"Convenient!" said Stratford. "Of course it is entirely convenient. Here is the room which you had before, all ready for you."

"That is very good of you," said Thorne, "and I don't mind in the least telling you why I came down here, or up, whichever it is. It is all on account of Miss Armatt. I never had anything take possession of me as that girl has! I have tried to be proper about it, but it's of no use. In fact, I am tired of being proper. It doesn't pay. Sometimes it makes me sick to see everything straight and proper about me, for I am just the other way myself. I have worked hard at one thing, and I have worked hard at another; that doesn't help me at all; I am thinking of her all the time.—Then I sat down, and said to myself: 'This trying to do the right thing is all stuff and nonsense. There is Stratford; he doesn't trouble himself about anything of the sort, and he is happy. If he likes a girl, he makes himself agreeable to her, he spends his time with her, and he carries out his theories. It doesn't make any difference to him that she is engaged to be married to some one else; now, why should it make a difference to me? I cannot expect to make myself agreeable to her, nor to spend my time with her, and I have no theories to carry out, but I can go there and look at her again.' And that I determined to do. Now, I know very well that even this is not right; that it is unjust to myself, and unjust to the man who is engaged to Miss Armatt. But, as I said before, I am tired of doing right. That sort of thing doesn't help me any. It simply gives me the worst of everything and puts me in the background; and I have made up my mind to drop it. Of course this is all very astonishing to you, Stratford, but I determined to be quite frank and open with you, and let you see everything just as it stands."

Stratford drew a long breath. "I wish to be perfectly frank and open with *you*," he said, "and therefore deem it my duty to tell you that Miss Armatt is not under promise to marry any one. Her engagement with Mr. Crisman has been broken off."

"Good Heavens!" exclaimed Thorne, springing up so suddenly that his chair fell backward on the porch.

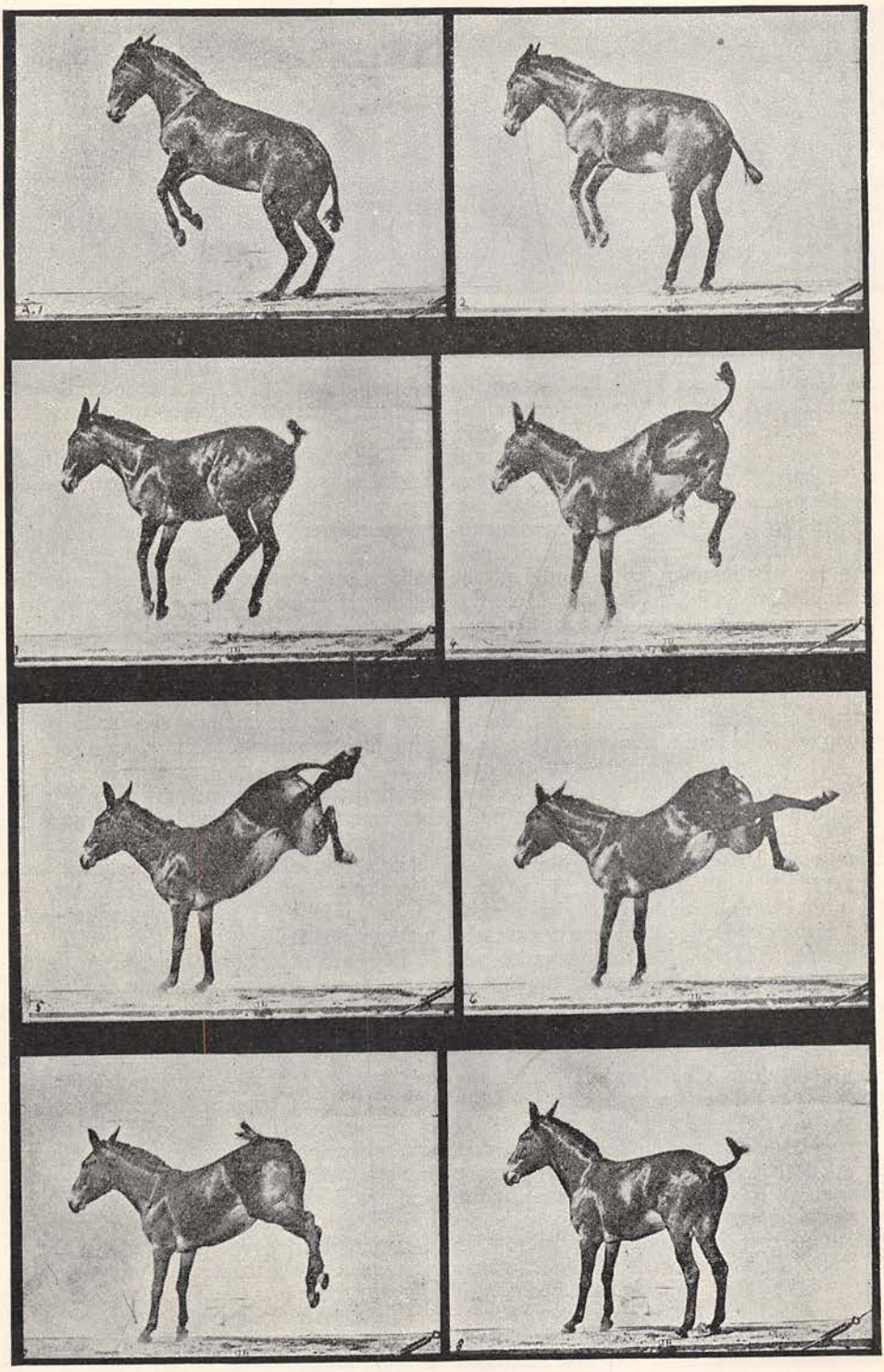
(To be continued.)

