakes of flint like the one figured, found so numerous, were used with pyrites as strike-a-lights. The comparative rarity of pyrites is, perhaps, because it is easily decomposed and disintegrates in unfavorable situations in a short time, so that the absence of pyrites does not militate against the theory that it was used. A subcylindrical nodule of pyrites  $2\frac{1}{2}$  inches long and bruised at one end was found in the cave of Les Eyzies, in the Valley of Vézère, Perigord, mentioned in *Reliquae Aquitanicae* (p. 248). This is supposed to have been a strike-a-light.

Prof. W. B. Dawkins thinks that:

In all probability the cave man obtained fire by the friction of one piece of hard wood upon another, as is now the custom among many savage tribes. Sometimes, however, as in the Trou de Chaleux, quoted by M. Dupont (*Le Temps*

Prehistorique en Belgique, second edition, p. 153), he may have obtained a light by the friction of a bit of flint against a piece of iron pyrites, as is usual with the Eskimos of the present day.<sup>49</sup>

Professor Dawkins also says that fire was obtained in the bronze age by striking a flint flake against a piece of pyrites, sometimes found together in the tumuli. He figures a strike-a-light from Seven Barrows,

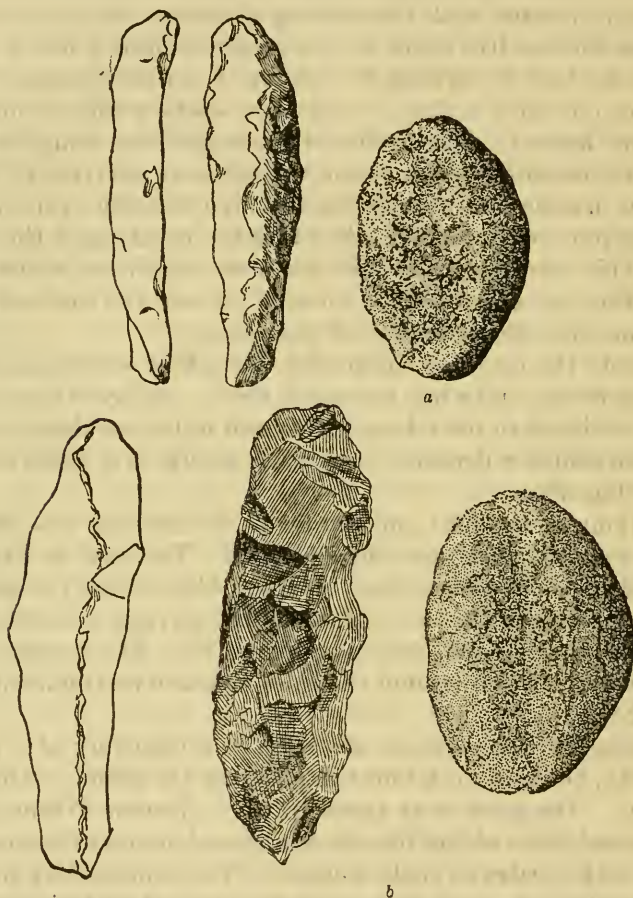


FIG. 40.—*a* STRIKE-A-LIGHT. SEVEN BARROWS, BERKS COUNTY, ENGLAND. FROM DAWKINS EARLY MAN IN BRITAIN, P. 358. (SEE DR. JOHN EVANS ANCIENT STONE IMPLEMENT, PP. 284, 288, FOR A SIMILAR FIGURE); *b* STRIKE-A-LIGHT. CAT. NO. 1861, U.S.N.M. INDIANS OF FORT SIMPSON, MACKENZIE RIVER DISTRICT, BRITISH COLUMBIA. COLLECTED BY B. R. ROSS

Lambourne, Berks, England, an outline of which is reproduced here for comparison with the one from Fort Simpson, British Columbia. (Fig. 40*a* and *b*.) Pyrites has been found in a kitchen midden at Ventnor, in connection with Roman pottery<sup>50</sup> Chambers's Encyclo-

<sup>49</sup> Early Man in Britain, p. 210. London.

<sup>50</sup> Idem, p. 258.



paedia, article, "Pyrites,"<sup>51</sup> is authority for the statement that pyrites was used in kindling powder in the pans of muskets before the gun flint was introduced.

It is thus seen that this art has a high antiquity and that on its ancient areas its use comes down nearly to the present day, the flint and steel being its modern or allied form.

In North America this art is distributed among the more northerly ranging Indian tribes and the Eskimo of some parts. Its use was and is yet quite prevalent among the Indians of the Athapascan (formerly Tinné) stock of the north. By specimens in the Museum and notes of explorers it is found to range from north of Dixon's Sound to Labrador, the following localities being represented: Stikine River, Sitka, Aleutian Islands, Kotzebue Sound, Point Barrow, the Mackenzie River district, at Fort Simpson, and probably Hershel Island, Pelly Bay, Melville Peninsula, Smith Sound, and Labrador. The Canadian and Algonquins strike two pieces of pyrites (*pierres de mine*) together over an eagle's thigh, dried with its down, and serving instead of tinder.<sup>52</sup> From other sources we know that the extinct Beothucs of Newfoundland did the same.<sup>53</sup>

As far as can be ascertained, the Eskimo and Indians both use the method, so that it is not characteristic of either, as the four-part drill is of the Eskimo, as contrasted with the simple rotation sticks of the Indians. A description of a flint and pyrites outfit, as at present used, will give a general idea of the status of the invention. In different localities the manipulation differs somewhat, as will be noted farther on.

The strike-a-light (No. 128405) was collected by Capt. E. P. Herendeen from natives who told him that it came from Cape Bathurst, hence he assigned the specimen to this locality on the evidence. John Murdoch has, with a great deal of probability, questioned this and thinks that it came from Herschel Island with the rest of Mr. Herendeen's collections and did not come from as far east as Cape Bathurst. While there is no improbability that this method is practiced at Cape Bathurst, yet the specimen has the appearance of the Mackenzie River strike-a-lights, hence it is deemed advisable to locate in the Mackenzie River district at Herschel Island.

The essential parts of the apparatus are a piece of pyrites, a piece of flint, and tinder. In the more northern parts of the Eskimo area tinder is made from the down from the stems and catkins of various species of dwarf arctic willows. At present the natives often soak the tinder in a strong solution of gunpowder and water to make it quick; an older way was to mix powdered charcoal with it. This

<sup>51</sup> Journ. Anthrop. Inst., Great Britain and Ireland, vol. 7, p. 83.

<sup>52</sup> Laftau. Moeurs des Sauvages Ameriquains, p. 272. An earlier account is found in Le Jeune, Relation de 1634, p. 24. Quebec, 1858.

<sup>53</sup> Journ. Anthrop. Inst., Great Britain and Ireland, vol. 5, p. 225.

plan is like the charring of the linen rags used in the old-fashioned tinder boxes of 40 years ago. The Eskimo then puts the tinder into a little round, flat pouch, with a flap in the middle. (Fig. 41, 1.)

The pyrites (fig. 42, 3) looks like a short pestle, to much of which appearance the repeated scraping has no doubt given rise. The upper end is concave, while the lower end has the original smooth surface of the concretion. Pyrite is found at Point Barrow in spherical masses of various sizes up to several pounds in weight. These spheres are nearly always cracked in two and scraped on the plane surface

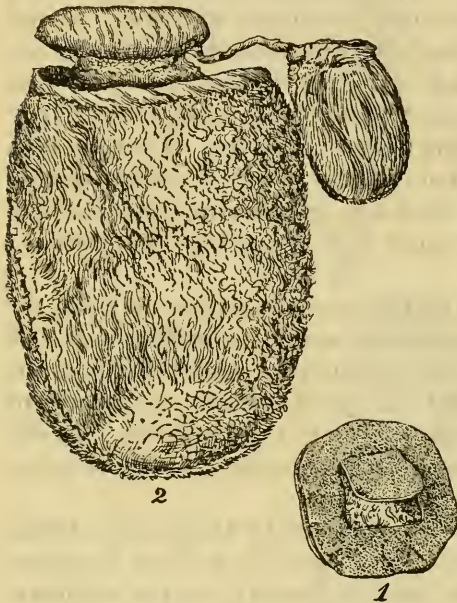


FIG. 41.—1. TINDER POCKET. 2. FIRE BAG.  
(PART OF STRIKE-A-LIGHT SET.) CAT. NO. 123405,  
U.S.N.M. MACKENZIE RIVER DISTRICT, BRITISH  
COLUMBIA. COLLECTED BY E. P. HERENDEEN

for very obvious reasons. This gives the shape seen in Fort Simpson and Long Barrows specimen. Mr. Murdoch says that the Eskimo think that pyrites comes down from above in meteors. They call it "fire-stone." A native related that in old times they did not use flint, but two pieces of pyrites, and got "big fire."

The flint (fig. 42, 4) is an oblong piece of chert, square at the base and rounded at the forward end. It is more elaborately made than the flakes so numerous in Europe, one of which was found with the piece of pyrites in the English Barrows. The Mackenzie River scraper is more like the curved ancient one. In most cases the flints used are not mounted in

a handle; this specimen, however, is fixed in a handle made of two pieces of wood held together by a thong of seal skin. (Fig. 42, 4a.)

The bag (fig. 41, 2) is made of reindeer skin. The little bag that hangs from the larger has a double use; it is a receptacle for reserve tinder, but its chief use is for a toggle; being passed under the belt it prevents the loss of the outfit, which is said to be carried by the women.

An oblong pad, stuffed with deer hair, is sewed to the mouth of the firebag to protect the hand from sparks and blows of the flint.

