Anchorage of New York's Skyscrapers Involves Marvels of Excavation

Manhattan's Steel Bound Burden Is Fastened Securely to the Island's Backbone by Remarkable Modern Methods of Burrowing Which Displace Annually an Almost Incredible Amount of Soil and Rock.

BY G. E. PHILLIPS.

AN old, white-haired country preacher from a little hill town in West Virginia came to New York a few weeks ago, and crossing the Hudson as the setting sun smote the mighty massed array of upbuilded New York he leaned on the rail of the ferryboat for a few minutes in silence, then he turned to the crowd of those who hurry to and fro—seeing, or rather failing to see, this splendid spectacle every day—and he said solemnly:

"God made man, and man made New York. Glory be to God." And the listeners smiled and nudged each other. Yet, how stupendous is the marvel which all of us have had a share in creating; few of us ever stop to think—resting content in a mild pride and faintly pleased when some one remarks bromidically: "It certainly is a great city." Little is known, however, of the magnitude of what lies underneath these miles of towering piles—the Titanic nature of the hidden structural work.

In the last twenty years, taking no reckoning of the work before that time and excluding subway and dock work, permits have been issued by the Buildings Department for excavations to the extent of 12,421,560,780 cubic feet. Enough earth and rock has been excavated in the city of New York to cover the entire state with a half-inch layer.

A NETWORK OF HOLES.

The result is that as ship-worms burrow into the planking of a wooden ship so the builders of New York have burrowed into the rocky back of Manhattan Island and have anchored their structures there, excavating great holes that have pitted the island from end to end. Should a grave catastrophe occur some time—should Gotham meet the ultimate fate of every great city since the world began, and even the mighty works of stone and steel perish, as stone and steel can and do perish, then some band of exploring scientists happening on the spot fifty thousand years hence, will find a queer puzzle awaiting them—the huge holes and tunnels, miles and miles of great square pits—we "prehistoric" men have dug into the living rock.

Yet it is safe to say were it not for that same rock there would be no New York of the sort that exists to-day. Long ago science and power brought excavating into the finished art class, yet every year—yes, every month—there is something new, something to shorten contracts for foundations on which to rear the steel-girded skyscrapers, and when the foundation for the great new Municipal Building was finished the other day it was considered the most wonderful piece of excavating and caisson work the city had ever known and no one thought the same year would bring new developments, deeper borings, new rules in the constructing of caissons and methods of application that shorten the work in time by almost a third. Yet it has.

Notwithstanding all the progress, the builders are confronted every day with serious foundation questions. In the southern end of the city the soil for a considerable depth below curb is very treacherous and extensive excavations are required before striking the hard strata. This can be done only by applying the caisson system. The characteristic geology of Manhattan Island is of itself very interesting. At the northern end Manhattan schist and Fordham gneiss crop up above the street level, and at such points the dip of the rock is in a southerly direction, but at the lower end of the island the same rock is found only at depths of from 50 to 150 feet below curb. Above this is an overlying layer of hardpan which is only an accumulation of disintegrated rock and glacial drift hardened by the pressure of the superimposed material which in the excavations for the Singer and United Express buildings has been found, among other geological discoveries of interest, to contain specimens of shells belonging to an extinct species.

A MASS OF QUICKSAND.

As the lower half of the island is very narrow and surrounded on all sides by tidal waters, the soil above the hardpan is saturated and layers of quicksand sixty feet deep are common. These quicksands are sedimentary deposits of disintegrated rock carried down from the Jersey shores by the Hudson and thrown back on the jut of the island by the tide; the red sands point to the red sandstones and the gray to the shales which are the characteristic rocks of Eastern New Jersey. In their very fineness there lies the difficulty of excavating, for, should pumping be resorted to in order to drain the pit, this fine material will be pumped with the water, and finally be drawn from under the old-fashioned adjoining buildings, eventually undermining them.

The supporting bottom on which these sands rest, however, is a naturally cemented mass of material, "hardpan" deposited during the glacial period, and often defying the eye of the expert by its resemblance to concrete. Bedrock surface of the island slopes from north to south and passes below the tidewater level at about 10th street, and below this is the great treacherous overlay of sand and silt deposits built up by tidal forces during tens of thousands of years.

