trying unsuccessfully gasoline motors attached to street cars, the case was put about in this way: "Steam automobiles are successfully used which weigh as much as our street cars, and operate at a higher rate of speed than we require. Send us out a car of our standard patterns, to be operated like an automobile." It was a difficult task to find firms willing to undertake this apparently simple engineering problem, and some two years has elapsed since the order was given to execute the idea. The John Stephenson Company, of Elizabeth, and the Reeves Engine Company, of Trenton, N. J., finally undertook the construction of the car and the equipping of it with an automobile engine of sufficient size and power for the purpose.

Our lower engraving represents an external view of the car with a truck load of lumber attached to it as a trailer, for the purpose of testing its power. The car body is 14 feet long, similar in every respect to the street cars used in the city of Merida.

The street railway system of Merida is an extensive one, but peculiar in that it radiates from the central plaza in all directions. The gage is 3 feet, and the motive power hitherto employed has been the small mules of the country, singly and in pairs. Switches and turnouts seem to be the exception rather than the rule, and the cars from the different lines come into the plaza in succession, so that the last in is the first out. As electricity is out of the question, the need for a self-propelled unit becomes unusually great.

The small size of the car is in some respects advantageous, but the narrow gage makes it difficult to find space for the machinery. The arrangement is shown in Fig. II., which is a side elevation, and Fig. III., which is a plan. These diagrams show the machinery with the car body removed. The boiler is located at one side of one platform. The engine, shown in a vertical position, is placed horizontally between the wheels under the car body. There is barely room between wheels for the compact little machine and the necessary gear wheels and chain.

The large view shows the location of the boiler, pumps, etc., on the platform. In the long view, looking upward under the side of the car, will be seen one of the broad cradle straps, by which the engine is held against the heavy subsills of the car. The engine and driving machinery is, however, self-contained and does not transmit any of its strains to the car body beyond those occasioned by its weight.

The boiler itself is an upright tubular of the standard automobile pattern. It is 2 feet high and 2 feet in diameter, with an automatic burner suitable for either gasoline or kerosene. The engineer, standing by the side of the boiler, finds within easy reach the reverse lever, throttle whistle, and all the valves necessary to control the apparatus. In fact, this part of the car resembles a magnified automobile.

The engine and the driving apparatus present the greatest novelties. The engine is the Reeves Engine Company's new compound engine, modified to suit the peculiar conditions of automobile service.

One view shows a partial section of the engine and its frame. The cylinders are 6 inches stroke by 3½ inches and 6½ inches in diameter. Two piston valves are employed, both of them capable of being adjusted at each end by taking off bonnets. A remarkable economy in steam is obtained by reducing the clearance to an unusually small amount.

For stationary purposes the cranks are set, as shown in the upright view, at 180 degrees, and exhausting directly across the low-pressure valve without the use of a receiver. This was impracticable for automobile purposes. The cranks being of necessity placed at 90 degrees, changes have been made in the ports and passages, and the high-pressure cylinder exhausts into the space around the low-pressure valve, which is used as a receiver. The low-pressure valve admits steam to and controls the exhaust from the low-pressure cylinders. These valves are controlled by eccentrics and a link motion, which gives a very perfect steam distribution and a perfect control of the engine. There are many interesting details in the construction of this engine, such as metallic packed stuffing boxes, counterbalances for the cranks and other things highly important, but which cannot be mentioned here. The engine drives a crank shaft, or jack shaft, upon which is placed a gear wheel. On the axle opposite the cylinders is another gear wheel. These two are connected by a Renold silent chain gear. These chains have been very happily described as "flexible internal gears." The speed ratio is 3¼ to 1, the engine being geared down to the 30-inch driving wheels. Both axles also carry gear wheels of equal size, over which a second Renold chain is placed, thus making all four wheels drivers.

The secret of the success of the machine is largely due to the gears. The direct-connected steam motor has but a small fraction of the tractive force possessed by a geared engine. A three or four per cent grade represents about the limit which a direct-connected machine can overcome, while a geared engine can successfully operate on grades up to eight or ten per cent.

