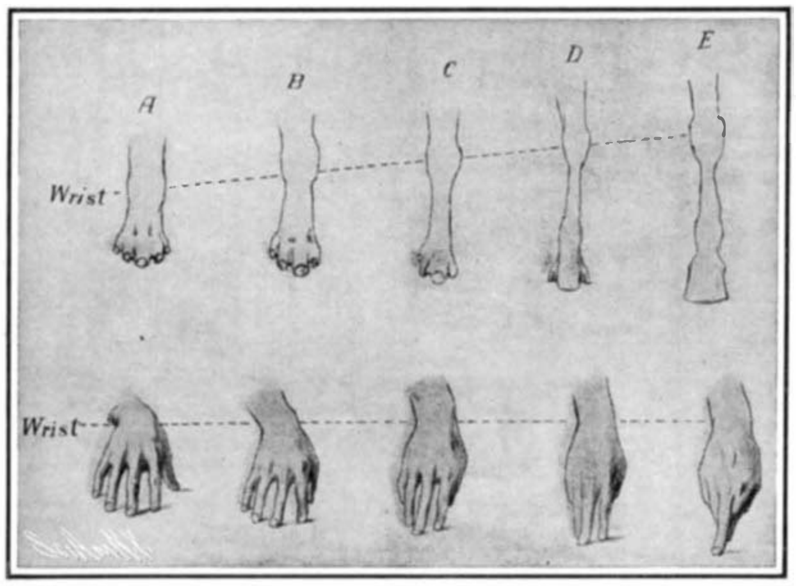
THE EVOLUTION OF THE HORSE.

At the American Museum of Natural History, Prof. Henry Fairfield Osborn recently gave six lectures under the auspices of the Trustees of Columbia University, entitled "The Jesup Lectures on the Evolution of the Horse." The lectures were illustrated, and covered first the recent and past researches of Prof. Osborn and his assistants (especially Mr. J. W. Gidley) and of other investigators on the fossil horses of America and Europe; second, the mass of writings by American and European zoologists upon the origin and evolution, relationships, structure, and habits of the breeds of domesticated and wild horses and of their near relatives, the asses and zebras. The following is an abstract of the lectures covering the first series of topics mentioned: The various races of the horse family furnish a beautiful example of adaptation, or the adjustment of the organism to its surroundings. In every animal of to-day the remnants of adaptations belonging to the remote past are mingled with adaptations to the present, and many characters of the domestic horse may be regarded as inherited adaptations of remote antiquity. Thus the habit of carrying the head high is a reminder of the time when the wild stallion at the head of the herd had to be always on the watch for foes; the sudden shying is an instinctive memory of the days when a quick jump to one side might save a horse from the sudden spring of a beast of prey; while bucking is a device for shaking an enemy off the back. Again, the usefulness of the horse for cavalry exercises depends upon his having inherited an instinct for acting in concert with his fellows.

The several parts and habits of a horse are also adjusted to each other, and these natural adjustments were what first made the horse valuable to man. Thus the horse is a quadruped, seeking safety and food by its speed and traveling power; it is also a "soliped," with stilt-like legs, walking on the tips of its single toes; and being a grazer and browser, its neck must be long enough to bring the lips to the ground. As a traveler it has acquired varied limb action and gaits, and also varied experiences, which have served to increase its resourcefulness and intelligence. Not being defended by horns or tusks, it uses its hoofs collectively as a weapon, which is particularly powerful and effective, the young being frequently defended from wolves by a ring of desperate hoofs. Since the chief enemies of the horse are the larger carnivores, it has developed quickness of sense and movement, and the young must be able to run with the herd at birth.

It is true that the horse is a complex "machine"; but it is more. No mere machine is self-perpetuating, no machine becomes perfected through long-continued use.