To get a spark, the Eskimo places (fig. 43) the piece of pyrites on the pad held in the left hand over the curved forefinger, the large end down and the thumb set in the cup-shaped cavity in the top. The flap of the tinder pocket is turned back and held on the forefinger under the protecting pad. The flint is held in the right hand and by a scraping motion little pieces of pyrites at a dull red heat fall down into the tinder. The pellet that glows is transferred to the pipe or fire, and the flap of the tinder pocket is turned down, serving to keep the tinder dry and to extinguish it if necessary.<sup>54</sup>

There comes in here appropriately a note of B. R. Ross on the burial customs of the Kutchin Indians of the eastern Athapascan stock. He says:

They bury with the dead a flint fastened to a stick, a stone to strike it on (pyrites) to make fire, and a piece of the fungus that grows on the birch tree for tinder and some touchwood also.<sup>55</sup>

There is no mention of this process of firemaking by the older writers of Greenland, Cranz and Egede, though they carefully note and describe the plan by wood boring. Later explorers going higher north in western Greenland have found it. Dr. Emil Bessels, writing about the Itah Eskimo of Smith Sound, says:

The catkins of the Arctic willow are used as tinder to catch the sparks which have been produced through the grinding of two pieces of stone.<sup>56</sup>

Dr. E. K. Kane gives a more complete account from nearly the same locality, the Arctic Highlands of northwest Greenland. He says that the Eskimo of Anootok struck fire from two stones, one a plain piece of angular milky quartz, held in the right hand, the other

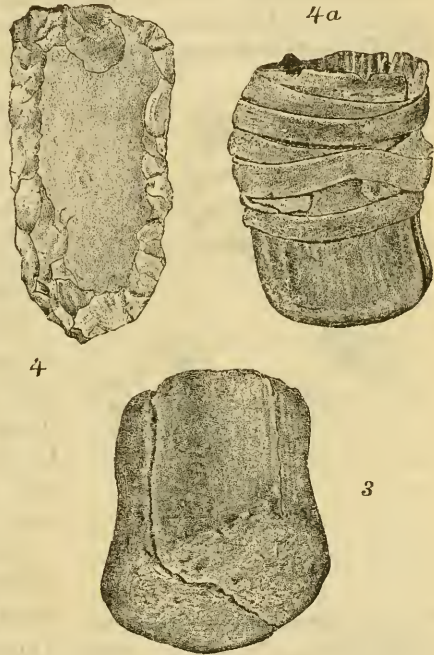


FIG. 42.—3. PYRITES. 4, 4a. FLINT STRIKER AND HANDLE. (PART OF STRIKE-A-LIGHT SET SHOWN IN FIG. 41.) CAT. NO. 128405, U.S.N.M. MACKENZIE RIVER DISTRICT, BRITISH COLUMBIA. COLLECTED BY E. P. HERENDEEN

<sup>54</sup> Extracted from an article by the author in Smithsonian Report, vol 2, 1888, pp. 181-184.

<sup>55</sup> Smithsonian Report for 1866, p. 326.

<sup>56</sup> Die amerikanische Nordpol-Expedition, p. 358. Leipzig, 1879.



apparently an oxide of iron [pyrites or iron ore?]. They were struck together after the true tinder-box fashion, throwing a scanty supply of sparks on a tinder composed of the silky down of the willow catkins (*Salix lanata*) which he held on a lump of dried moss.<sup>57</sup>

Very much farther west on Melville Peninsula Parry gives a complete and interesting description of the primitive way. This account gives us a link between the western and eastern Eskimo. He writes:

For the purpose of obtaining fire the Eskimo use two lumps of common pyrites, from which sparks are struck into a little leathern case (see fig. 25, pl. LXXIV) containing moss well dried and rubbed between the hands. If this tinder does not readily catch, a small quantity of the white floss of the seed of the ground willow is laid above the moss. As soon as a spark has caught it is gently blown till the fire has spread an inch around, when the pointed end of a piece of wick being applied, it soon bursts into a flame, the whole process having occupied perhaps two or three minutes.<sup>58</sup>



FIG. 43.—METHOD OF USING THE STRIKE-A-LIGHT. CAT. No. 128405, U.S.N.M. DRAWING BY W. H. BURGER

The Museum was in possession of a specimen catalogued, "Moss bag and lumps of pyrites used by Innuitt for getting fire," collected by Capt. C. F. Hall at Pelly Bay, in latitude 69°, longitude 90°, several degrees west of Melville Peninsula.

The only other record of the process under consideration among the Eskimo is found in the Aleutian Islands. There is absolutely no evidence had by the writer that the Eskimo south of Kotzebue Sound (western Eskimo)

use the pyrites and flint for making fire. The latest information about the Aleutian Islanders is given in a manuscript of the careful explorer, Lucien M. Turner. His observation will serve to explain the description of striking a light by earlier travelers.

They use the four part drill but they also use pyrites. A stone containing quartz and pyrites is struck against another similar one, or a beach pebble, into a mass of sea-bird down sprinkled with powdered sulphur. This ignites and is quickly caught on finely shredded blades of grass or beaten stalks of wild parsnips. This method prevails to this day on the islands west of Unalashka.

The people told Mr. Turner that this was the ancient way. There is a doubt in the writer's mind that Sauer's (Billing's Expedition, p. 59), and Campbell's (Voyage, p. 59,) observations, brought

<sup>57</sup> Arctic Explorations, vol. 1, p. 379.

<sup>58</sup> Second Voyage, p. 504. London, 1824.

together by Bancroft,<sup>59</sup> were accurate with regard to the stones used. All the other details are correct, but they say they took two pieces of quartz, rubbed them with sulphur, and struck them together. It is well known that pieces of quartz even when rubbed with sulphur will not strike a spark of sufficient heat to cause ignition. The pieces used must have been pyritiferous quartz as noticed by L. M. Turner.

To summarize, the following facts arise out of the foregoing considerations of the flint and pyrites method:

(1) It is very ancient, inferring from the few reliable finds of pyrites and flint in juxtaposition.

(2) Its distribution is among high northern tribes, both Eskimo and Indian.

(3) As far as known, its range is limited to this area, only one other instance coming to our notice, that of the Fuegians.

2. *Flint and steel*.—The flint and pyrites method is the ancestor of the flint and steel. The latter method came in with the iron age. It is found in the early settlements of that period. A steel for striking fire was found in the pile dwellings of the Ueberlingen See.<sup>60</sup> The Archeological Department of the Museum has a specimen of a strike-a-light of the early age of iron in Scandinavia. It is a flat, oval quartz stone with a groove around the edge; it is thought to be for holding a strap by which it could be held up and struck along the flat surface with the steel. It is scored on these surfaces. The specimen in the Smithsonian is from the national museum at Stockholm. In Egypt it is believed to have been used for a long period, though there is no data at hand to support the conclusion.<sup>61</sup> In China it has been in use for many centuries. Chinese history, however, goes back to the use of sticks of wood. The *briquet* must have been carried nearly everywhere by early commerce from the ancient countries around the Mediterranean, as it was into new lands by later commerce.

Many persons remember the tinder box that was taken from its warm nook beside the fireplace whenever a light was wanted; the matches tipped with sulphur used to start a blaze from the glowing tinder are also familiar to the older generation. The tinder boxes in use in this country were just like those in England from time immemorial down to 50 years ago. (Fig. 44.) Edward Lovett, of Croydon, England, who has studied this matter thoroughly, calls attention to the resemblance of the old English tinder flints to the neolithic scrapers. These scrapers, picked up at Brandon, can scarcely be discriminated from those made at the present time at that place, and there

<sup>59</sup> Native Races of the Pacific States, vol. 1, p. 91.

<sup>60</sup> Keller. Swiss Lake Dwellings, pl. 28, fig. 29.

<sup>61</sup> Sir J. W. Dawson gives an interesting account of the strike-a-light flints used in Egypt in 1844, in Modern Science in Bible Lands, p. 30.

is a suspicion that the present tinder flint has come down directly from neolithic times. The old English steel, or "flourish" (fig. 44) is the characteristic shape, and has been carried by English commerce into many places. A picture of a strike-a-light used by the Lenguas of Brazil seen lately, shows the unmistakable old "flourish."

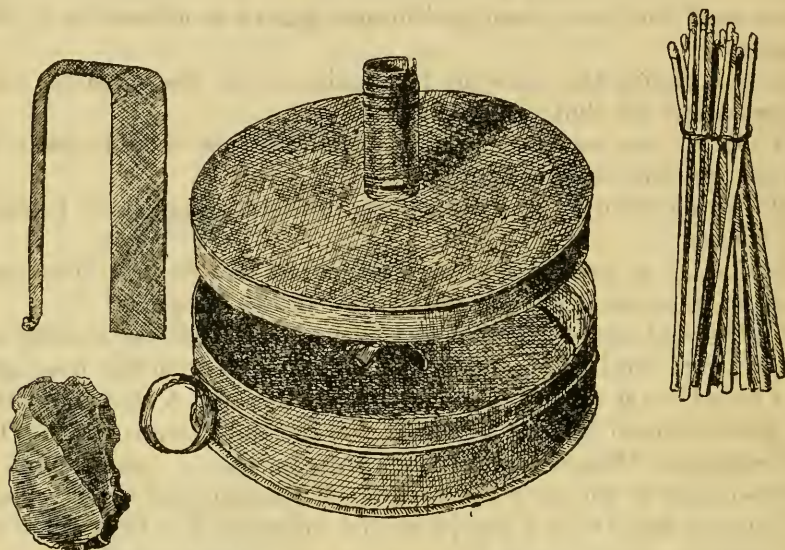


FIG. 44.—ENGLISH TINDER BOX (WITH FLINT, "FLOURISH," AND BUNDLE OF SPUNKS). CAT. NO. 75516, U.S.N.M. ENGLAND. COLLECTED BY LOUIS AND MAURICE FARMER

The tinder boxes had also a damper to extinguish the tinder of burnt linen and to keep it dry. The lids were furnished often with a candle socket. This feature, says Mr. Lovett, has led to their preservation as candlesticks long after they were superseded by matches.