It is here amid the greatest possible difficulties that the magic towers have been reared, and deep under the sand and silt and water the tallest building in the world is now being anchored to the rock bed. It is told you in almost awed whispers that the Woolworth building will in a short time rear its fifty-five stories into the air—but the news could be shouted from the housetops and there need be no misgivings, for the rock of the island extends to so great a depth that it could be covered with structures half a mile high and their weight would cause no sagging or crushing of the layers, and there are no fissure faults to allow a side slipping of the masses of masonry.

ANCHORING ON ROCK.

All that New York builders need do is to cut down to living rock, anchor the foundation there and shoot up the steel stringers and girders. They never need give one minute's thought to the gray old island's shrinking under the enormous load it bears on its ancient back. Long after the brick, stone and concrete have crumbled away and the steel has corroded and molecularly yielded to the lateral pressure, the foundation will be as sound and inviting as ever it was.

Each foundation excavation and each building must be independent of the others so far as its security is concerned. Any man might build a narrow twenty story building between two broad twenty story buildings and be sure that it would not topple over as long as those buildings stood, and a great economy could be effected by co-operation of all buildings newly built in the same block, but as the law and practice now stand each one must be built as if it were the only one on the island.

There are buildings in New York now, very many of them, that have the exact proportions of a domino piece on end; at least twenty others resemble half a lead pencil placed on end more than anything else. Any hurricane or earthquake shock would bowl them over with as much ease as a touch will tumble a house of cards were they not securely "anchored," and in the anchorage of a huge skyscraper are found the countless marvels of caisson and excavation methods of the twentieth century.

The caisson work is picturesque in the extreme and was first used by Stephen A. Dutton in the construction of the Manhattan Life Building where the sub-surface strata were not of a stable consistency, the layers of rock being faulty and interspersed with sea sand, shale and shells.

The caisson is a massive steel, brick, wood or concrete cage, originally fourteen feet in diameter, now either smaller or larger as the work demands. In the construction of the Woolworth Building foundation the Foundation Company, of No. 115 Broadway, is trying out a new caisson and with success. This is a concrete rectangular cage only six feet wide and varying from sixteen to twenty feet long. They also have the largest caisson at work, one made of brick, cylindrical in shape and measuring more than nineteen feet across. The engineers of the Foundation Company have put the ban on all timber caissons and have decided on concrete construction rather than steel or brick.

Caissons are simply airtight, bottomless boxes, rectangular or cylindrical in cross section, having interior chambers large enough for a gang of men to enter and excavate from the bottom. In the roof of the box is an opening from which a shaft communicates with the ground level, and this is of a size sufficient for the conveyance of men and material. Compressed air is pumped into the caisson as it sinks below the water level, and the water is in this way expelled from the open or cutting edge. By the undermining, its own weight and the addition of concrete forms and pig iron blocks it is gradually sunk to the satisfactory hard stratum. The rock is then cleaned and levelled and the whole interior of the caisson and the shaft connecting the working chamber with the outer air is filled with well rammed concrete. They have then a solid monolith on which the superstructure is readily mounted.

An air lock, called the Moran lock, is used to permit the passing of men and material to the working chamber without too great a loss of compressed air, and by this innovation, which surmounts the top of the shaft, it is now possible to sink caissons through quicksands and water very close to the adjoining buildings without causing a flow of material from under the latter.

Some idea of the precarious work on the new Municipal Building now under construction is shown when one considers that the site is bounded on all sides by important and heavy structures, all on comparatively shallow foundations, and that Chambers street, one of the city's busiest thoroughfares, runs directly through the building. The tower-carrying caissons of the Municipal Building rest on bedrock seventy-seven feet below street level.

GETTING THE "BENDS."