One of our photographs represents a beautifully mounted group consisting of the skeleton of a horse rearing and of a man, recently placed on exhibition in the American Museum. The picture shows that the bones of man and horse are strictly comparable, but man has retained more of the primitive or generalized features common to all mammals, the horse being far more specialized in the structure of its limbs and of its grinding teeth. The special structure and motions of the limbs are elucidated by the accompanying photographs of rearing and leaping horses. Figures were used by Prof. Osborn showing sections of the limbs, the various types of joints, the action of the muscles and tendons, of the ligaments and of the patella or knee cap. The several parts of the limb in their capacity of levers must also be considered. The rate of oscillation of the upper arm and thigh bones when acting like a pendulum has been increased by the shortening of these bones, and they have become drawn up among the muscles. For purposes of locomotion, the movements of the horse's limbs are principally fore and aft, the muscles for drawing the limbs across the body and for rotating the arms having been lost during the course of increasing specialization. The photographic and mechanical analyses of the motions of animals made by Muybridge, many of which have been published in early numbers of the Scientific American, show the varied gaits of the horse in comparison with those of the raccoon, tiger, elephant, camel; and the mechanical superiority of the trot over other gaits must be admitted. The traditional representations by artists of the trot and gallop are usually wrong. A draft horse in the act of pushing against the collar of the harness, and thus of drawing a heavy load, causes the backbone to curve somewhat at each thrust of either of the hind limbs, so as to bring the point of application of the force as near as possible to the midline of the body.

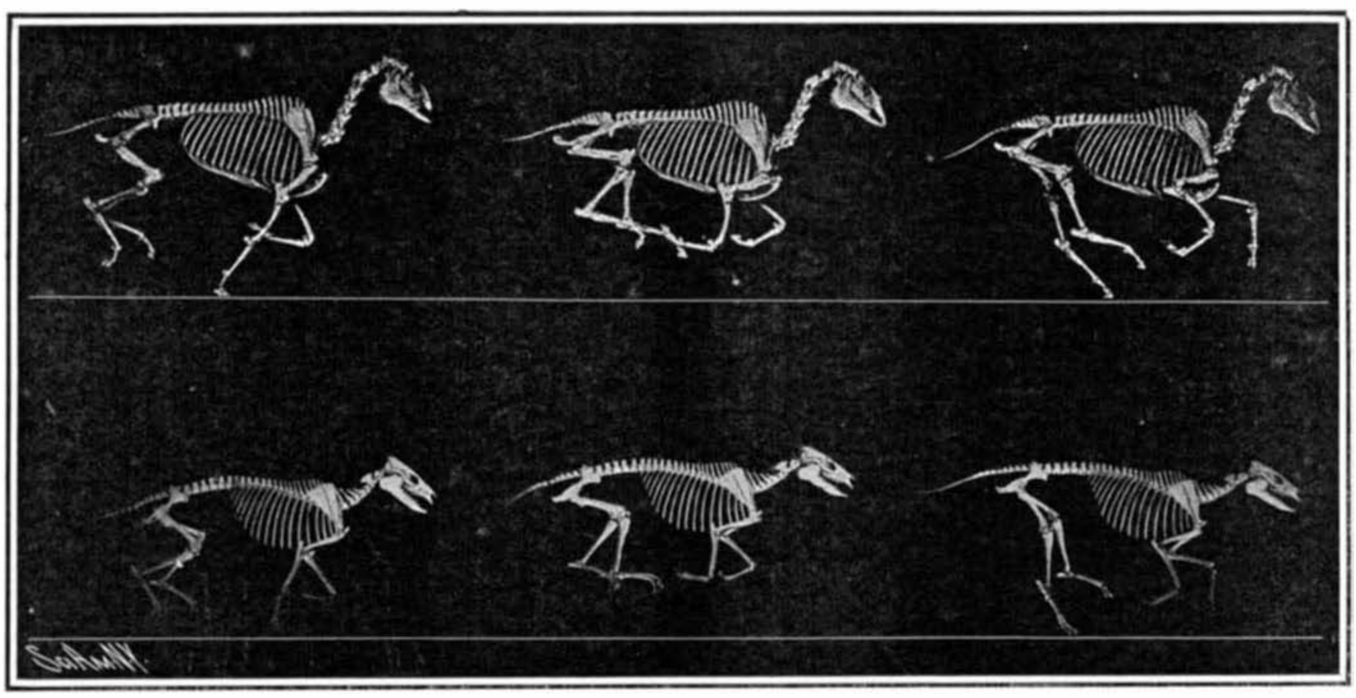


The Successive Stages in the Process of Rising on the Tip of the Middle Toe.