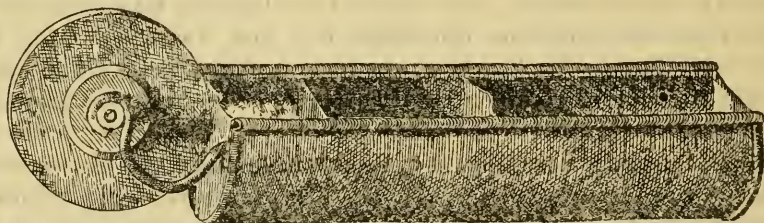


FIG. 45.—WHEEL TINDER BOX. CAT. NO. 130431, U.S.N.M. BROADALBIN, N. Y. PRESENTED BY F. S. HAWLEY

Many devices were invented in order to improve on the crude way of holding the flint and steel in the hands to strike the spark into the tinder box. One of these was the wheel tinder box. (Fig. 45.) The compartment near the wheel held the tinder. The flint was placed in a socket on the sliding lid and the wheel was turned by unwinding



a string from off its axle with a sharp pull as in spinning a top. The flint was pressed against the rapidly revolving wheel, and a shower of sparks fell into the tinder. The tinder pistol, whose name suggests its use, was another device.<sup>62</sup>

Other devices were intended to be carried in the pocket and were probably brought out by the introduction of tobacco and the need of smokers for a convenient light.

The pocket strike-a-light is still used. The one shown (fig. 46) was bought in 1888 by E. Lovett, at Boulogne-sur-Mer. They are still used by the peasants and workpeople of France. An old specimen in the Museum of this character is from Lima, Peru. The roll of tinder, or "match," is made of the felt lining of an ant's nest (*Polyrachus bispinosus*).

Among many of our North American tribes the flint and steel superseded the wooden drills as effectually as did the iron points the stone arrowheads.

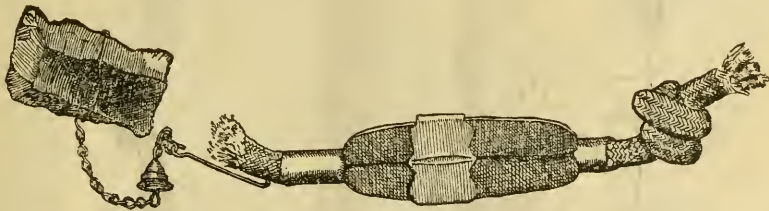


FIG. 46.—STRIKE-A-LIGHT (BRIQUET). (CAT. NO. 129693, U.S.N.M. BOULOGNE-SUR-MER. FRANCE. COLLECTED BY EDWARD LOVETT)

Some of these tribes were ripe for the introduction of many modern contrivances. Civilized methods of fire lighting appealed to them at once. Among the Chukchis, Nordenskiöld says, matches had the honor of being the first of the inventions of the civilized races that have been recognized as superior to their own.<sup>63</sup> It was so among our Indian tribes; the Mandan chief "Four Bears" lighted his pipe by means of a flint and steel taken from his pouch when George Catlin visited him in 1832.<sup>64</sup>

The Otoes (Siouan stock) made use of the flint and steel shown in Figure 47. The flint is a chipped piece of gray chert, probably an ancient implement picked up from the surface.

The steel is a very neatly made oval, resembling those of the Albanian strike-a-lights,<sup>65</sup> or the Koordish pattern. (Fig. 52.) Here arises one of the perplexities of modern intercourse; perhaps both of these steels were derived from the same commercial center.

<sup>62</sup> See figure in D. Bruce Peebles's address on Illumination, in Trans. Roy. Scottish Society of Arts Edinburgh. vol. 12, pt. 1, p. 96.

<sup>63</sup> Voyage of the *Vega*, vol. 2, p. 122.

<sup>64</sup> The George Catlin Indian Gallery. Smithsonian Report for 1885, vol. 2, p. 456

<sup>65</sup> See figure in Journ. Anthrop. Inst., Great Britain, vol. 16, 1886, p. 67.

The flint, steel, and tinder were always carried in a pouch, usually suspended from a belt as in specimen No. 8481 from the Assiniboins (Siouan stock) of Dakota. This is a buckskin waist belt, beaded and fringed, ornamented with bells of tin. It supports a flapped pouch for the flint, etc. The tinder used was fungus.

The pouch of the Cheyennes (Algonquian stock) is compact, and neatly made of leather. (Fig. 48.) The equipment is complete and of a superior order. The bone cup is used to hold the tinder while striking a spark into it. It is the tinder horn of early days, a cow's horn which was used to hold tinder before sheet-iron boxes came into

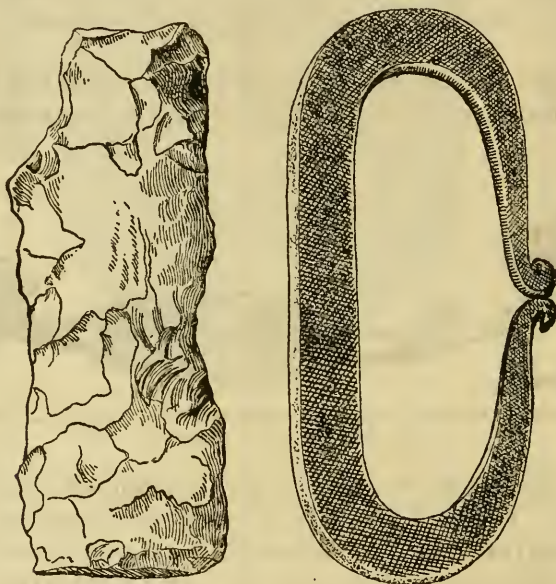


FIG. 47.—FLINT AND STEEL. CAT. NO. 22431, U.S.N.M. OTOIE INDIANS, KANSAS AND NEBRASKA. COLLECTED BY J. W. GRIEST

use. The Lenguas of Brazil use a horn for the same purpose.<sup>66</sup> In the Aino set (fig. 54) can be seen this feature. The tinder with this set is rotten wood. Nearly all Indians know the value of fungus tinder.

The Comanche Indian strike-a-light is a similar pouch to the one described, but much poorer in equipment. (Fig. 49.) A broken rasp, a piece of chert, and a piece of spunk is enough for the purpose, and a bag made from a saddle skirt to hold them completes the outfit.

The flint and steel is still used nearly all over Mexico, Doctor Palmer informs me. There is at present a manufacture of gun and strike-a-light flints at Brandon, England, whence they are shipped to Spain, Mexico, Italy, and other civilized countries. Doubtless this

<sup>66</sup> See figure in *Jahrbuch Mittelschweiz. Commercial. Gesellsch.* Arau, vol. 2, 1883, pp. 114-115.



flint from Guadalajara (fig. 50) came from Brandon. It is real calcareous flint, such as does not exist in this country. The steel is the "swallowtail" pattern. The tinder is of prepared fungus sold in little packets.

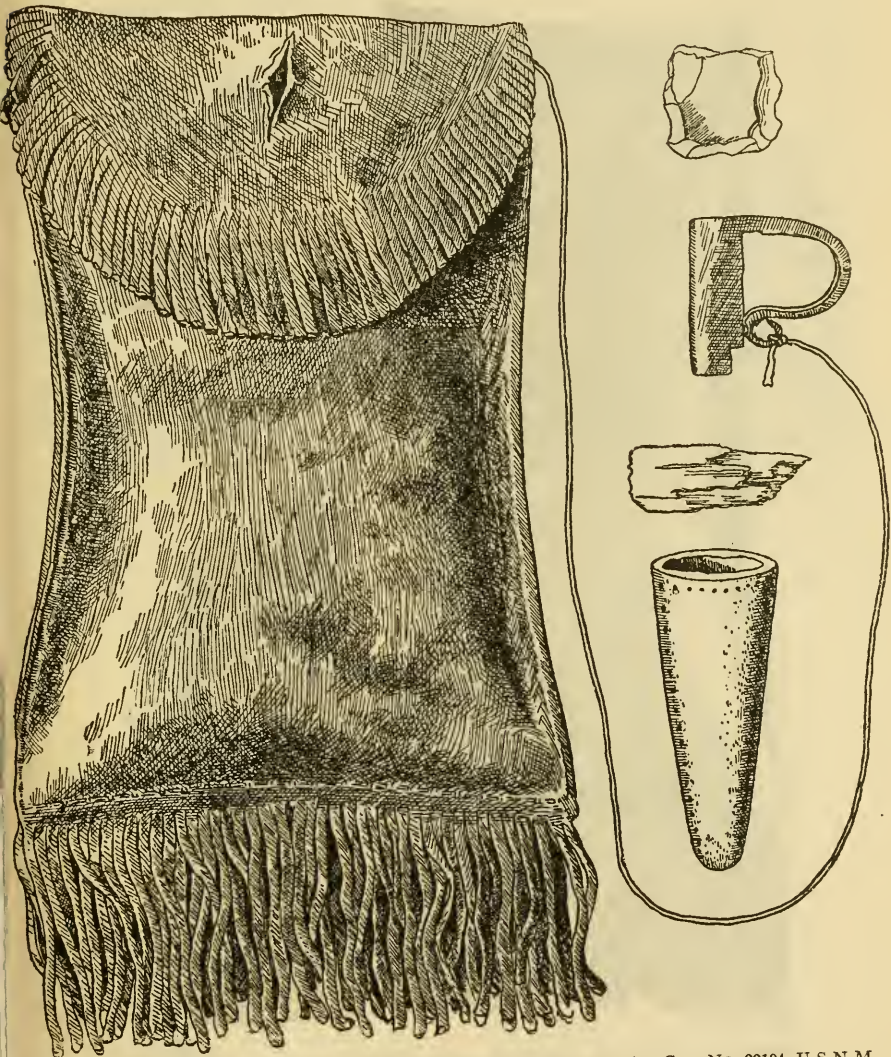


FIG. 48.—STRIKE-A-LIGHT (FLINT, STEEL, TINDER HORN, SPUNK, AND POUCH). CAT. NO. 22104, U.S.N.M. CHEYENNE INDIANS, ARKANSAS. COLLECTED BY DR. J. H. BARRY

The Koords of Bhotan, eastern Turkey, carry a pipe pouch containing besides flint, steel, and tinder, a pipe pick and a pair of pincers, to transfer the lighted tinder to the pipe. (Fig. 52.) The tinder is prepared from a fungus, probably a species of *polyporus*. The



steel, shaped like an old-fashioned bell pull, is a very good form for holding in the hand.