Frank R. Stockton.

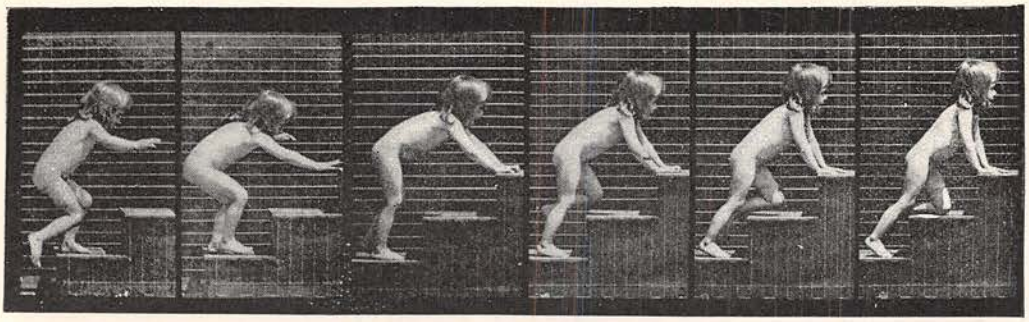
ANIMAL LOCOMOTION IN THE MUYBRIDGE PHOTOGRAPHS.

IT is now nine years since the photographs of Eadweard Muybridge, taken in California, surprised the world by challenging all received conceptions of animal motion. Their subsequent publication in "The Horse in Motion," in 1882, constitutes the most considerable record on the subject hitherto accessible. In the interval since their appearance, it has become clear that what was at first presented as altering the portrayal of living movement was in reality an important addition to the instruments of scientific research, by extending observation along a path where the limits of human sense had barred advance. For the past four years the University of Pennsylvania, chiefly through the efforts of Dr. William Pepper, its Provost, has furnished Mr. Muybridge the apparatus and the scientific supervision requisite to widen the record and extend the research of instantaneous photography into the method and mechanism of animal motion. Whether animals should be drawn as they appear in the camera is still *sub judice;* but there is no question whatever that in no other way can they be seen for the study of their locomotion.

We see with a camera whose drop-shutter winks in a thirtieth of a second, but on whose plate impressions last for from a sixteenth to an eighth of a second, so that moving objects for any space they cover in this time appear either as blurred, like the shimmer of a turning wheel, or continuous, like the circle left by a whirling and lighted stick. To read this record takes the brain an appreciable fraction of time—at least one five-hundredth of a second. If the four feet of a quadruped are in consideration, there is the absolute dead-wall that when a leg moves there are five points to think about together and the mind can only carry four objects at once in consciousness—as more than one confused observer has found in trying to catch and carry the sequence of footfalls in the slowest walk of horse or cow. These limits of brain and eye, not in what is unseen but in what is seen, are less easy to appreciate and accept as fundamental than those with which we are more familiar. That we cannot see under a certain size or beyond a certain distance, that the retina makes no accounting of the photographic dark beyond the violet and knows naught of the heat dark this side the red, that in the world of unheard sound about us some notes we cannot hear because they are too high and some because



MULE BUCKING AND KICKING.