Most of the physical and mental traits of the horse are entirely useful. Usually each habit, each structure, must, as it were, pay its way, to give a definite return for the blood and food it receives from the organism as a whole. However, in human society there are individuals and institutions that have outgrown their usefulness, and although reduced in importance and destined to disappear ultimately, they still manage to "hang on." So too the horse retains traces of many former habits (e. g., a trace of the habit of brushing away the snow with its fore foot, so as to get at the grass underneath), and especially many vestiges in the skeleton. Among these may be mentioned the vestigial bony elements in the pelvis and shoulder girdle, in the wrist and ankle joints, and the famous "splint" bones back of the cannon bone, which are the vestiges of inner and outer toes. Sometimes organs which have entirely disappeared from the normal individual occur sporadically as "reversions." Thus the splints mentioned above very rarely appear as well-developed side toes, the foot of such a "freak" horse closely resembling that of one of the ancestral three-toed horses of the Tertiary period.

Many of the fossil skeletons now regarded as representing ancient equines were not recognized as such by their discoverers, on account of their very obvious differences from modern horses. For example, the great French naturalist Cuvier (1783-1844) who described the three-toed *Anchitherium*, recognized its horselike characters, but as he did not believe in the evolution or change of species, he naturally did not regard it as an ancestral equine. Other French naturalists described a number of other species with similar results. In England the great comparative anatomist Sir Richard Owen, had the good fortune in 1839, 1842, 1857, to discover in rocks of Eocene age the fossil remains of what is now regarded as one of the most ancient and primitive horses known (the term horse being used here in a very broad sense), namely, the little four-toed *Hyracotherium*. Darwin's great work on the "Origin of Species" (1859) set naturalists searching for "missing links" and ancestral forms, and so the French naturalist Gaudry in 1865 fully recognized the equine affinity of the three-toed fossil genus *Hipparion* of Greece and the ancestral character of the horses of the Upper Eocene period. Finally, Huxley predicted in 1870 that the horse and all other hoofed mammals would be traced back ultimately to a form with five toes on each foot, and both Kowelevsky and our compatriot Cope prophesied that this generalized form would have bunodont, or low-crowned, grinding teeth. Finally, the discoveries of Leidy, Cope, and Marsh (of Yale) in this country first made clear in a general way the successive steps of equine evolution, and furnished Darwin and Huxley with a celebrated instance of evolution as indicated by fossil history.

Evolutional changes involve either, (1) the remodeling of old parts, as in the evolution of the grinding teeth; (2) the reduction of certain parts and enlargement of others, as in the loss of inner and outer toes and the great enlargement of the middle toe; (3) the coalescence or fusion of parts, as in the case of certain wrist bones and the fusion of the two forearm bones (ulna and radius); (4) the addition of new parts, as for example the great increase in the total number of cusps in the premolar grinding teeth. Thus "evolution" does not imply a uniform advance of all organs. If some develop, others degenerate. In the feet, the outer and inner toes (like Peter) were "robbed to pay Paul" (the main middle toe). Sometimes we seem to have evidence that evolution has taken place in a definite or determinate direction, as if, for example, the final complex pattern of the horse's grinding teeth were the goal toward which the trend of evolution had been aimed from the first. In fact, as shown by a series of photographs, all the elements of the complex later teeth are present, as it were "in embryo," in the crown of the molars of the ancestral *Protorohippus*, the grinding teeth being low-crowned and their crowns with low tubercules, instead of the elaborately folded crests of later types. Hence, all the earliest hoofed animals retain this condition more or less fully, and among early horses the famous *Protorohippus*, the virtual founder of the horse dynasty, makes the nearest approach to it. A number of illustrations published some time ago in these columns represent the skeleton, the foot structure, teeth, and probable appearance in the flesh of this fascinating little creature, which was actually smaller than the head of one of its modern representatives. The *Protorohippus* had already lost by reduction the inner or first, and the outer or fifth toe in the hind foot, and most of the inner or first toe in the fore foot. This process of reduction was demonstrated to have gone on until in the final stage of evolution but one great toe, the middle of each foot, remained. The reason for this change is quite apparent. The horse family has made speed the keynote of its evolution; it had elected, as it were, to run instead of to hide, to seek for food over a wide area. One factor of speed is length of limb;



Skeletons of the Modern Horse (Above) and of the Small Four-Toed Horse (Below), Showing the Superiority in Length of Limb of Modern Horse.