It is in this caisson work that men get the "bends," as the sickness is called. Artisans in this employment are known familiarly as sandhogs, and owing to the construction of the Hudson tunnels, the Pennsylvania tunnels, the Steinway tube, the Brooklyn Interborough tunnels, etc., and the extensive work on big office buildings, New York in the last ten years has become the greatest centre in the world for them. Under heavy air pressure the natural gases of the body are compressed into small space, and if the pressure is relieved too quickly the gases expand rapidly, causing "bubbles" in various parts of the body. Deaths have been very frequent, but are wholly due to carelessness on the part of the men themselves or to some constitutional weakness. In all the recent excavations hospital "air locks" are a complement to the contractors' equipment.

The McAlpin Hotel, being built by the Thompson-Starrett Construction Company for the F. M. Andrews Company at 34th street and Broadway, is to be, for a time at least, the largest hotel in the world. Its twenty-five stories and two thousand rooms have been much written and talked about in the last few months, but Degnon & Co., contractors, are at work on the excavation for the four underground floors, the independent tunnel which communicates directly with the Pennsylvania Station, the underground moving sidewalks to the nine transportation lines that will diverge from Herald Square and the intricate subterranean plans which will make it perhaps the most wonderful hotel in the world as well as the most massive.

The excavation is in close proximity to the railroad tunnels to Long Island and the sub-basements of the Saks and Gimbel stores. The McAlpin has no caisson work, but the column footings will reach more than one hundred feet into the rock, and the stone is being worked out from a common centre. This gigantic work will be completed in four months, and the plans were submitted to the Degnon Contracting Company only a week before the time limit on bids, and the next competitor asked for seven months.

Two entirely new things are being done in connection with the McAlpin foundation work. The rock slopes in such a way from east to west at this particular corner that there is danger of its being loosened and slipping away from under the new foundation of the Mutual Bank, in 33d street. In cases of this sort it has long been customary to shore the adjoining buildings or walls, a procedure that calls for great expense and time, and in order to keep more readily within the terms of their contract Mr. Gustin, the engineer in charge, has arranged to construct for the Mutual Bank a wall, much stronger and deeper than the existing one, which will extend to the required depth of the new hotel foundations. It is much heavier and deeper than the weight of the Mutual building requires at the present time, but in the event of that company wishing to erect a taller structure the west foundation wall will be sufficient for all future requirements.

The second apparently unnecessary but highly profitable work is that of cutting a channel into the rock bed under a small building on the northeast corner of the plot and building a wall up under the standing foundations before doing any blasting in that sections. When these two things are accomplished work can be pushed rapidly ahead, and the June sunlight will be hidden from Greeley Square by the long shadows of the first huge girders.

In the superstructure of these big buildings there are some interesting details. The first floor pillars must be of a size to bear the weight of all the upper pillars, the transverse girders and brick work, with liberal allowance for floor load. The brick work of each story is supported by the girders of that floor level and the girders by the pillars. The tremendous strain on some of the lower pillars—say, under the Metropolitan Life tower, or those such as are being put under the Hotel McAlpin—is something to give the imagination pause. It is not what the pillar will stand in pressure on the end before it bursts, but how much it will stand before it buckles. Its tensile strength is known by its carbon value, and the architect knows just how much it will hold aloft in the sky, inch by inch. He knows to a pound what that load must be; that it takes one load of sand and one and one-half barrels of lime to lay 1,000 bricks, and that there are twenty-one bricks to the cubic foot; so he merely has to figure the weight of his top story load, his next story and its possible load, plus that of the top story, and so on, and when he gets to the bottom he knows just what size pillars and girders he must use. One girder hauled through the streets recently by twenty horses in itself weighed sixty tons.