CHILD WALKING AND CRAWLING UPSTAIRS.

they are too low, that we live in a world of odors of which to our grave loss we smell a bare hundredth part of what a healthy dog smells,—these limitations we daily act upon, and the use of all instruments of precision rests upon them. The use of instantaneous photography in reading the secret of motion was as much the introduction of a new instrument of precision to supply the lack of sense as the use of the microscope, and had the same limitations in its application. More was claimed than was meet, and less admitted than was true, of the revelations of Mr. Muybridge. Art is one long convention which accepts the ordinary impressions of sense in interpreting nature. "Flowers, like everything else that is lovely in the visible world," says Mr. John Ruskin, "are only to be seen rightly with the eyes which the God who made them gave us, and neither with microscopes nor spectacles." The artist responds to science, not in her discoveries, but in their influence in changing the general and average perception of nature. Landscape art has not been altered by geological discoveries, but their collective influence has created an atmosphere in which an artist breathes uneasily if he has put slate débris at the foot of a basalt cliff.

The real discovery which Mr. Muybridge made was, therefore, the addition of a new method of research, which put before the eye what it could not see unaided.

To obtain the results of this new method through a complete and consecutive series of observations, carried on with a definite purpose under a scientific direction as proposed by the University of Pennsylvania, required in an abundant measure both time and money. The late Mr. J. B. Lippincott, of Philadelphia, whose interest in the lower animals had shown itself by his repeated gifts to the veterinary department of the university, was much interested in the investigation, and liberally advanced the preliminary expenses. Additional advances were made by a committee of five guarantors, under the stipulation that the scientific conduct of the work should rest in the hands of the university through a commission appointed from its faculties to supervise the work.

When the work, begun four years ago, was completed, $30,000 had been expended, and 100,000 plates exposed; and the final results, as reproduced by a photo-gelatine process, extend, in the completed work, through 781 folio sheets, presenting over 20,000 positions assumed by men, women, and children, draped and nude, and by birds and animals in motion. Human action is extended through all the round of work and play, for both sexes and all ages; the Zoölogical Garden was drawn upon for animals, the university hospital for instances of disease, and the entire field of athletic action was covered by university students, some of them "record-breakers." The photographs of moving animals taken in this work nearly equal all others, while those taken by Mr. Muybridge covering a series of motions automatically timed are many fold the successive exposures ever made elsewhere.

The merest beginner can spring a drop-shutter so as to obtain a single exposure of a moving object. To secure a series of such pictures accurately divided in time and evenly distributed in space is a different matter, and can be achieved only by successively exposing different plates or exposing successive portions of the same plate. The latter has been the favorite method of Monsieur E. J. Marey, the French investigator in this field, who whirls a perforated disk over an instantaneous plate before which the object is moving. This is the principle of the zoëtrope, but with the plate where the eye is in the toy and with the slit whirling, instead of the painted ring of figures. When a man turns a somersault before this apparatus, the developed plate shows him flinging himself in successive positions across it, as each successive slit in the perforated disk lets in a new image as it passes. A "battery" of cameras in a row, tripped in suc-

cession as the object moves before them, has been the method usually employed in this country. In the familiar illustrations taken in California, each camera was exposed by a thread which the moving horse broke as he went across the field. In the present researches, an electric circuit worked by a chronometric apparatus opened and closed each shutter. The studio through which this great defile of life-studies passed was a fenced space open to the sky. A screen, before which the object moved, reticulated in small squares of 2 inches and large ones of 19¾ (5 and 50 centimeters), whose net-work appears on the background of some illustrations, faced a "battery" of from 12 to 24 cameras. At right angles stood another row, arranged perpendicularly, and for many movements a third set was employed. Each act was therefore raked fore and aft as well as registered in passage, and was often covered from top to bottom besides. Sloping white screens "threw up" the under lights. Beyond all, there was above neither roof, glass, nor sky-light, nothing but the clear and open sky. For photography which has to do with the human figure, so rarely exposed to the frank, kindly, and searching light of the heavens, this is a difference, not of degree, but of kind. There is no mirror, no reflector for diffusing a perfect light like the perfect arch of the sky. To one familiar with work from the model, and knowing the chill and steady north light of the studio and the life-class, dead to changes, there was full suggestion in this long succession of studies and poses in the complete light of day, complex, intricate, but full of teaching in form, in motion, in texture, and in color. It will be a broad service to art if the study of these photographs suggests to some one the possibility of putting under the searching sky work from the life. It would change its *motif*, as landscape art has been transfigured by a like translation to the haven and heaven of nature.