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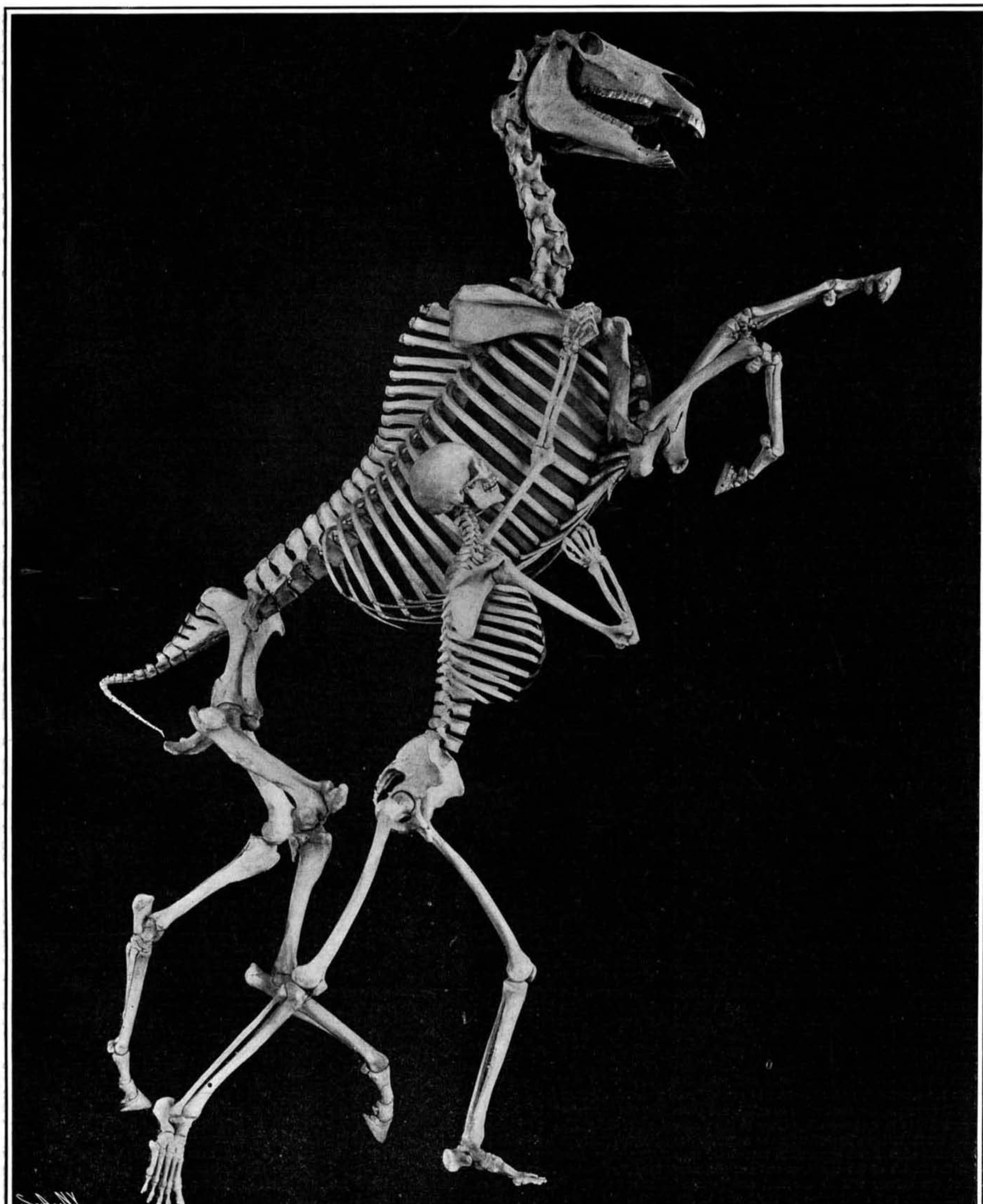


Skeleton of a Man and of a Horse Mounted for Comparison. Man Has Retained More of the Primitive Features Common to All Mammals, the Horse Being Far More Specialized in the Structure of Its Limbs and of Its Grinding Teeth.