The engine, chains and gear wheels, and fixtures, weigh about 1,000 pounds. The boiler, pumps, etc., bring the total weight of the machinery up to about 2,500 pounds. The running gear and car body weigh approximately 5,500 pounds. This makes a total load of 9,000 pounds. Loaded with the equivalent of twelve or fourteen passengers, this car handles with ease around sharp curves the loaded four-wheel truck shown in our lower engraving. This was a loaded lumber car, weighing about 9,500 pounds. The test was made in order to ascertain whether the car could handle a crowded trailer with ease, and it was evident that it could do so. Probably two of the smaller cars used in Merida could be hauled when crowded to their utmost capacity.

The steam pressure is 225 pounds, and the boiler is capable of maintaining this pressure when the engine is working to its fullest capacity. In the cases of the trial trip, the car on one occasion, without a load, pushed the trailer, weighing more than 9,000 pounds, with perfect ease on the straight track.

This car illustrates the fact that an invention or an idea cannot always be made successfully until the times are ripe for it. In this case we have the necessary features of a compact, efficient compound engine; a driving chain; a safety boiler; a burner, automatically controlled; liquid fuel; a compact direct-acting steam pump; an air pump, and an injector. All these individual features are the result of years of experiment in their lines, and success would be hardly possible with any one omitted.

INDIAN PHYSIOGNOMIES.

BY GEORGE WHARTON JAMES.

The study of facial characteristics has always been interesting. "The eyes are the windows of the soul," the poet tells us; and there are few people who do not believe themselves competent to judge somewhat of character from what the face presents. Lavater and his followers believed a definite science could be constructed, the laws of which would infallibly determine the reading of character from facial or physiognomic characteristics. Later scientists, while discarding Lavater's ideas, are emphatic in their statements that important ethnologic truths may be learned by careful study and competent measurements of facial, cranial, and other physical developments. Much work recently has been done by Dr. Hridlika, of the Hyde Exploring Expedition under the direction of the American Museum of Natural History of New York, along these later lines.

A few notes on Indian physiognomies may therefore not be without interest to the readers of the Scientific American. The Indians pictured are of the Mohave and Yuma tribes, residing on the Colorado River, on both the California and Arizona sides, and the photographs were made on a trip I took by boat from the Needles to Yuma in February of last year.

These tribes are akin and are classed by Powell as the Yuman family. By some they have been regarded as of Apache kinship, but there is little, either in their language or in any other characteristic, to connect them with this Arizona branch of the great Athabascan family.

One thing is especially noticeable, and that is that all the older men have very wrinkled faces. These marks of time, of Nature's stern furrowing, seem to me to have one clear significance. It is the outward and visible sign of the pathetic struggle for existence which has been never-ceasing in the history of most aboriginal races, and especially so since the advent of the white man. Indeed, when I made the photograph (Fig. 1) of a Mohave Indian he was telling me of the hard fight he was having to get a sufficiency to eat for himself and his family. It is not a distinctively Indian face. Dressed as a white man, smoothed and straightened up, he would not be far from a Caucasian in appearance. His lips are not so thick, the base of his nose not so broad, and his cheekbones not so high as those of most of his tribe. His hair was done up in long "towy" kinds of rolls, and then wound around on his crown somewhat after the fashion of the Chinese. (I coin the word "towy" to suggest the tow-like appearance of the hair as seen in Fig. 2.) The major portion of the old men of both the Mohaves and Yumas wear their hair in this fashion, and it is this custom that led the Indian Department a few months ago to issue an order that all Indians who were in any way dependent upon the government for bounty or pay must cut their hair shorter. Fig. 2 is of a much older man, toothless and almost blind. He is a tall, stately Mohave, and must have been a physical giant in his youth. The square jaw, thin lips (for an Indian) denote power. Yet there is a singular gentleness shown in the arch of the nostrils. The large coronal or brow development is remarkable. If one covers the eyes and back of the head, and looks but at the nose, lips and chin, an astonishing resemblance is readily seen between this face and that of Gladstone.

I doubt very much whether the most renowned physiognomist could have read cannibalism in the face of the Indian pictured in Fig. 3, but if his own confession goes for anything, he has often been a consumer of human flesh. Though he wears a beard, he has more genuine Indian characteristics than either of the two hitherto considered. His nose is flat at the base, cheekbones high, lips thick, and his eyes are dark, liquid, and large. There is something positively "ogreish" in the manner in which he licks his lips and rolls his eyes when reciting his cannibalistic feats before the campfire to a circle of his admiring tribesmen.