The Chinese strike-a-light is the customary appendage to the pipe pouch. It is a very ingenious way for combining the steel with a

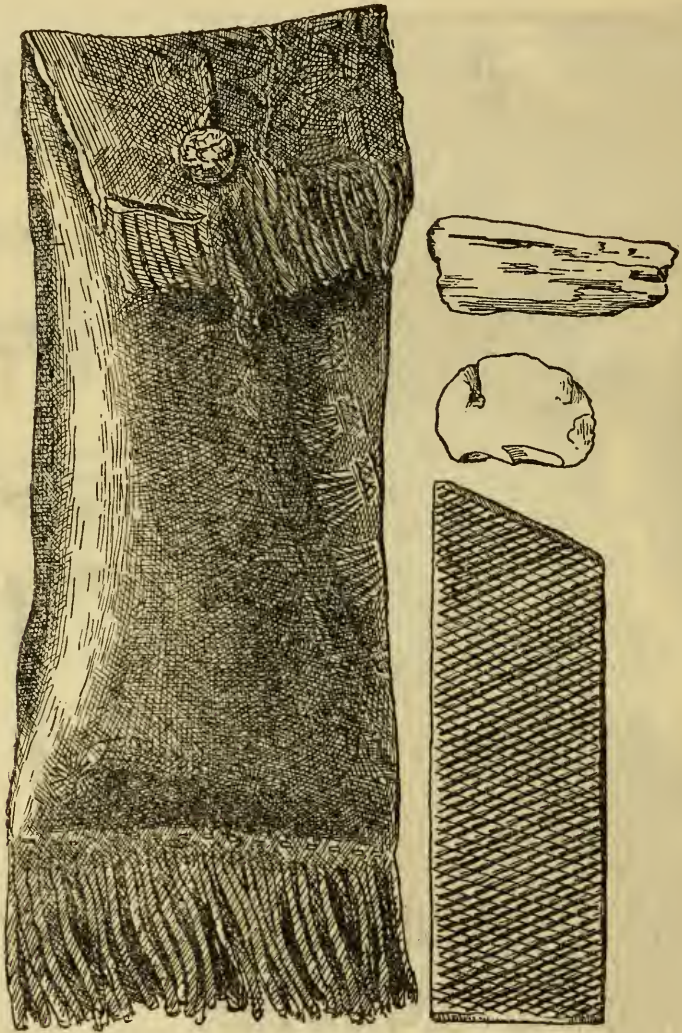


FIG. 49.—STRIKE-A-LIGHT. (POUCH FOR HOLDING FLINT AND STEEL.) CAT. No. 6972, U.S.N.M. COMANCHE INDIANS, TEXAS. COLLECTED BY EDWARD PALMER

pouch in which to keep the flint and tinder. (Fig. 51.) In Tibet they are made very large and are finely decorated. One owned by Mr. W. W. Rockhill has a curving steel between 5 and 6 inches long, finely carved. The pouch was trimmed with encrusted silver set with jewels.

The Ainos of Japan use flint and steel for striking a light, this method having supplanted the generation of fire by sticks (p. 26.) This outfit shown (fig. 54) is complete. The shoe-shaped steel

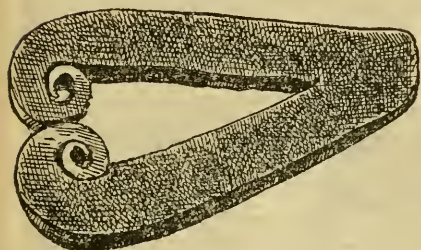
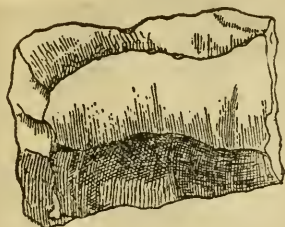


FIG. 50.—FLINT AND STEEL. CAT. No. 126576, U.S.N.M. GUADALAJARA, INDIANS, MEXICO. COLLECTED BY EDWARD PALMER

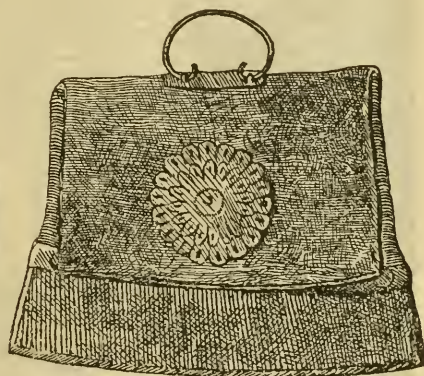


FIG. 51.—STRIKE-A-LIGHT. CAT. No. 130311, U.S.N.M. CHINA. GIFT OF GEORGE G. FRYER

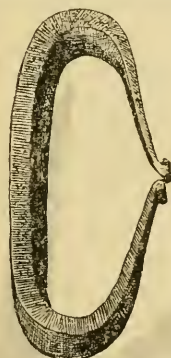
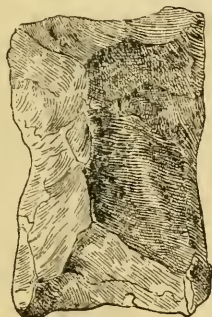
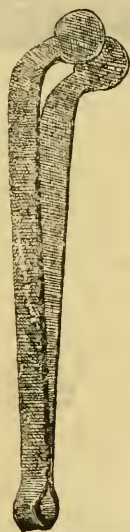
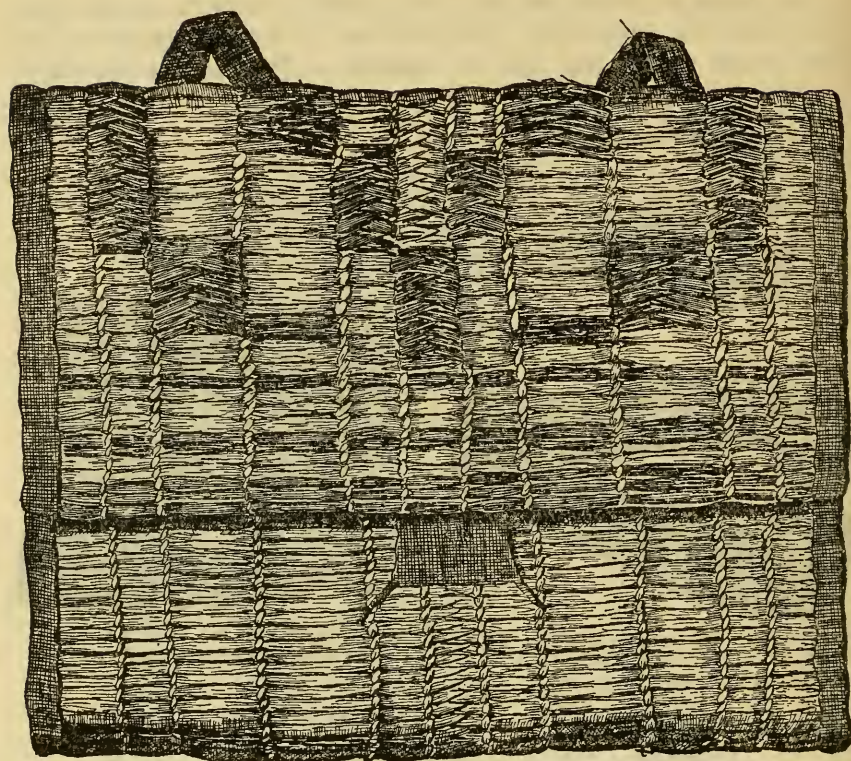


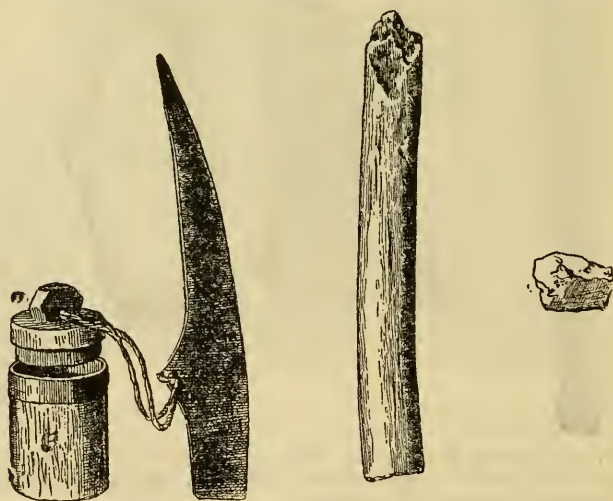
FIG. 52.—SMOKERS' PIPE-LIGHTING OUTFIT SHOWING FLINT, STEEL, PIPE PICK, AND PINCERS). CAT. No. 130607, U.S.N.M. KOORDS OF BHOTAN, EASTERN TURKEY. COLLECTED BY REV. A. N. ANDRUS.

is attached by a piece of sinew to the cork of a small wooden bottle containing the soft charcoal used as tinder. The flint is a small piece of ferruginous silex. With this set is a piece of stick which





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FIGS. 53-54.—53, RUSH FIRE SET POUCH. 54, STRIKE-A-LIGHT. FLINT, STEEL, AND TINDER BOX. CAT. No 22257, U.S.N.M. AINOS OF YEZO, JAPAN. COLLECTED BY B. S. LYMAN



retains fire for a long time. It is the root of the *Ulmus campestris*, or *laevis*, formerly used for the fire drill, but has come into a secondary place since the introduction of the flint and steel.

To strike a light the Aino takes out the cork with the steel attached and stirs up the tinder with the sharp point. He then holds up the flint in his hand over the box and strikes a spark down into it. He then transfers the coal to his pipe, or material for fire, or fire stick, with the point of the steel. These articles are kept in a rush pouch of twined weaving. (Fig. 53.) A much ruder pouch of fishskin is in the Museum.

The Japanese tinder box has two compartments, one with a damper for the tinder and the other larger one for the flint and steel. This box is a familiar object in Japanese kitchens. The mounting of the steel in wood is an improvement on holding it between the fingers. (Fig. 55.) No one, it seems, ever thought of so mounting the steel in western countries. The matches are broad shavings tipped at both ends with sulphur, and are the Japanese rendering of the "spunks" used with our tinder box.

Smokers in Japan carry a very small strike-a-light. (Fig. 56.) The cloth pouch with a long flap that can be rolled around several times and tied contains the three essentials, flint, steel, and tinder, the latter of burnt cotton.