THE EVOLUTION OF THE HORSE.—[See page 81.]

wherefore the "horse" rose up on its toes, and the toes began to elongate. The first effect of this was to lift the shorter toes, Nos. I and V, clear of the ground, and being no longer useful in supporting weight, they speedily dwindled and vanished. Meanwhile the middle digit had to bear more and more weight, and hence it grew larger. The process of getting up on tip-toes being continued, Nos. II and IV followed Nos. I and V, until finally only No. III, the middle toe, remained, with vestiges of I and V.

A Fireproof Theater of Armored Concrete.

A well-known German firm is building a miniature fireproof theater of armored concrete, which is specially intended for fire tests, and is to become a model theater where any safety devices which have so far been suggested against the danger of fire, as well as any preventions that might be proposed in future, will be demonstrated.

The theater is to be fitted with a stage of 7.5 meters breadth and 6 meters depth, separated by an iron curtain from an amphitheater 5.5 meters in breadth and 7 meters in depth. The stage consists of the resting place, the rolling floor, a working gallery to the right and another to the left, and an adjusting bridge. The latter parts are of iron, and are suspended by ties of the same material from the ceiling, which consists of massive Monier concrete. The amphitheater consists of a simple gallery with lateral issuing staircases leading into the open. Special rain attachments are to be provided.

In connection with the experiments contemplated, the outlets through which smoke of a fire may escape will be studied with especial care. Any combustible decorations exposed will be fitted as in actual operation. It is thought possible by these experiments to find out devices for rendering a stage fire ineffective to the amphitheater. If the gases are led away promptly and safely from the stage into the open air, and if sprinkling proves an efficient fire-extinguishing agent, an amphitheater of fireproof construction might be safe against any danger of fire. According to a report in Der Gesundheits-Ingenieur, it is intended to make fire tests before filled amphitheaters.

Accident to the Montgomery Aeroplane.

On July 18, in the presence of 2,000 persons who had gathered at the Santa Clara College grounds to see the flight of Prof. John J. Montgomery's aeroplane, the "Santa Clara," the machine collapsed when at the height of nearly half a mile and Aeronaut Daniel Maloney was hurled to the ground. The flying machine was shivered into fragments, and Maloney, who was picked up with a fractured skull, lived only an hour.

A balloon raised the aeroplane to a considerable height. When the fabric was but a speck in the sky, balloon and aeroplane slowly parted company. To the left the aeroplane slowly circled, cutting pretty figures. Maloney seemed to have perfect control of the machine.

Then, suddenly, the device refused to obey the guiding hand of the aeronaut, and with an abrupt circle it plunged quickly to the left and nearly overturned. Maloney could be seen struggling with the guide wires, but it was apparent that his efforts were futile. The machine fell swiftly earthward. One of the wings collapsed as the aeroplane gained added impetus and the mate snapped from its support and fluttered limp in the air. The front wings still remained outspread and checked to a slight degree the swiftness of the descent, but down with fatal impetus the aeroplane came through 2,000 feet of space.

The disaster was probably due to the guy rope catching one of the wings of the aeroplane as it was liberated. The machine has been fully described in these columns.

The Current Supplement.

The current Supplement, No. 1543, opens with a most thorough article on motor omnibuses in London, by the English correspondent of the Scientific American. The article excellently shows how automobile omnibuses are competing with English tramways and gives valuable data. The Cerebotani facsimile telegraph is described by Emile Guarini. Mr. Brysson Cunningham presents a most instructive article on concrete, giving much practical information. "An Island Prison on the Forth," is the title of an article which describes the picturesque Bass. The English correspondent of the Scientific American writes on a torsionmeter for recording the horse-power of steam turbines. Dr. Alfred Gradenwitz contributes a brief but interesting article on the use of bronze castings for naval purposes. Many years ago Prof. Henry Draper prepared a monograph on the construction of a silver glass telescope 15½ inches in diameter in aperture and its use in celestial photography. That monograph to this day is by far the best treatise of its kind ever written on the construction of a reflecting telescope. The Editor of the Supplement has deemed it advisable to republish this valuable monograph and accordingly the first installment will be found in the current issue.