Figs. 4 and 5 are front and side views of the same Mohave. Here is a pure Indian face, with a strange resemblance to that of the late Li Hung Chang. In the smile, there is a jolly good nature shown. The profile view is by no means displeasing, though the front face shows broad base of nostrils and thick lips. The eyes are diseased, as those are of many of his people, undoubtedly owing to the constant sitting over the smoky fire of a chimneyless hut. The cheekbones are not protuberant; the ears are well shaped and set on the head. In marked contrast to most of their people, this Indian, as well as the one pictured in Fig. 3, have beards. It is one of the most common of sights to see the Indian, with small mirror and a pair of tweezers, pulling out the hairs on his chin and upper lip one at a time. This, and not that they cannot grow a mustache and beard, is the explanation of their general hairless lip and chin.

The next group of four photographs is of Yumas all belonging to the so-called friendly faction of this tribe. In almost every tribe are to be found two factions, corresponding somewhat to Conservatives and Liberals. The former are those who wish to adhere to the "ways of the old"—the habits, customs, ceremonies, religion, and general procedure of their forefathers; the latter compose the progressive element—those who are willing to forsake the old ways, and, ostensibly at least, follow the Washington way. While the effect of this following the new way may be of benefit to their children, there is little doubt in the minds of those who know them that the old men follow the new way because of the "loaves and fishes" associated therewith.

Fig. 6 is of Pasqual, the leader of the Friendlies. While present with the Yumas, I got the chief of the hostile faction to call a powwow, in which I stated my desire to photograph them, and why. There must have been fully a hundred men, women, and children present, and their resentment to the whites was open and pronounced. The chief said little, and it was soon evident that he was a mere puppet in the hands of Miguel, the orator and spokesman of that faction. This man is a disappointed politician. Because he could not be selected chief, he is determined to give the authorities all the trouble he possibly can. It was his son, it is generally believed, who set fire some time ago to one of the Fort Yuma school buildings, out of revenge for his father's defeat and to show that he himself had daring blood in his veins.

The result of our powwow was a refusal to allow themselves to be photographed, and a request that the whites leave them alone and allow them to walk in their own ways.

Defeated in photographing the Hostiles, I appealed to the Friendlies, with the result that I was rebuked for not first going to them. The policeman (Fig. 7) was eminently mortified. His face is narrower than Pasqual's, and in his policeman's uniform few would take him at first sight for an Indian. It is astonishing what a great change follows the cutting of the long matted hair, and the removing of the bands and other articles of Indian wearing apparel and substituting therefor the dress of the white man. If it were not for his dark skin, the Indian of Fig. 7 could walk through any city and not be suspected as an Indian.

Fig. 8, though of a young man, is a far more decided Indian type. Forehead, nose, lips, chin, cheekbones, and eyes, as well as hair and skin, all speak him an Indian. He is one of the leading athletes of the tribe, and is skilled in playing a pole and hoop game common to many Indian peoples and described by Catlin long ago as the chief game of the Mandans.

Fig. 9, too, is an Indian face, though much less so than some of the others. There is a keenness about these eyes, though old, and a general look about the mouth that denotes cruelty, and he is one who, in olden times, would have added a little more torture to that already decreed against any enemy hapless enough to fall into their hands.

Of the Mohaves it may generally be said that they are the most degraded tribe in the southwestern part of the United States to-day. They are the lowest in the moral scale from our standpoint, having not the least idea of morality as we see it. They believe God—their God—to be dead, but that his spirit is alive and is an evil spirit corresponding to the devil of the orthodox whites; that he resides in the Needles Mountains (passed by all transcontinental passengers on the line of the Santa Fé Railway as they cross the great bridge over the Colorado River at the Needles). This spirit acts as a judge before whom all the spirits of the dead Mohaves must pass ere they are allowed to enter into their Paradise, which is located on the Williams Fork of the Colorado River.

The Yumas are slightly more progressive, having come in contact more with the whites since the establishment of the city of Yuma. Their children, too, seem to make better progress in school.