3. *On bamboo*—Under percussion is classed the bamboo and porcelain strike-a-light first described by Sir Alfred Russell Wallace as used by the natives of Ternate, Malay Archipelago. Sir Alfred remarks that the Ternate people make great use of bamboo in their daily life and describes a particular method by which fire is struck from the flinty surface of the bamboo with a small piece of broken china, producing a spark which is caught on tinder. This apparatus vies with the fire piston as fire-making curiosities. Necessarily the method is confined to the bamboo area strictly, but has never been found in the Western Hemisphere. The bamboo selected and from which the specimens in the United States National Museum are made has a rough surface layer feeling like fine sandpaper. This coating is in the form of a flinty layer about one-half millimeter thick which is chipped away in small bits under the stroke of the china. The material of the layer is probably a combination of silica with some organic substance rendering it capable of taking up the force of the blow and converting it into heat sufficient to ignite tinder. The specimens in the Museum consist of a joint of bamboo or cane, a tinder box of bamboo with cap lid, and hooped with braided rattan. A cord passes through holes at the bottom, through holes in the cap, and forms a loop to pass around the bamboo joint. Some of the Battak tinder boxes are decorated with incised patterns. The Battak specimens usually have two tinder boxes.

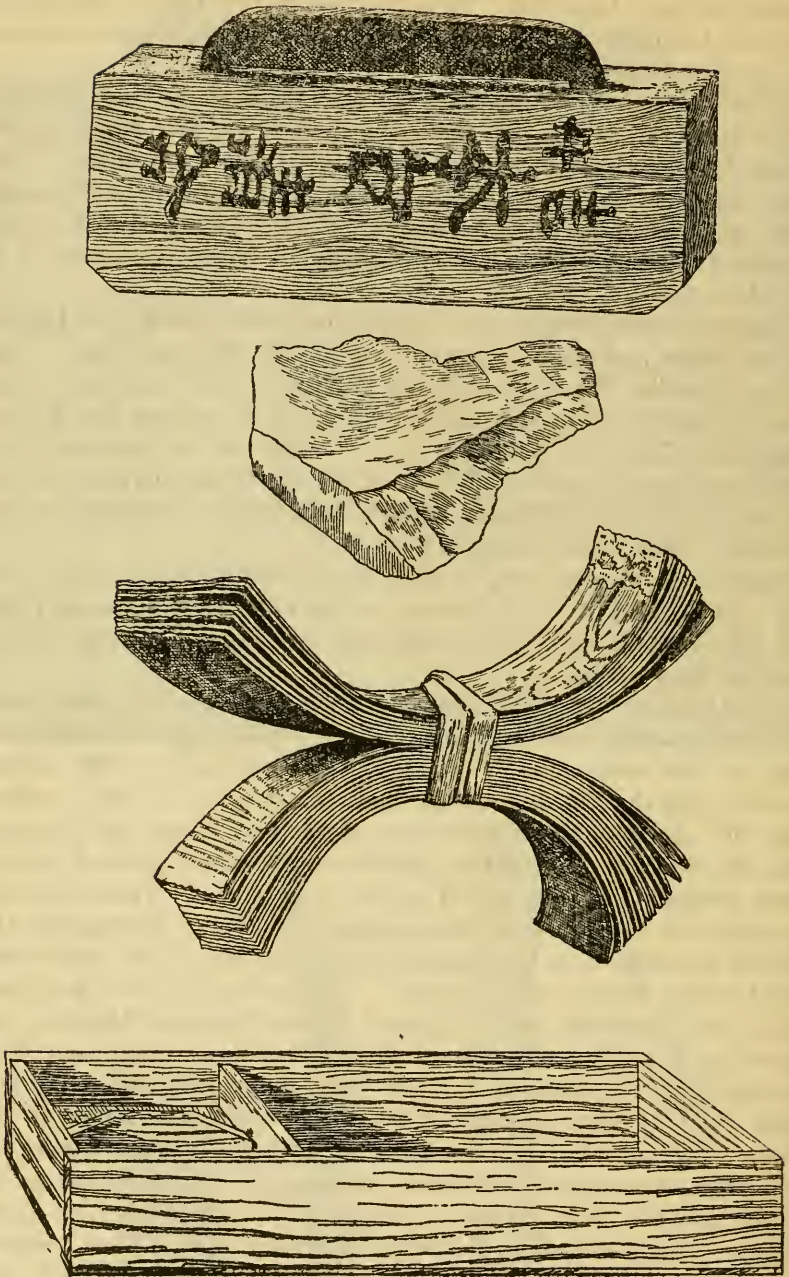


FIG. 55.—TINDER BOX (SHOWING MOUNTED STEEL, FLINT, AND BUNDLE OF SHAVING MATCHES; BOX ONE-THIRD NATURAL SIZE). CAT. No. 127137, U.S.N.M. JAPAN. GIFT OF THE JAPANESE DEPARTMENT OF EDUCATION, TOKIO

The specimens are as follows:

Cat. No. 326011, a set from the Battaks of Palawan, collected by Capt. E. Y. Miller. The bamboo tube is 14 inches long (35.5 cm.), three-fourths inch deep (2 cm.); the boxes are  $5\frac{1}{4}$  inches long (13.5 cm. and 3.1 inches deep (5.25 cm.). (Pl. 10, fig. 1.) One of the boxes contains tinder and a bit of flint. Cat. No. 326012, Battaks, Palawan, P. I. Mrs. F. G. Miller has a bamboo tube 17.6 inches long (44.5 cm.), 1 inch deep (2.6 cm.). One tinder box is 5.5 inches long (14 cm.) and 1.7 inches deep (4.5 cm.).

The box contains tinder and a piece of flint. (Pl. 10, fig. 4.) Cat. No. 232283, Malays of Balabac, an island south of Palawan, P. I.; collected by Capt. E. Y. Miller. Captain Miller has two tinder boxes not matched as to size. The bamboo tube is 17.45 inches long (44 cm.), 1.1 inches deep (2.5 cm.). The larger tinder box is 7 inches long (18 cm.), 2.4 inches deep (6 cm.). (Pl. 10, fig. 2.) The tinder is brown and appears to be the scurf of a palm. The striker is a gunflint. Two well-decorated tinder boxes brought from Palawan by Captain Miller are Figure 3, Plate 10, and measure 5.5 inches long (14 cm.), 2.4 inches deep (6 cm.); 5.5 inches long (14 cm.), 2 inches deep (5 cm.), Cat. No. 326013.

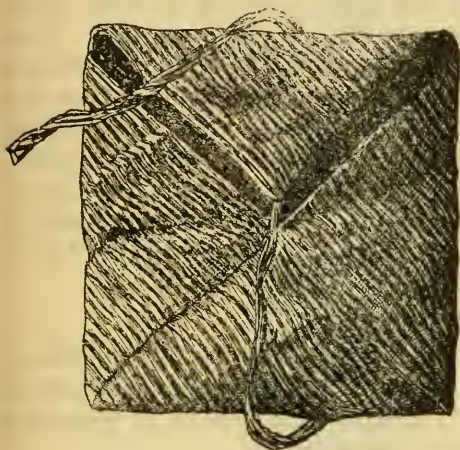


FIG. 56.—SMOKERS' STRIKE-A-LIGHT. CAT. NO. 128133, U.S.N.M. TOKIO, JAPAN. GIFT OF THE JAPANESE DEPARTMENT OF EDUCATION

Plate 9, Figures 1, 3, show boxes open exposing tinder.

Above Figure 3 is a pistol flint found in one of the boxes. Ordinarily a bit of broken dish is employed, since flint is not local in a vast Pacific area.

There is evidence that the bamboo strike-a-light had a considerable range in Malaysia, and notices of it have come from Cochin China, southern Philippines, Ternate, and Waigiou, an island off the north-west point of New Guinea, all on a line running southeast from Cochin China.



## V. BY COMPRESSION OF AIR

The fire syringe, as it is called, consists of a piston and plunger. Generally the piston is a smooth circular canal drilled in hardwood or horn. The plunger fits the cavity with exactness. In practice a bit of tinder is placed in a slight cavity at the end of the plunger; the latter is set in the orifice and driven down with a sharp blow. Quickly withdrawing the plunger the tinder is found alight.

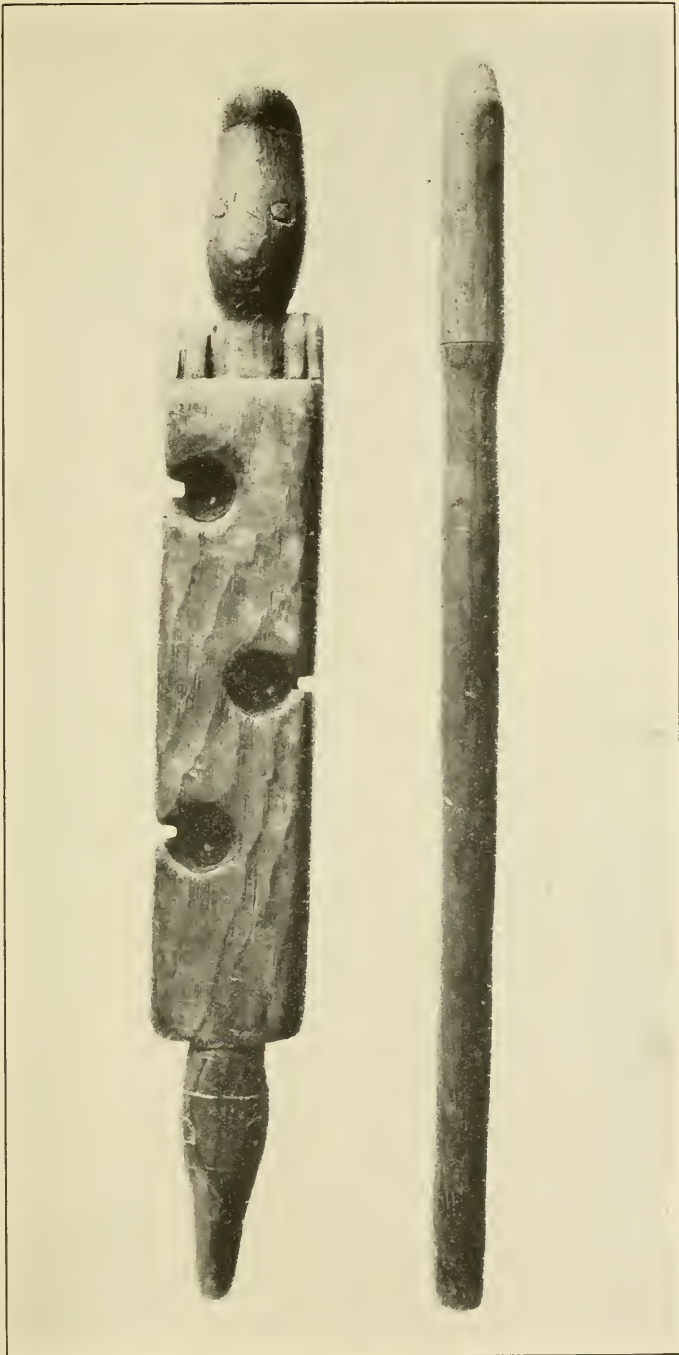
The principle is that in being compressed to a smaller volume air gives up heat. In the case of the fire syringe this is enough to ignite tinder. This is a method which has been employed by many tribes of men in Malaysia, and it appears to be a native invention. Plate 11 shows three specimens from various parts of the Philippines, Figures 1, 3, and 4, Cat. No. 235261, Mindoro, Philippine Commission; 5 inches long (12.5 cm.); Cat. No. 215659, Luzon, Dr. Charles E. Woodruff, United States Army,  $3\frac{1}{2}$  inches long (10.75 cm.); Cat. No. 216736, Luzon, Col. F. F. Hilder, 5 inches long (13 cm.). Figure 2 is of horn, Cat. No. 176007, Lower Siam, Dr. W. L. Abbott, 3.5 inches long (9 cm.). Figure 5 is of hard palm. Cat. No. 175270, Java, M. F. Savage,  $8\frac{1}{2}$  inches long (21 cm.).