Minute photographs were taken by the cameras in action, and were enlarged from the small representations of beast or bird to the illustrations used in this article, which picture but portions of the original plates. Full light, careful manipulation, and perfect lenses enabled these enlargements to be made without distortion, replacing the silhouettes which are the usual and familiar result of instantaneous work by prints distinct, defined, and determinate. A new device, opened and closed by the automatic action of an electric circuit, reduced the exposures to a point apparently much below any previous record. Careful calculation tends to show that the exposures of a number of plates must have been less than $\frac{1}{2000}$ of a second, and not impossibly as low as $\frac{1}{5000}$. In practical work, however, $\frac{1}{600}$ to $\frac{1}{800}$ of a second proved fully short enough to catch the phase of a stride of a horse, and $\frac{1}{200}$ of a second was used for most of the slower movements. No clock can measure these brief intervals, but a tuning-fork, keyed to one hundred vibrations in the second, left its tell-tale dots on a moving cylinder where the opening circuit which tripped the cameras made their marks. It is possible that elements of error as to time exist in such a method absent from M. Marey's, but they are counterbalanced for popular exposition by better pictorial results.

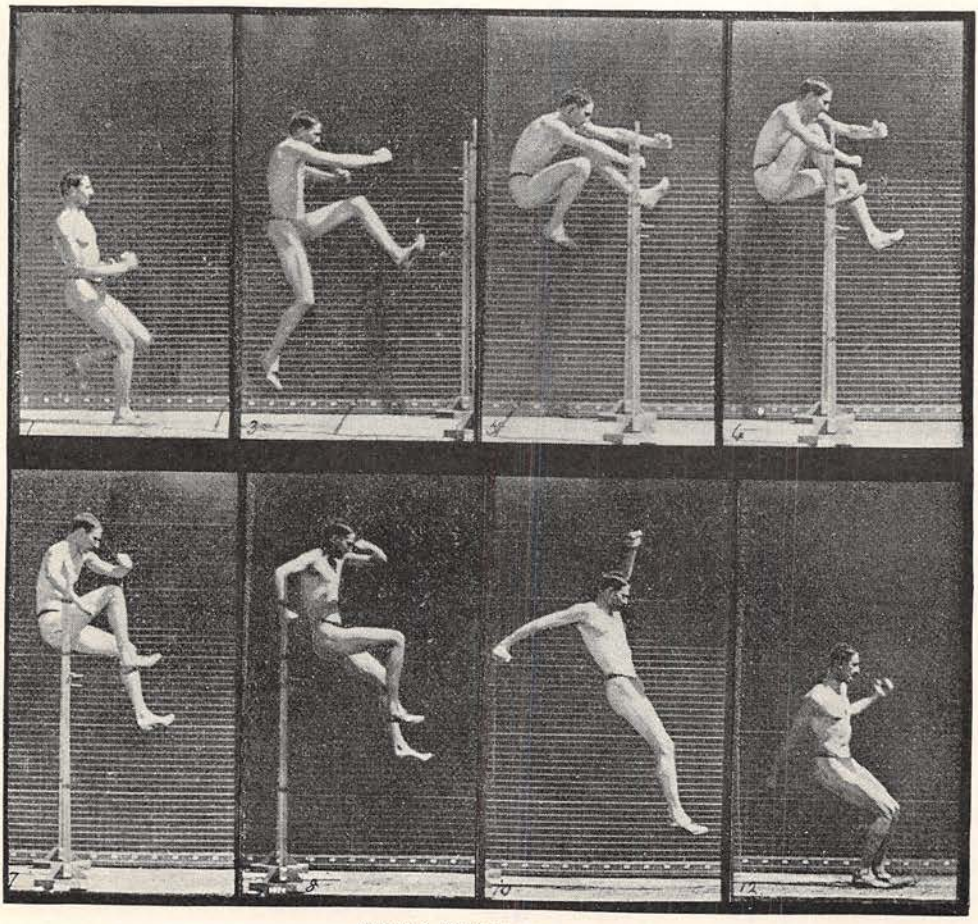
The great body of records secured by these methods makes no such special revelation as Mr. Muybridge's earlier photographs. The attitudes which amazed the world then were accepted by most, as they were by Mr. George E. Waring in an article in THE CENTURY for July, 1882,* as settling the manner, method, and mechanism of progression by the horse and dog.