A NEW INTERRUPTER.

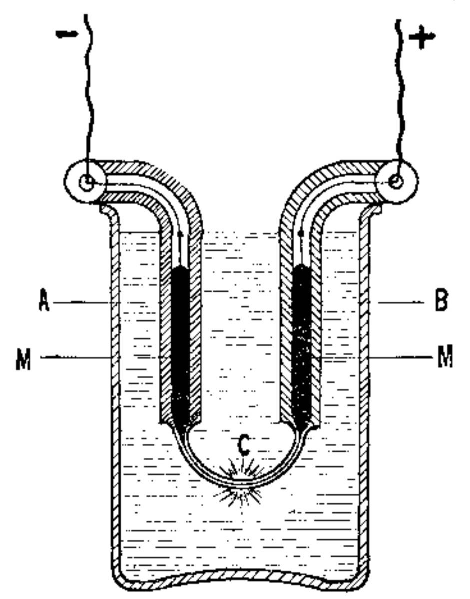
BY HUCK GERNSBACK.

Experimenting with different magnetic and electric interrupters, the idea occurred to me that it might be possible to construct an interrupter whose chief functions would be based upon the expansion and contraction of mercury, when heated, by passing a current through it.

After many fruitless experiments I succeeded in making such an interrupter, and the definite form that proved most satisfactory is explained in the following lines:

A barometric glass tube of about 15 centimeters length, with a central opening of 3 millimeters, is heated in an oxy-hydrogen flame and drawn into the shape, as shown in the accompanying drawing. This is by no means easy, as the tube, *C*, which represents the main part of the interrupter, must be so attenuated as to leave a capillary bore within, its minute diameter not surpassing ⅛ of a millimeter.

Heat the middle part of the tube over the flame by constantly rolling the ends between three fingers of each hand, till it is red hot and soft. Take the tube quickly out of the flame, and draw it straight out, till it is thin enough; then bend it into the right shape, and let it cool slowly. Of course, these manipulations have to be done quickly, because the glass will not remain soft very long in the open air, and it is nearly impossible to draw the capillary tube when the flame touches it. The tube has to be filled then with chemically-pure mercury, which is easily done by placing the end of the open column, *A*, in a receptacle containing the quicksilver. By drawing the air out of *B*, the mercury will quickly mount in *A*, then pass through *C*, and rise up in *B*. It is well to only half fill both columns. The apparatus will generally work



A NEW INTERRUPTER.

satisfactorily, when the whole arrangement can be placed in any desired position without the mercury flowing out of it. This is a sign that the capillary tube, *C*, is sufficiently attenuated.

Two thin platinum wires are introduced into *A* and *B* till they dip in the mercury. The apparatus is put into a vessel containing water, which serves to constantly cool *C*, which part would soon break in the open air. Connect the two wires with two small storage batteries, and the interrupter will start instantly. In the middle of *C* there will be a bright bluish-green spark, and a high-pitched tone will emanate from the interrupter, indicating that the interruptions are of high frequency.

I found that this interrupter works most satisfactorily with 4 to 6 volts; it will consume, when made according to directions, from ¼ to ½ ampere, and run as long as desired. By making the part, *C*, of a larger cross-section, the voltage may be higher and more current will be absorbed, but the interruptions will be very unsteady and irregular, and will very often give out entirely.

The instrument, I believe, cannot be used with high tension currents, as it is too delicate, but it will work satisfactorily in connection with small induction coils, for instance, although a condenser will be required.

The explanation as to how this interrupter works is as follows:

The instant the current is closed, the mercury at the smallest cross-section in *C* will become so heated that it commences to boil, and the force of the resulting bubbles, falling against each other, will be sufficient to make a momentary rupture in the thin mercury column. There will be a little shock, and the expanding quicksilver will rise in *A* and *B*. Of course, a vacuum will be created at the place where the rupture occurred; and as the tube is immersed in water, the mercury will stop boiling; it cools instantly, then contracts, and the atmospheric pressure, combined with the weight of the quicksilver columns in *A* and *B*, will help to bring the metal in contact again, after which the same play commences as described.