## VI. TINDER

It is no doubt true that acquaintance with tinderlike substances was forced on man by the behavior of the camp fire in consuming at different rates such material. Tinder is also implied in preparing and arranging the fuel for starting a new fire.

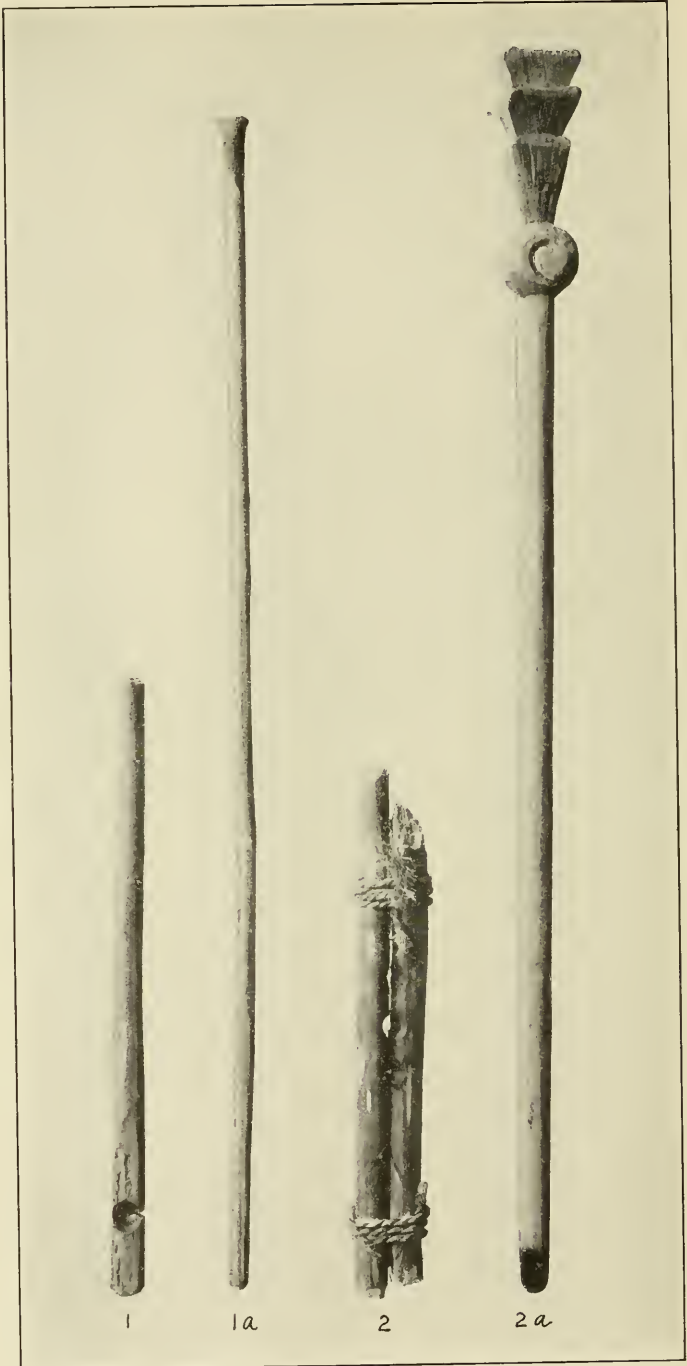
From these considerations it seems probable that this feature involved in the invention of the fire drill had been prepared in a measure long previously.

The collection of tinder in the Museum is almost exclusively of vegetal substances, but in many cases these have been improved by the addition of charcoal, gunpowder, and niter. Animal substances are necessarily rare and so far as observed consist of the down of birds and the nest lining spun by an ant (*Polyrachis bispinosus*), the latter from South America. Vegetal substances used as tinder are classified as follows: (a) Bark, especially the outside spent layers of trees with stringy bark in the first stages of decay; (b) scrapings of inflammable wood; (c) scurf down from leaves and about the flowering areas of certain plants; (d) downy catkins or down from seed heads out of bloom; (e) dry leaves rubbed fine or grass treated in the same manner; (f) rotten wood also used for retaining fire; (g) fungi, either natural as in the sheet fungi or worked into condition for use as by boiling in solution of potassium nitrate or saltpeter; (h) imperfectly charred cotton or linen cloth or thick, soft cords impregnated with a chemical. The Chinese use soft paper prepared in a similar manner. The Japanese so far as known are unique in using mixed tinder composed of several of the substances mentioned above.