But, now that a broader record is presented, there is tolerably certain to be something of a reaction to the more familiar views of movement. The wet-plates of a decade ago gave simple outlines and not rounded pictures. Greater skill and care in manipulation, and more numerous examples, make it clear to any one who examines the photographs presented here, that the impression of automatism left by the earlier illustrations disappears in these later views of motion. The character of the stride, certain simple facts in the sequence of footfalls, and the alternation of support were reasonably well conveyed; but less apparent manifestations, which convey both the character of the individual animal and the characteristics of each motion, disappeared in the dense shadows of the earlier silhouettes. If, as Mr. Waring said of them five years ago, "the testimony of the zoëtrope, and, later, of the zoöpraxiscope, has silenced all skepticism, and one can no longer hesitate to concede the truth and simplicity of what at first seemed complicated and absurd," still, I take it that no one who had ridden a horse or loved a dog but felt a certain outraged sensibility in being assured that creatures whose footfalls, the slip and swell of whose shoulders, and the gathering arch and spring of whose back had an individuality all their own, as distinct as the pressure of a friend's hand or the tone of his voice, were four-legged machines chiefly occupied in balancing on one toe, straining a pastern to breaking, or gathering their legs in a disorderly bundle on their stomachs. These photographs, taken under more favorable conditions, give each of the remarkable positions

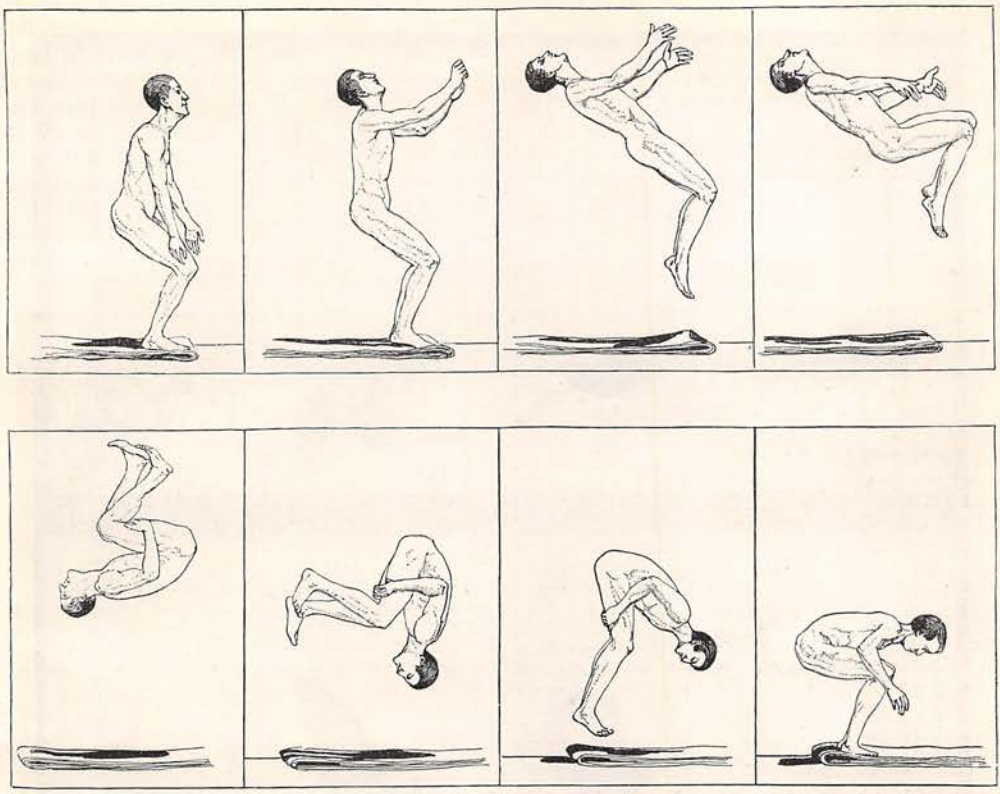
* "The Horse in Motion," by George E. Waring, Jr. CENTURY, Vol. 24, p. 381.