These pictures and the accompanying remarks, though necessarily brief and cursory, will show, I am sure, that there is a great field for the physiognomists of every school among the Indians of the American Southwest.

Safety Exploder for Wet Guncotton Shells.

A new safety exploder for use with wet guncotton shells has been invented by the New Explosives Company of London, the use of which may affect the charges for heavy artillery. Wet guncotton has been generally regarded as one of the safest and most powerful explosives in existence. The only objection to its general use for shell purposes hitherto has been that, to insure complete detonation, a primer of dry guncotton and a fulminate of mercury detonator have been required, and both of these agents are too sensitive to premature ignition to be of any practical utility. The new safety exploder contains neither dry guncotton nor fulminate of mercury, but it will detonate wet guncotton with certainty and safety, and will not detonate itself under a temperature of 360 deg. C. It cannot be ignited by friction or shock, but at the same time it is brought into action with an ordinary detonating pellet such as is commonly employed in percussion or time fuses. The force then exerted will detonate in its turn any charge of wet guncotton, without leaving any traces of unburnt explosive or residue. The composition is very stable and stands an excellent heat test. At Ridsdale, the explosive experts of the British War Office witnessed a series of experiments with this material. The main bursting charges of a shell were made by a new process introduced by the company, whereby changes can be formed in one block instead of being built up of smaller pieces. The first trial consisted of ten rounds from a 6-pounder quick-firing gun. The total weight of each shell was 5 pounds 10½ ounces, the weight of wet guncotton bursting charge being 3.5 ounces, and that of the explosive in the safety exploder 138.8 grains. The shell was fitted with the ordinary Hotchkiss fuse, Mark IV. The target was a ¾-inch steel plate, and the range about 150 feet, and arrangements were made for securing the fragments of the shell. A 7½-ounce charge of ordinary cordite was used. The weight of the pieces of shell recovered on these ten rounds varied between 4 ounces and 8¾ ounces, and the number of pieces ranged between 81 and 337. Of three rounds the chamber pressure and muzzle velocity were respectively 11.28, 12.26 and 12.39 tons, and 1,800, 1,827 and 1,838 foot-seconds. A second experiment consisted of the bursting of a 6-inch shell at rest in a closed cell in order to show that the exploder would work without shock of impact at short range. The wall of the cell was burst open by the force of the explosion of an ordinary cast shell weighing 119½ pounds, fully loaded. The fragments recovered numbered 2,122 pieces, their total weight being 65¼ pounds. The wet guncotton charge weighed 6 pounds 9 ounces, and the explosive composition in the exploder weighed 10.5 ounces. The fuse was of the ordinary direct-acting pattern, and was fired electrically. Further trials showed that wet guncotton with this new safety exploder can be fired through the thickest armor plate without exploding until it had passed through.

A New Magazine Rifle.

It is said that the Danes have adopted a new magazine rifle for naval and military purposes. It fires, on the proving ground at least, at the modest rate of fifteen rounds a second, and allowing for reloading, 300 a minute. The magazine holds thirty cartridges. It is heresy, we suppose, to say so, but we are of opinion that there is an unnecessary fuss made about rapid-fire rifles. They have to be aimed to be of much service, and the time to aim cannot be reduced. The Danes, maybe, have read about the need of a ton of lead to kill a man, so propose to try and deliver the ton as quickly as possible. But, as the utmost a soldier can carry is 300 rounds, and supply is not easy in real war—ashore or afloat—there seems a fair chance of Danish warriors being short of their quota of the needful ton at critical moments. Afloat, this is beginning to be felt; and though the Vickers-Maxim firm, with the bare charge, have done much to save us feeling the "weight of ammunition problem," any advance in rapidity of fire seems likely to bring the problem back. Given a weapon that fires fast, men in battle are pretty sure to fire it as fast as they can.

Greatest Passenger Transportation in the World.