SOUTHERN TLINKIT DRILL

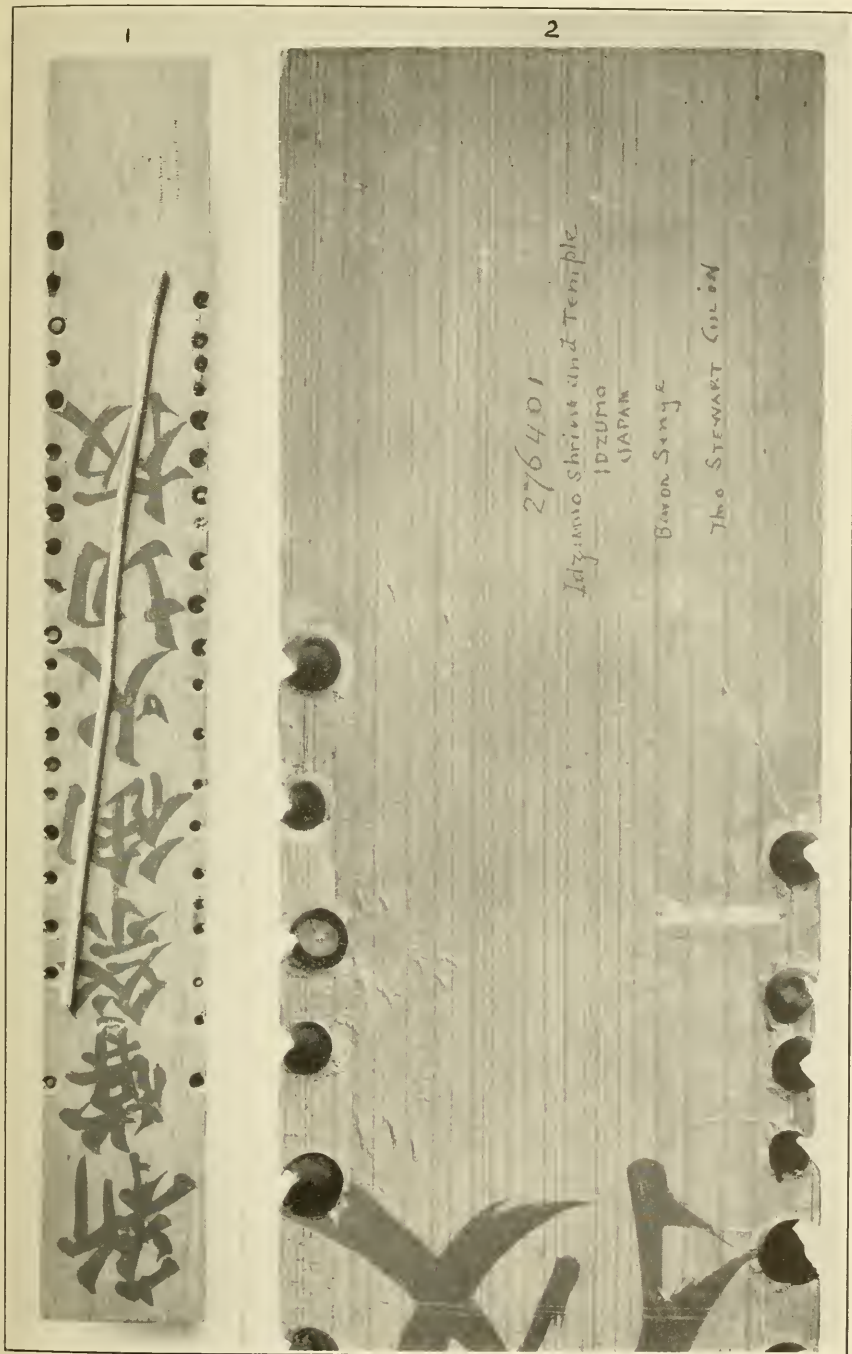
FOR DESCRIPTION OF PLATE SEE PAGE 11



BRITISH GUIANA, WEST INDIAN, AND MEXICAN DRILLS

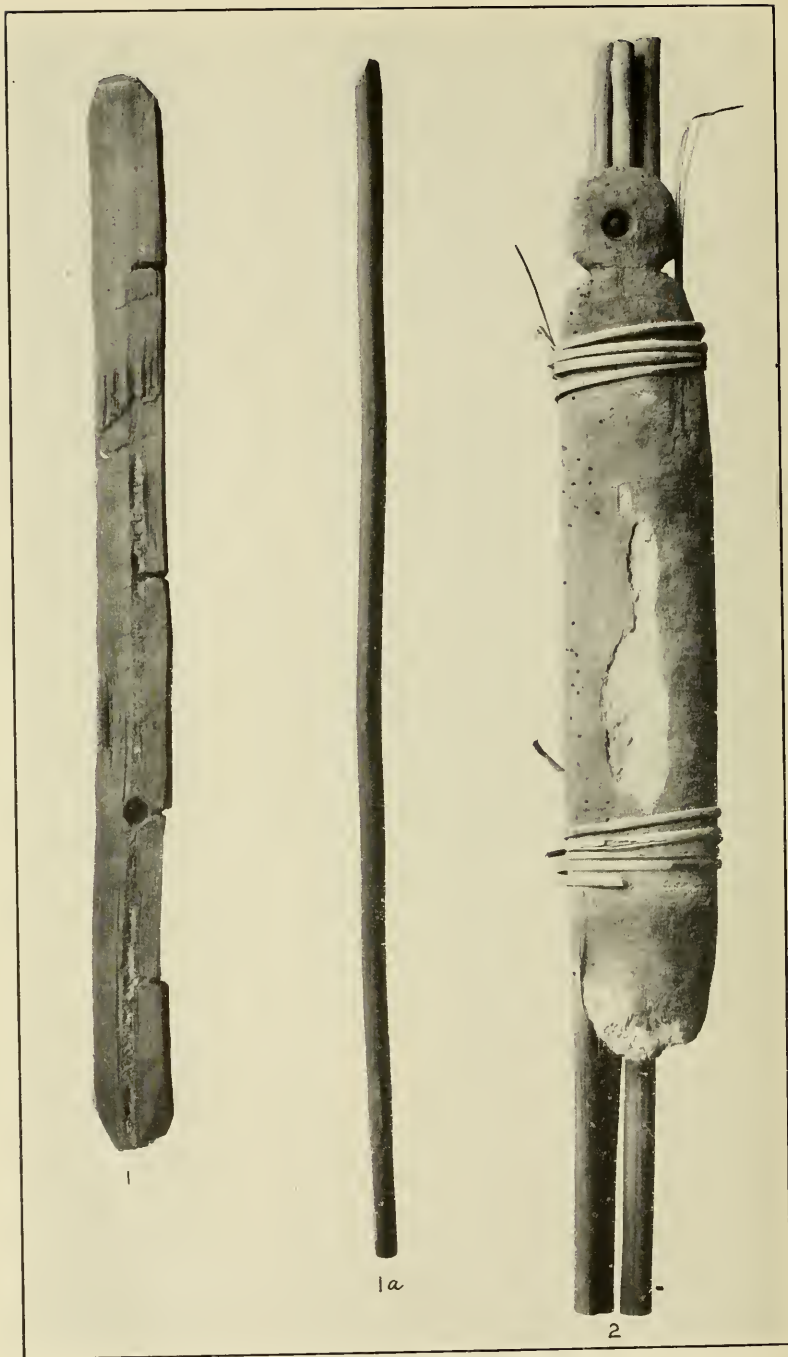
FOR DESCRIPTION OF PLATE SEE PAGES 21, 22, AND 25





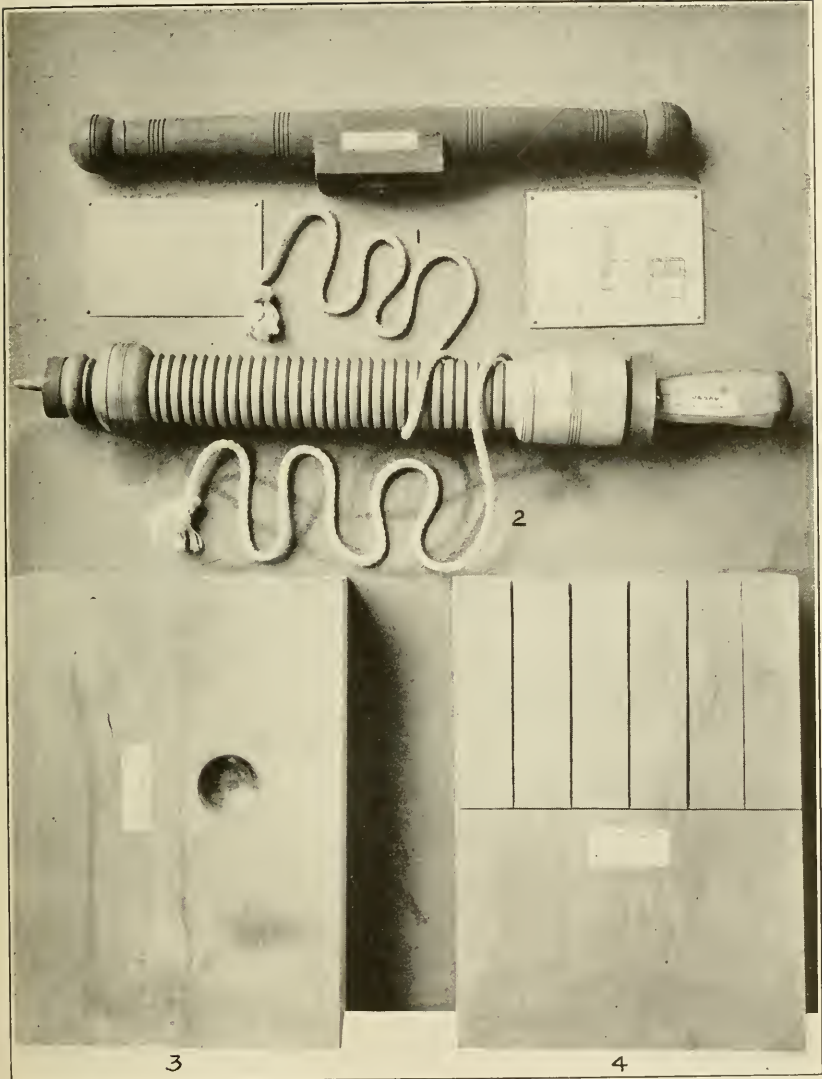
JAPANESE SACRED FIRE DRILL, FULL VIEW AND SECTION

FOR DESCRIPTION OF PLATE SEE PAGE 27



BHILS, INDIA, AND AUSTRALIAN DRILLS

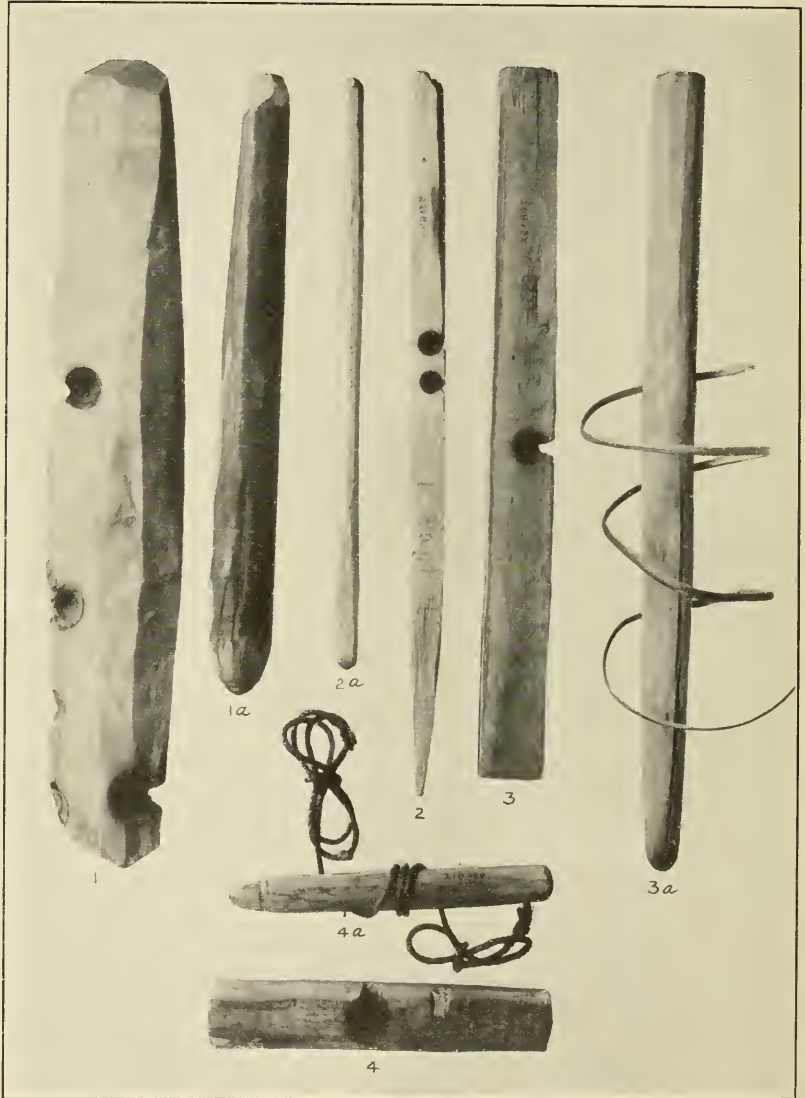
FOR DESCRIPTION OF PLATE SEE PAGE 28 AND 32



HINDU SACRED FIRE DRILL (REPLICA)