The Charcot Expedition.

An interesting lecture on Antarctic exploration was recently delivered before the British Royal Geographical Society by Dr. Jean Charcot. This explorer has only recently returned from an expedition which was organized and primarily financed by himself, and the lecturer related the results of his researches. Dr. Charcot limited his expedition to the survey of the northwest coast of the Palmer Archipelago (Hoseason, Liege, Brabant, and the Antwerp Islands); the exploration of the southwest entrance to the Gerlache Strait and of Graham Land, with a view to elucidating the Bismarck Strait, and to follow the coast as far as Alexander I. Land, so as to substantiate and further the labors of the Gerlache and Nordenskjold expeditions.

His vessel, the "Français," was of only 245 tons. The staff consisted of six unpaid officers and a crew of fourteen, all French except one Italian, an Alpine guide. Dr. Charcot himself was captain, doctor, and in charge of the bacteriological studies. The expedition left Buenos Ayres on December 23, 1903, reached Smith Island (South Shetlands) on February 1, 1904, and thence went on to Low Island. Coasting the northwest side of the Palmer Archipelago, they entered Briscoe Bay, and afterward stayed eleven days in Flanders Bay. Then, after erecting a cairn on Winche Island (this cairn was missed by the Argentine relief expedition, which therefore believed and reported that the "Français" and her crew were lost), they sailed on and reached Pitt Island on February 26, but were compelled by ice to return to Wandel Island, where they wintered. The ship was protected from ice brought in by the northeast gales, with cables across the mouth of the narrow haven. They erected a portable house, excavated storehouses, and set up shelters and instruments for magnetic observation, observation with quadrant and sextant, and so forth. The temperature varied much and suddenly; the lowest was —30.4 deg. F., but a rise from —22 deg. F. to 26.6 deg. F. in a few hours was not uncommon, and was always followed by violent gales from the northeast, which broke up the ice between Wandel and Hovgaard islands, and so prevented any move being made, in spite of many efforts. In December a channel was made by means of melinite and saws and picks, and the "Français" returned to Winche Island. Early in January they came in sight of the Briscoe Islands, and on January 11 saw Alexander I. Land rising very high on the southeast. The voyage was continued in great difficulty and danger in the hope of finding means to reach the land, on which several peaks hitherto unknown had already been descried. On January 14 the "Français" struck a submerged rock, and received damage which necessitated pumping incessantly all day and night, and this was maintained for weeks until the ship so far recovered as to be safe with only fifteen hours' pumping, in which condition she ultimately returned to Buenos Ayres. The new coast along which she was sailing was surveyed, drawn, and named after President Loubet, and the "Français" turned north again past the Briscoe Islands, the expedition completing its survey as it went, and finally reached Puerto Madryn on March 4.

Another Device for Preventing Seasickness.

An ingenious self-leveling sea bunk for vessels, the object of which is to overcome the discomfort to the passenger of *mal-de-mer*, has been devised by a London dentist. It has now been in successful operation upon one of the mail-boats plying across the English Channel. The device comprises a swinging cot with four cords passing from the corners to electric brakes, which automatically check any attempt of the cot to depart from its position. While the cot remains level, the cords are free to pass on and off the pulleys on the brakes. The slightest loss of horizontality of the cot causes mercury in four tubes to fall in some of them and rise in others, and so complete the electric current to the particular brake required to be put in operation to check the further loss of horizontality. The loss of level from the variation of the position taken by the passenger is automatically compensated; water being practically the same specific gravity as the human body, a heavy man will press more water to the foot of a specially-designed water bed than a light weight, as also from side to side.

The Dangers of Cheap Leather.

The danger attending the use and wearing of adulterated leather is not perhaps fully realized. A large amount of the cheap leather is weighted with glucose and barium, especially the latter, so that when the weight test is applied, such adulterated leather may pass as first-quality material. Leather so treated, however, has the peculiar quality of absorbing moisture freely and retaining it to an extreme degree. The result is that a boot made of this chemically-treated material is in actuality never dry. Even in the driest weather the perspiration of the feet is sufficient to render the footwear dangerous, as such natural moisture acts upon the inner sole and collects there.