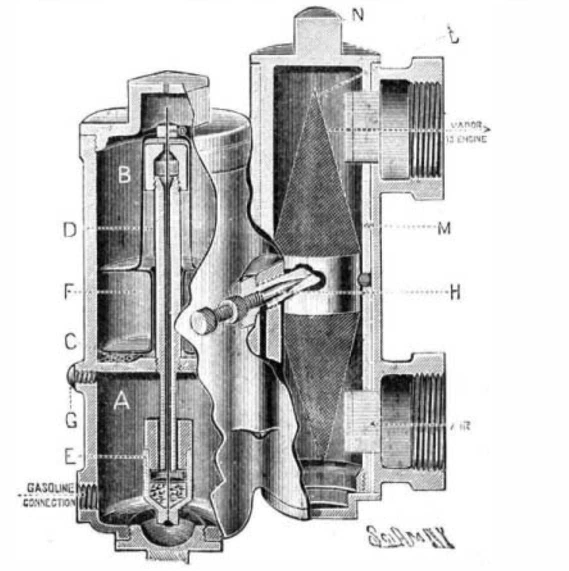
The elevated railroads of Manhattan and the Bronx are unmatched by any open-air steam railroad system in the world in the number of passengers carried each year. The report of the business done by these elevated railroads for the year that ended June 30 last shows that in that year 215,000,000 passengers (round numbers) were transported. It might have been added that they were transported without accident to one of these passengers excepting some trifling bruises.—Philadelphia Press.

AN IMPROVED VAPORIZER FOR GASOLINE ENGINES.

The cross-sectional cut of a gas engine vaporizer, or carbureter, seen in this column, shows very clearly its salient features, which are the invention of Mr. A. W. Olds, of Hartford, Conn.

The inventor's idea, in designing the vaporizer, was to do away with the needle-valve usually employed for controlling the flow of gasoline, and substitute for it an arrangement that would never fail owing to wear of the valve, such as sometimes occurs with the ordinary type. Mr. Olds had recourse to the difference in density of gasoline and mercury, in carrying out his idea; and the manner in which this difference is made use of, we will now describe.

The vaporizer is made up of two cylinders—the supply cylinder, filled with gasoline, and the atomizing cylinder, through which the air and vapor are drawn to the engine. The supply cylinder is divided by a horizontal partition, *C*, into two compartments, *A* and *B*, which are the gasoline feed chamber and the float-feed chamber respectively. A vertical tube, *D*, connects the two chambers, and a long, fine wire passing through this tube, is suspended from the bail of the float, *F*, by a collar and set screw, and carries at its lower end a cup, *E*, half filled with mercury. The gasoline, entering the small pipe hole near the bottom of the chamber *A*, rises through tube *D*, and, overflowing at its upper end, falls into chamber *B*. As this chamber fills, float *F* rises, carrying with it the mercury cup, *E*. When the surface of the mercury covers the bottom of the tube *D*, the gasoline forces some of



AN IMPROVED VAPORIZER FOR GASOLINE ENGINES.

the fluid up in the tube. This of course lowers the level slightly in the cup, allowing the end of the tube to become uncovered sufficiently for more gasoline to flow up in it, as a result of which the cup is again raised, and more mercury forced up the tube. A column of mercury is thus formed in the tube, and the gasoline bubbles up through it until its height becomes sufficient to balance the head of gasoline, when the latter will cease to flow. By this time the gasoline will have filled chamber *B* to within a short distance of the needle atomizer valve *H*, through which it is fed to the engine. When the engine is running, a small, steady stream of gasoline overflows from the top of tube *D* into the float-feed chamber, in order to keep up the level. That this stream is continuous, rather than intermittent, was demonstrated in a test made on a Westinghouse gas engine in the presence of the SCIENTIFIC AMERICAN representative.

Besides the mercury column for controlling the feed of gasoline to the float-feed chamber, the carbureter has a double valve in the vaporizing cylinder, for throttling the air inlet and vapor outlet. This valve consists of a sleeve *M*, adapted to be turned by a wrench on lug *N*. The sleeve has ports that match those in the cylinder proper, which are arranged with the lower one slightly smaller than the upper, so that there is always a slight vacuum in the cylinder, which tends to draw the gasoline through the needle valve *H*. By throttling both the vapor and air proportionately, the suction is always the same, and the mixture never varies, no matter at what speed the engine is run. The two wire gauze cones, *L*, serve to break up the gasoline and thoroughly vaporize it. These are not absolutely essential, however, and can be left off if desired.