which repetition has made familiar and to which even repetition can scarcely reconcile us; but they are given with subtle variations, with change and alteration, with departures from the automatic sequence first suggested, which show how individual is the movement, not merely of each species, but of each animal.

The University Commission intrusted to Dr. Harrison Allen, emeritus professor of physiology in the university and a comparative anatomist of high rank, the work of studying the entire series, with the view of eliciting and illustrating the laws of animal motion and muscular action shown by it. Dr. Allen has published his conclusions as a preface to the memoir on the series, in which will also appear the results reached by other investigators. These conclusions somewhat redeem the unaided human eye from failure to catch the principle of animal locomotion. The apparent spring from the fore foot, which was the most conspicuous revelation of the photographs of the "Horse in Motion," led its author to assert that in the work of propulsion and support the fore limb "does more than its share of both offices." Dr. Allen offers a different theory. These rounded photographs of the play and action of muscle suggest that the history of animal movement is the development of the rear limbs for use as a spring and source of energy and of the fore limbs as a basis of support. For the race-horses, the fore limbs are vaulting poles. To them, when the hind-quarters have given their powerful impulse, he passes; on them he balances; and from them he moves on to the next gathering launch of his haunches. Through generations of adaptation, the slender, "clean" fore leg has become a straight but springy column of support. The great muscular system of the shoulder is, in Dr. Allen's view, little able to give the leg impulse, and is arranged for support about the firm shoulder-bones which hug the spine — the horse has no collar-bone to smash like a bow bent beyond its limits, as his



RUNNING STRAIGHT HIGH JUMP.