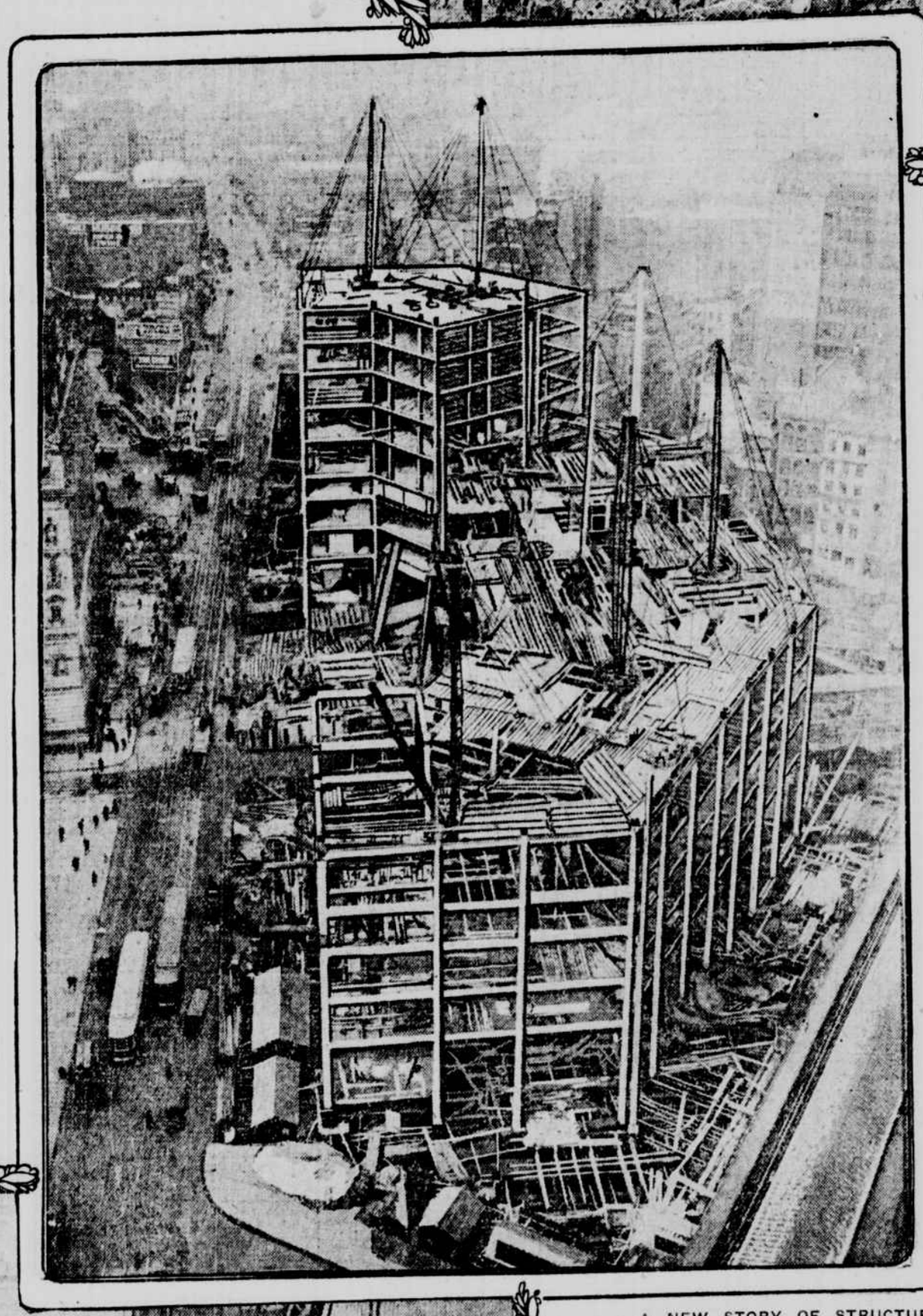
The rock foundation of New York and the anchoring system have proved a great economy in time and consequent interest in real estate investment to builders. There is no need to allow a year or two for the foundation to settle, as in almost all other cities. The greatest amount of time in the construction of a big building now is in the excavation for the foundation. Once this is completed the steel superstructure seems literally to grow up before one's eyes.

To illustrate this: Last fall a business man with a small Fourth avenue store left the city for a short trip to California, the whole journey to be accomplished within a month. When he went away his store door was bathed in sunshine from the south. When he came back it was as dark as if at the bottom of the Grand Canyon. During his absence fourteen stories of a building across the street had shot into the air.