The vaporizer is made of brass or aluminium, and will be found a most satisfactory article for use on all kinds of gas engines where absolute surety is wanted that there will be no leakage of gasoline. With it, an auxiliary shut-off cock is unnecessary, as the mercury column can always be depended upon for shutting off the gasoline flow when the engine stops.

Correspondence.

The Aerodrome.

To the Editor of the SCIENTIFIC AMERICAN:

My attention has been called to the communication of your Mexican correspondent, F. McC., in your issue of January 10, which is a fair criticism of the aerodrome illustrated by the writer in SUPPLEMENT No. 1399, for which is claimed the important characteristics of inherent stability and automatic control; also levity and translation through the air by a single physical action of aeroplanes operating under the simple law of the parallelogram of forces. He expresses the belief that the swivel support of the rider will not permit the rider's changing the plane of revolution of the aeroplanes by varying the center of gravity, and instances a floating barrel upon which a swimmer is trying to climb.

I may say that the reasonable assumption of your correspondent was anticipated and fully realized at the first conception of this type of machine years ago (caveat drawn in 1894), note taken, and provision made accordingly in such a way that, to a degree, a lighter, simpler, and cheaper combination resulted. A possibility was forestalled, and a fact, if fact it proved, curious as it may seem, was to be utilized to remedy a difficulty.

As to the barrel simile, your correspondent must admit that the boats and vessels of commerce, which approximate barrel shape, and probably descended from such primitive shapes, do not careen to such an extent as to render water navigation impracticable. Why? Because in the evolution of the art of boat building and operation, the tendency is minimized and rendered negligible.

It is hoped to show your correspondent and others whom it may concern, that notwithstanding his assumption of absolute prohibition, it will not be realized, or, more carefully stated, will not be apparent to a detrimental degree in the first machine produced, of the *type* illustrated.

As to steam power, it may be said this type of aerodrome lends itself to the adoption of steam prime movers very completely, and was so first designed, but set aside for a larger factor of safety. The trouble with it is, and always will be, the weight of water, or any substitute therefor, where lightness is a desideratum and considerable radius of action important. Condensation and the re-use of the water is, for the writer, entering too much into the refinements of this particular art at this stage. 'Tis best to follow the lines of least resistance. S. D. MOTT.

Passaic, N. J., January 12, 1903.

Irrigation in the Southwest.

There was recently begun in Texas what is planned to be the most extensive system of irrigation in the United States, for it involves the utilization of no less than 295,000 acres of land. A main canal will be constructed 100 miles in length, extending 30 miles from the town of Pecos in a southwesterly direction, crossing the Texas and Pacific Railroad 6 miles west of Pecos, and on to Toyah Lake, 7 miles south of Pecos, where one of the largest reservoirs in existence is to be constructed. From Toyah Lake the canal will run on and join the Williams Canal 30 miles farther down, finally emptying into the Pecos River 60 miles below Pecos.

The Cooper Hewitt Converter and Lamp in England.

The readers of the SCIENTIFIC AMERICAN are more or less familiar with Mr. Peter Cooper Hewitt's mercury vapor lamp. It will be gratifying for them to learn that it has met with no little favor in England. Lord Kelvin was unstinted in his praise of Mr. Hewitt's work. The Hewitt lamp, it will be remembered, resembles somewhat Macfarlane Moore's contrivance; but differs radically therefrom in the principle of its operation. Instead of employing rapidly alternating currents, Mr. Hewitt renders incandescent the vapor of mercury, for which purpose a low-pressure continuous current is employed.

Mr. Hewitt has also invented a new form of converter which it appears differs radically from the present machine for converting alternating currents into direct currents. In the course of his experiments with his mercury-vapor lamp, Mr. Hewitt evolved the present invention. From the meager details at hand we are unable to state precisely the form of the new converter, but we are informed that it is based on the discovery that certain vapors under peculiar conditions suppress certain portions of the alternating waves so as to change the flow into a direct current. The resulting current is pulsating, however, having the same frequency as the original alternating current. The apparatus is said to be very simple and extremely small as compared with the rotary converters now in use. It is also asserted that the new converter, in its present form, will handle voltages as high as 3,000, and that probably this figure may be increased to 10,000 upon further investigation and experiment.