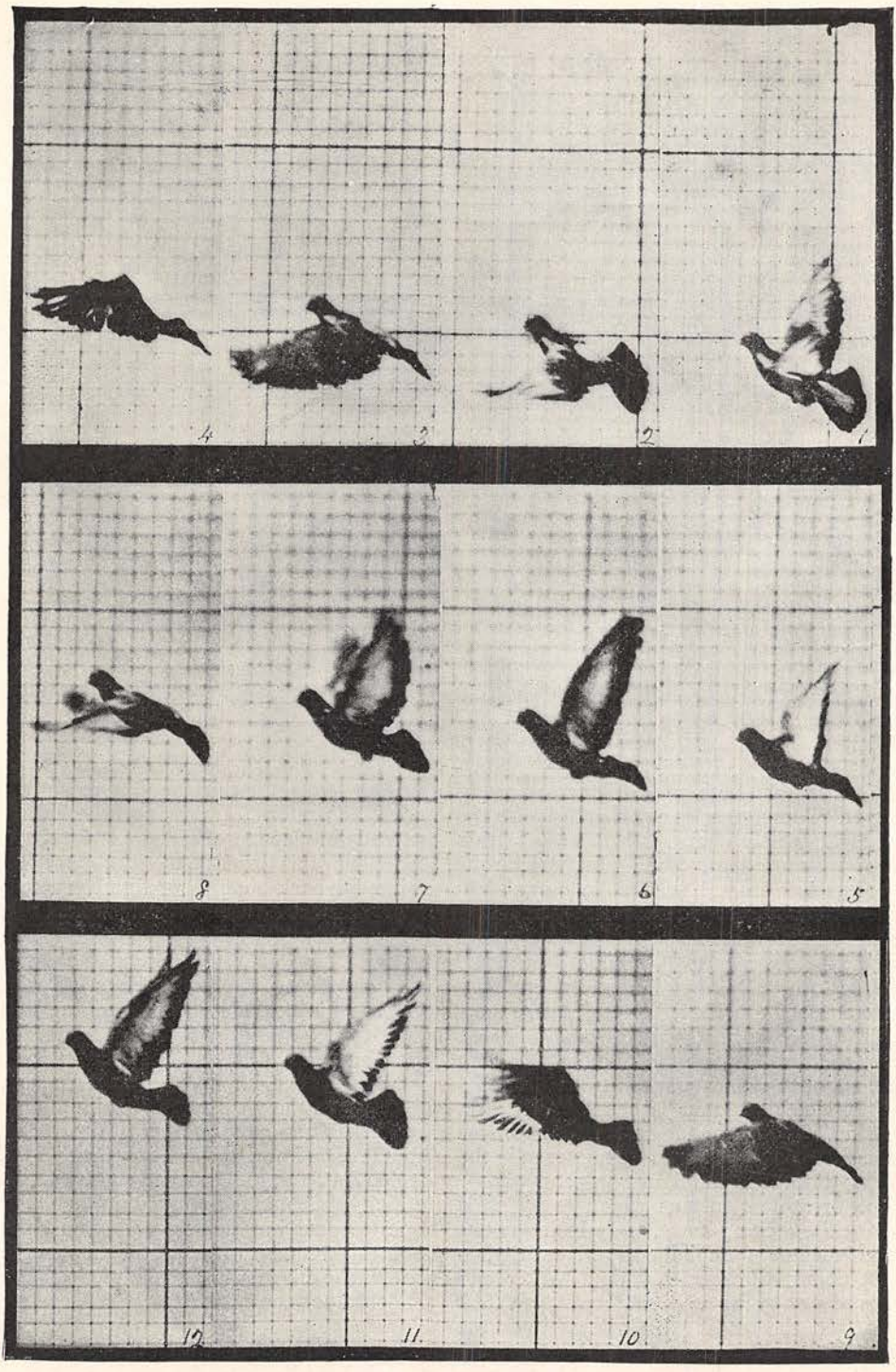


BACK SOMERSAULT.

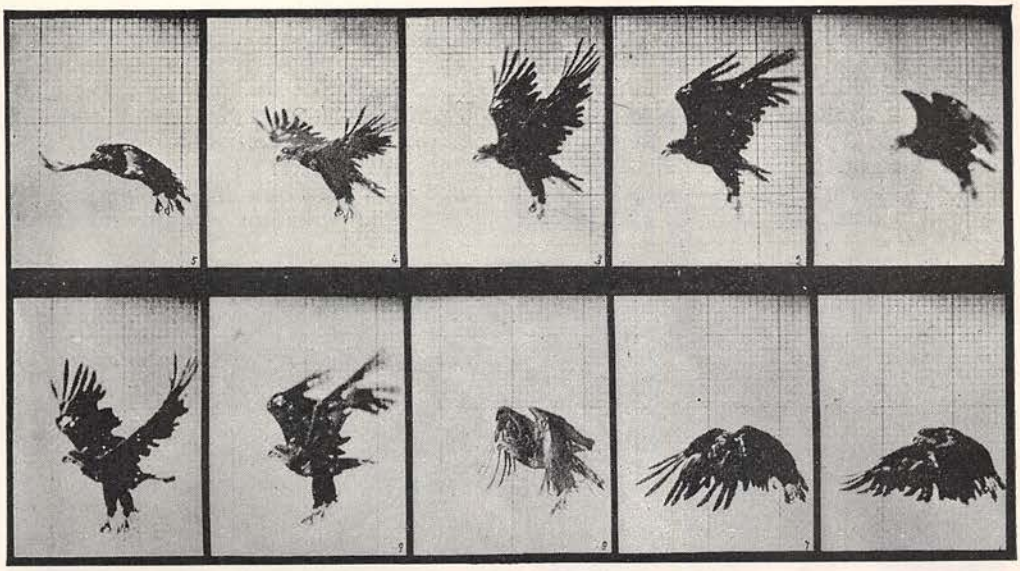
rider's does when both go headlong in an ugly cropper. These muscles catch and diffuse the shock with which a horse in his forward stride lands on his fore legs. Each joint, which rolls so simply with smooth surfaces in animals less highly organized for speed, has become in the horse tongued and grooved at elbow, wrist, and knuckle,— to apply to "shoulder," "knee," and "pastern" joints their human analogues,— the fore hoof has widened to a larger support than the hind, largest of all in draught-horses, where the fore feet are the fulcrum on which the push of the hind-quarters turns, until the straight elastic column is equal to its task, breaking, if at all, at the springy joint whose flex carries off the shock of impact even in the rushing descent in the figure on page 367.