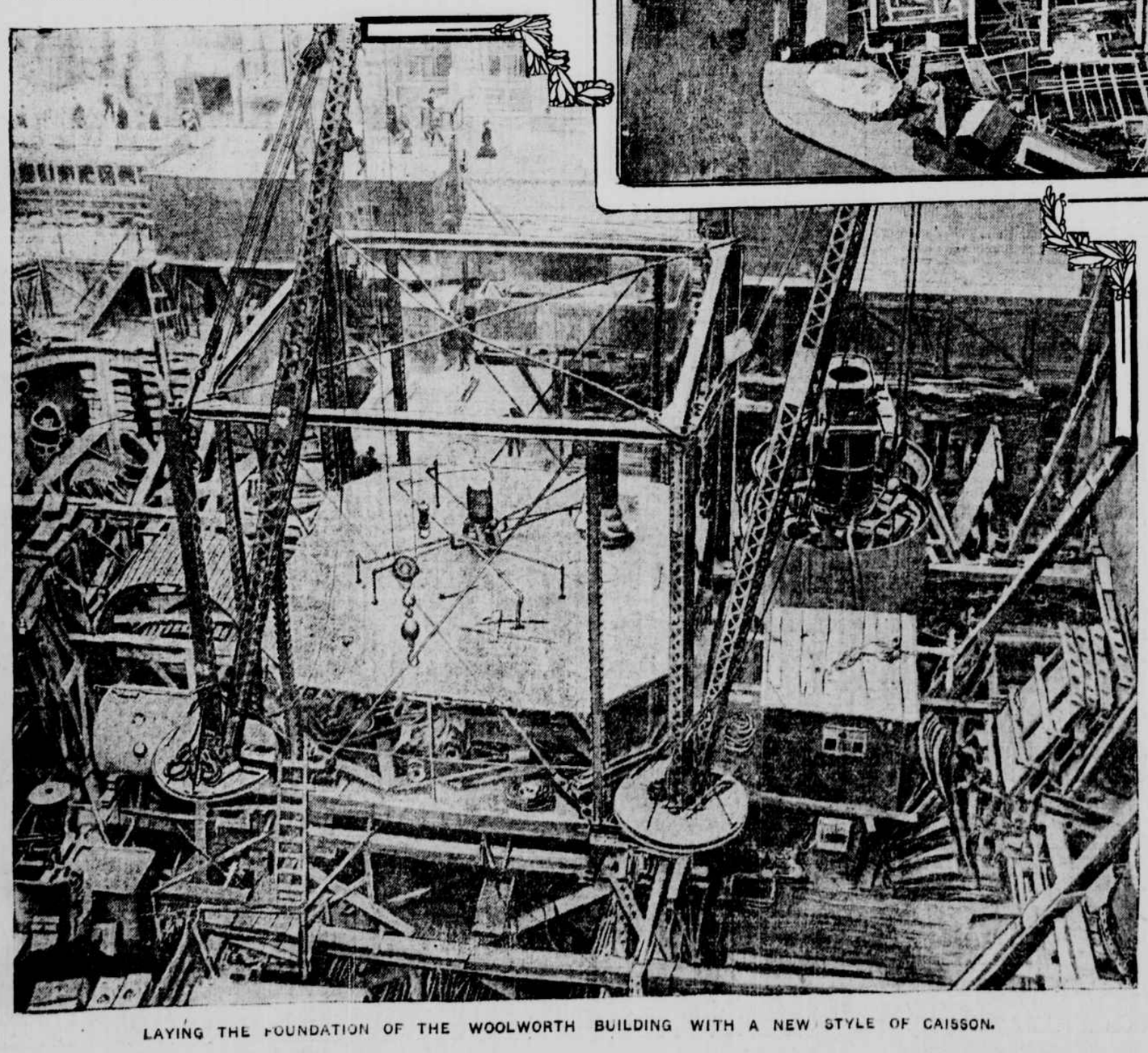
In the history not only of this city but of the world there has never been anything like the change that has taken place in Fourth avenue in the last three years. Three years ago from 14th street to 23d street and beyond Fourth avenue was one succession of low, old-fashioned buildings, the tallest being the Parker. It seemed as if attention was suddenly drawn to the possibilities of the avenue first in 1906. In a few months buildings were mowed down in rows, a little while longer and there were dozens of great foundation pits, and before another year had passed huge loft and office buildings were up and tenants moving in.