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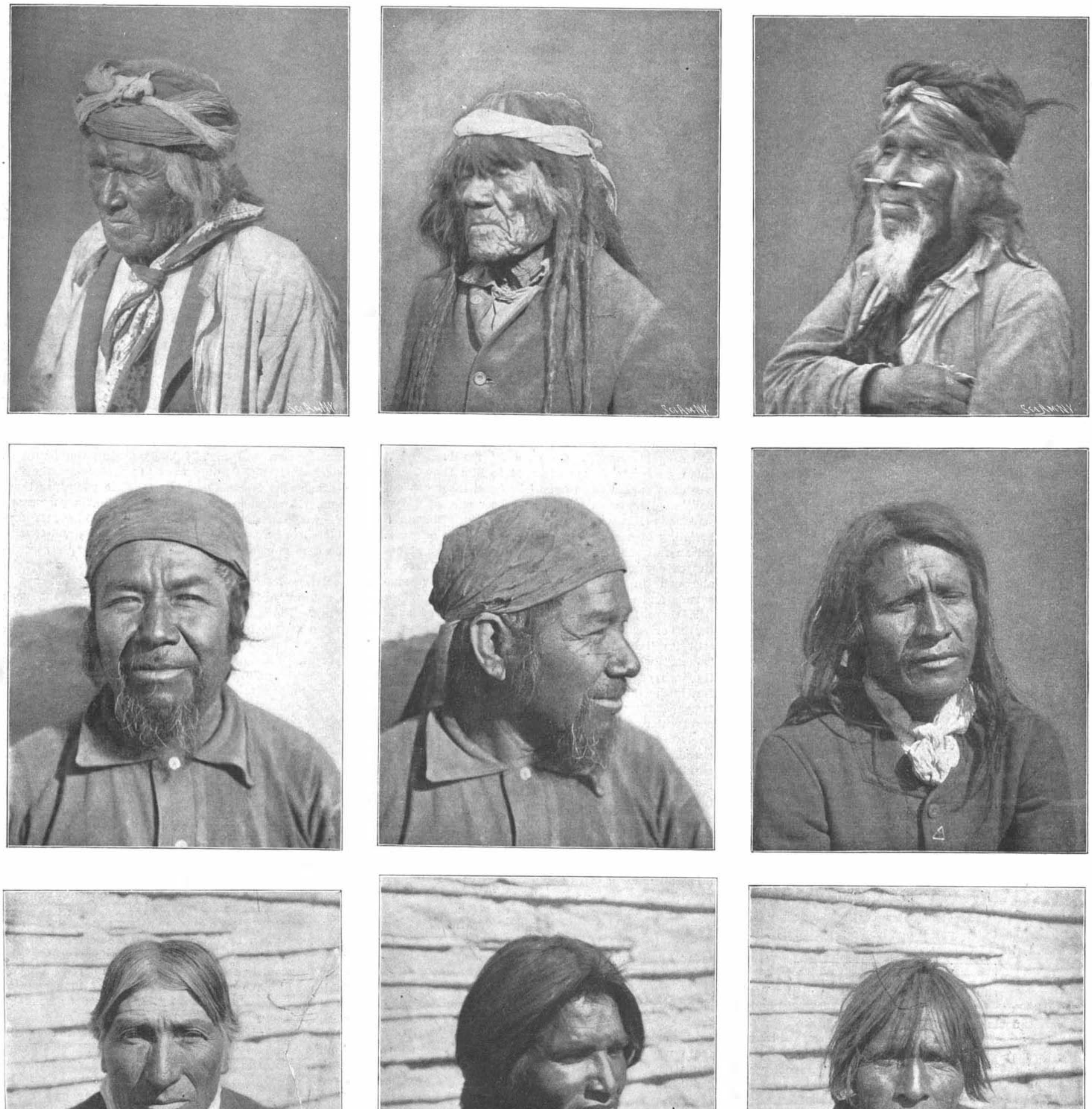

SOME TYPES OF MOHAVE AND YUMA INDIAN PHYSIOGNOMIES.—[See page 58.]