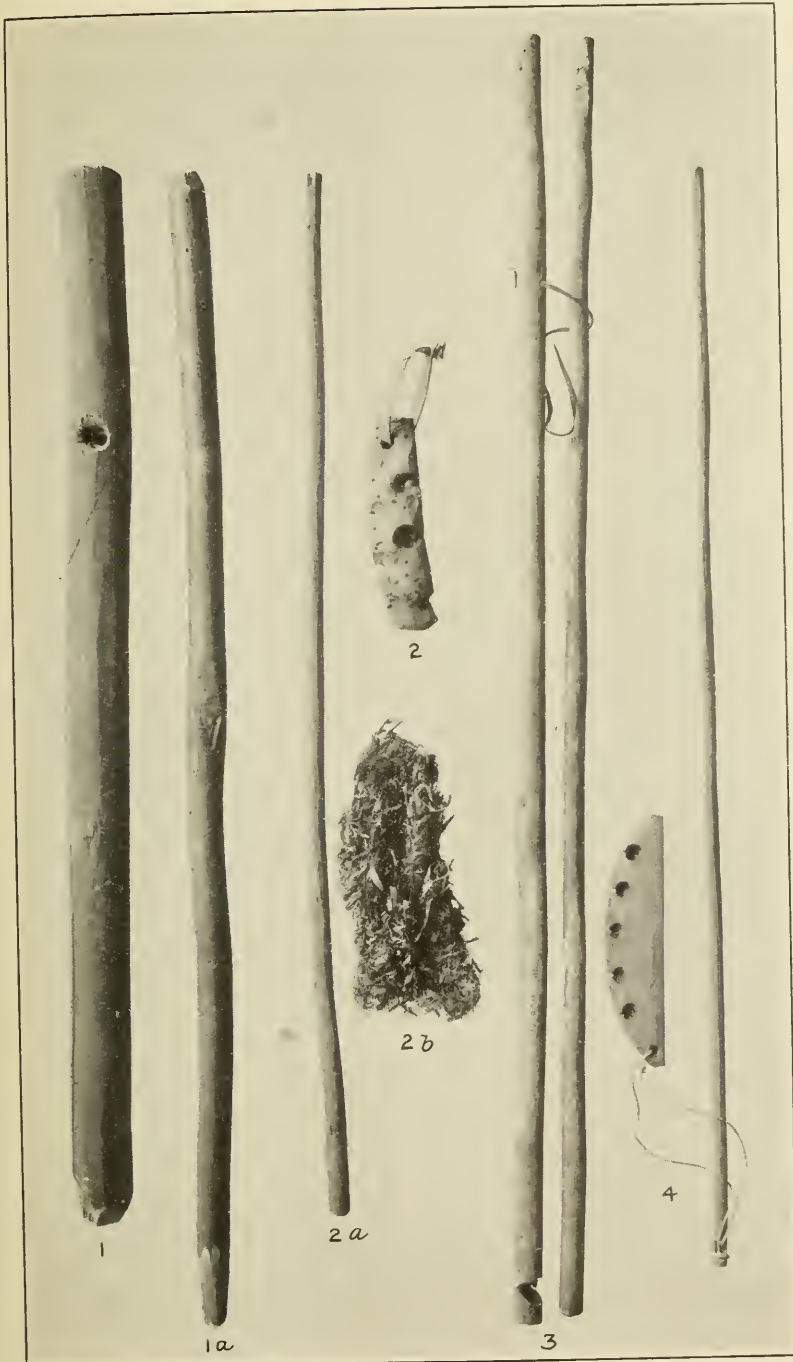
FOR DESCRIPTION OF PLATE SEE PAGE 29





EAST INDIAN FIRE DRILLS

FOR DESCRIPTION OF PLATE SEE PAGE 30



AFRICAN FIRE DRILLS

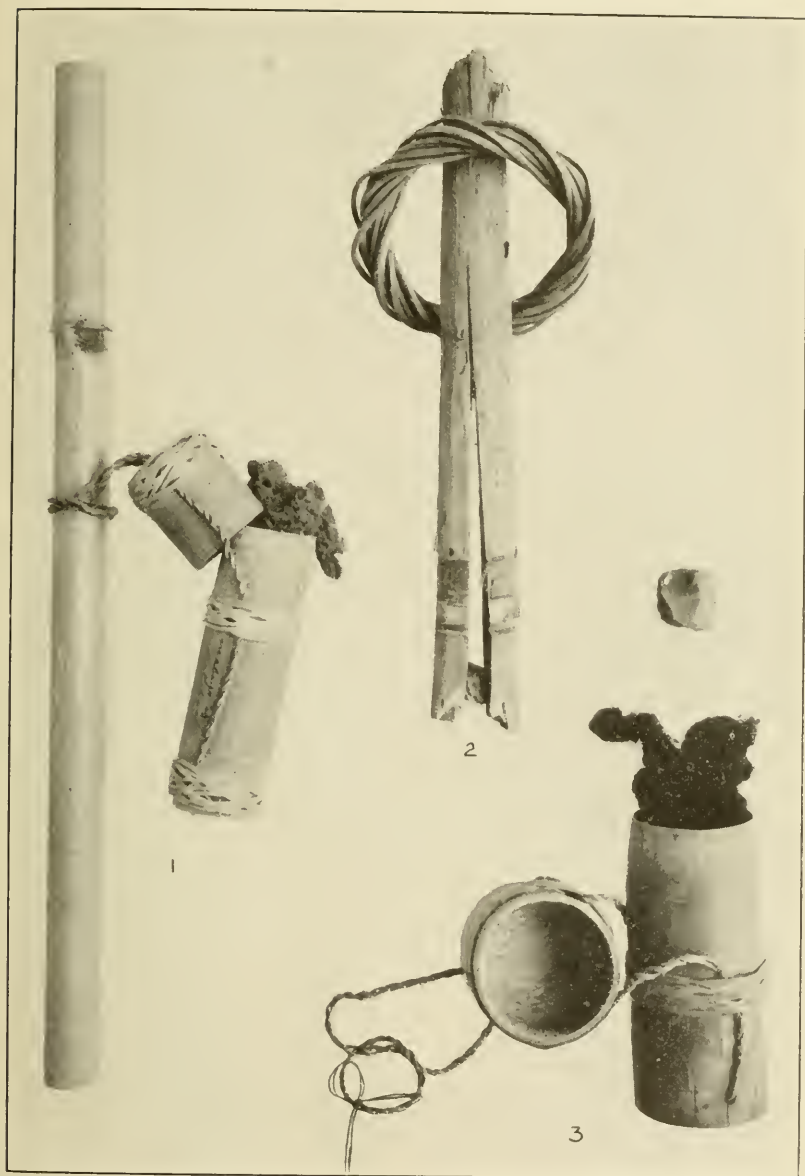
FOR DESCRIPTION OF PLATE SEE PAGE 31



BAMBOO FIRE SAW, PHILIPPINES

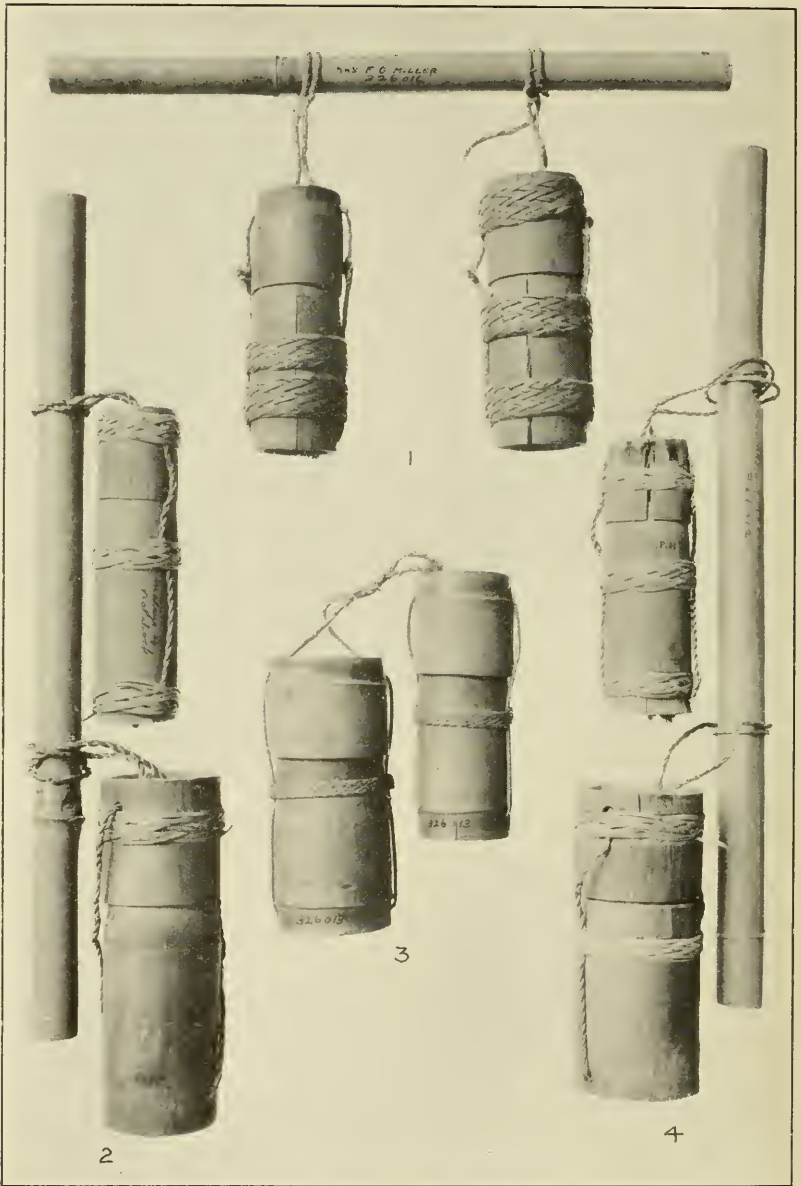
FOR DESCRIPTION OF PLATE SEE PAGE 52





BAMBOO STRIKE-A-LIGHTS AND BATTAK (NEGRITO) FIRE THONG

FOR DESCRIPTION OF PLATE SEE PAGES 30, 55, 71



BAMBOO STRIKE-A-LIGHTS, MALAYSIA

FOR DESCRIPTION OF PLATE SEE PAGE 71



FIRE PISTONS, MALAYSIA

FOR DESCRIPTION OF PLATE SEE PAGE 72