At first blush it sounds absurd, but there has been some talk of standardizing many parts of structural steel to save more time and money. If the big steel works and the big architects and contractors got together there would soon be an end to the necessity of subscriptions and special orders so far as the bulk of the steel was concerned. For instance, some foundry will receive orders for four great enterprises. One set of girders will be 28 by 9 by 14 inches, the next 27 by 11 by 10 inches, and so on, and when they are done if they were laid in the same yard it would be necessary to measure them to tell them apart, if they were not marked. The proposition is to standardize these the same as rails, and the architects could draw their plans according to standard productions. If special steel were needed for unusual dimensions it would cost no more to make it than it does now, when all the work is special.

LAYING THE FOUNDATION OF THE M'ALPIN HOTEL, INVOLVING UNUSUAL CARE OF ADJOINING STRUCTURES.



A NEW STORY OF STRUCTURAL STEEL IS ADDED EVERY THREE DAYS TO THIS SKELETON OF THE NEW MUNICIPAL BUILDING.



LAYING THE FOUNDATION OF THE WOOLWORTH BUILDING WITH A NEW STYLE OF CAISSON.

Osage Indian Packs

Curious Sacred Bundles Obtained by the Smithsonian Institution.

Officials of the Bureau of American Ethnology of the Smithsonian Institution are highly pleased over an addition which they have just made to their collection, and which they regard as one of their choicest treasures. This acquisition comprises four sacred bundles, or packs, of the Osage Indians, very few of which have ever been obtained by scientists, as they are generally buried with their "keepers."

These sacred bundles are just as precious from a religious point of view to the Indian as they are from a scientific point of view to the ethnologist, and are extremely hard to obtain. They represent the holiest fetich of a tribe, and so zealously are they guarded from any profanation that they are put in the charge of a special priest or medicine man, who keeps them carefully hidden. At certain periods they are opened and the contents worshipped amid the most elaborate ceremonies, but even at these times only the chosen men of the tribe are allowed to see the strangely assorted articles that are kept in the bundles.

These Osage packs differ greatly from any that have been found hitherto, both as to the texture of the various wrappings and also as to the nature of the articles they contain. The bundles were obtained for the National Museum by Francis La Flesche, an educated Omaha Indian, who is in the employ of the Bureau of American Ethnology. While at work in Oklahoma he learned of the existence of such bundles, and immediately opened negotiations with the Indian to whose care they had been intrusted. After exercising considerable diplomacy he succeeded in persuading the Indian to part with them, and brought them to Washington and turned them over to the Bureau of Ethnology.

One of these was opened with much care by Dr. Walter Hough, one of the curators of the national museum. Dr. Hough found the outside wrapping or sack to be made of a rare Indian fabric, woven of the silky brown hair of the buffalo. This was bound with a buckskin band decorated with human scalps, and the leg of an eagle. Inside this was a buckskin bag and inside that a haversack made of a material resembling Chinese matting.

In this haversack were a pipe decorated with scalps, a tobacco bag, a braided cord made of woollen fabric and a bundle of buffalo bladders, bound with a thong ornamented with scalps, and one other bundle which was the most important of all, for it represented the "holy of holies." This bundle was a buckskin case, to which was bound a buckskin object resembling a beaded band. Inside this bundle was found the most sacred object of the pack—the body of a hawk, which had been mummified and then painted a brilliant vermillion and green. Attached to the tail was a circlet of human scalps. The body was suspended by a braided band made of woollen fabrics, which evidently had been obtained by the tribe through trade with other Indians.

One of the three other bundles was found to contain the tattooing apparatus and materials used by the Osage Indians, all of which are regarded as sacred, as the tattooing is a religious ceremony. The other two packs were similar to the one described, but the articles each contained were different.

After careful examination by Dr. Hough and his assistants the bundle was restored to its proper condition, and carefully stored away, but it will be the subject of long study by the ethnologists, who are greatly interested in the industrial accomplishments of the Indians revealed by the contents, as well as in the mystical and symbolical meanings of the pack and the various articles it contains.

"Do you believe in telepathy?"

"Certainly not," replied Mr. Dustin Stay. "Even if the scheme were practicable there is no money in it."—Washington Star.