The breathless instant which every child knows on a rocking-horse, and which any one of vivid memory for childhood will recall, when doubt comes whether this time rocker and rider are not going to pitch forward on their noses, and the settling back in safety on the hind rockers, illustrate very fairly the swing by which a horse passes from stride to stride — with the advantage in the horse that he swings his hind rockers forward as his body launches on past the perpendicular support of the fore leg, until this too has passed from under the center of gravity and the hind legs are ready in place to offer support for the next stride. For this impulse, the hind-quarter rivets into the back-bone, whose lumbar vertebræ can double like a curving spring under the pull of the great system of muscles whose sheathing swell is so plainly apparent in the figure on page 367 as the horse flings his weight over the hurdle. How far this spring of the loins can go stands graphically forth in the figure on page 367. The buck, first with one foot and then with both, the return to the ground, and the vicious lash behind, fall well short of half a second; but there is time in this to show at once how rigid and how flexible is this mechanism. Or, as Dr. Allen says, with a scientific elegance and accuracy no layman can hope to equal in touching at a safe remove upon this frequent object of the paragrapher's pen, "The excursus of the hind legs is dependent upon the flexibility of the lumbar vertebræ."

So, too, as an elastic bow suddenly and strongly bent has a tendency to spring to one side and another, the horse's rear limbs, taken as a whole, tend to spring out; and it is this spread outward of the stifle or upper joint



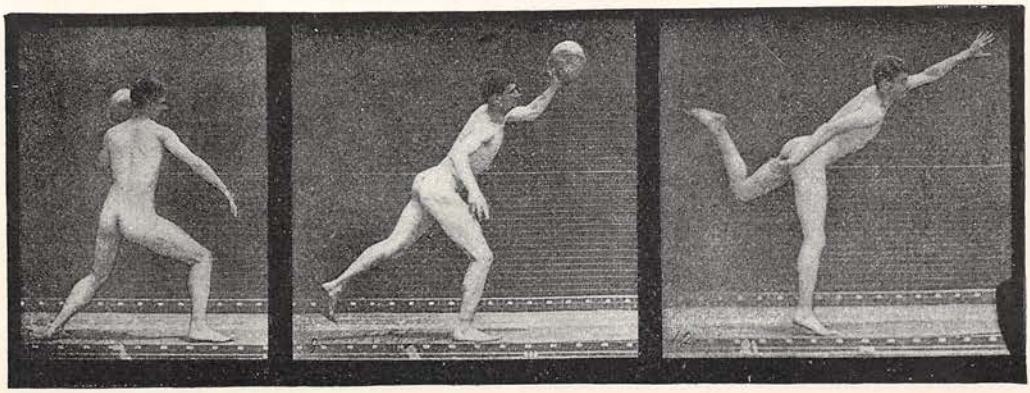
PIGEON, FLYING.



AMERICAN EAGLE, FLYING.

and bend inward of the back or "knee" which gives the "stifle action" whose presence is accepted as the sign of speed present or to be transmitted. In a dog moving at full speed, the back, in furnishing these impulses, doubles like a bent bow, giving those curious foreshortened curves which at swift intervals turn a coursing hound in all appearance to a rolling ball as one rides hard behind; and in more than one instance these photographs show that the impulse of the hind legs is strong enough to keep the fore legs busy through two or three steps as the dog goes balancing forward, shot on by the curving spring of back-bone, haunch, and hind leg.

Such a view of animal movement has its support, Dr. Allen urges, to summarize his views, in the circumstance that the earliest progression was by the hind legs alone, still apparent in the kangaroo, and yet more striking in the earliest animals. If the path by which vertebral movement has developed be followed, a regular sequence appears, beginning with lizards like the salamander, whose legs are spread straight out on each side and move independently. By degrees and by pairs, first back and then fore, the legs of quadrupeds turn downwards until they have gone through all the successive angles, and reach in man the possibility of fore and aft extension. Just as a series of angles can be drawn beginning with the reptile prone and moving up by a growing angle until man stands at a right angle with the ground, so the legs spread flat in lizards of an early type slowly crook down until they are bent under the crocodile, extend straight down, bent a quarter circle around, below higher quadrupeds, and can at last be placed in a direct line with the trunk in man. *Per*

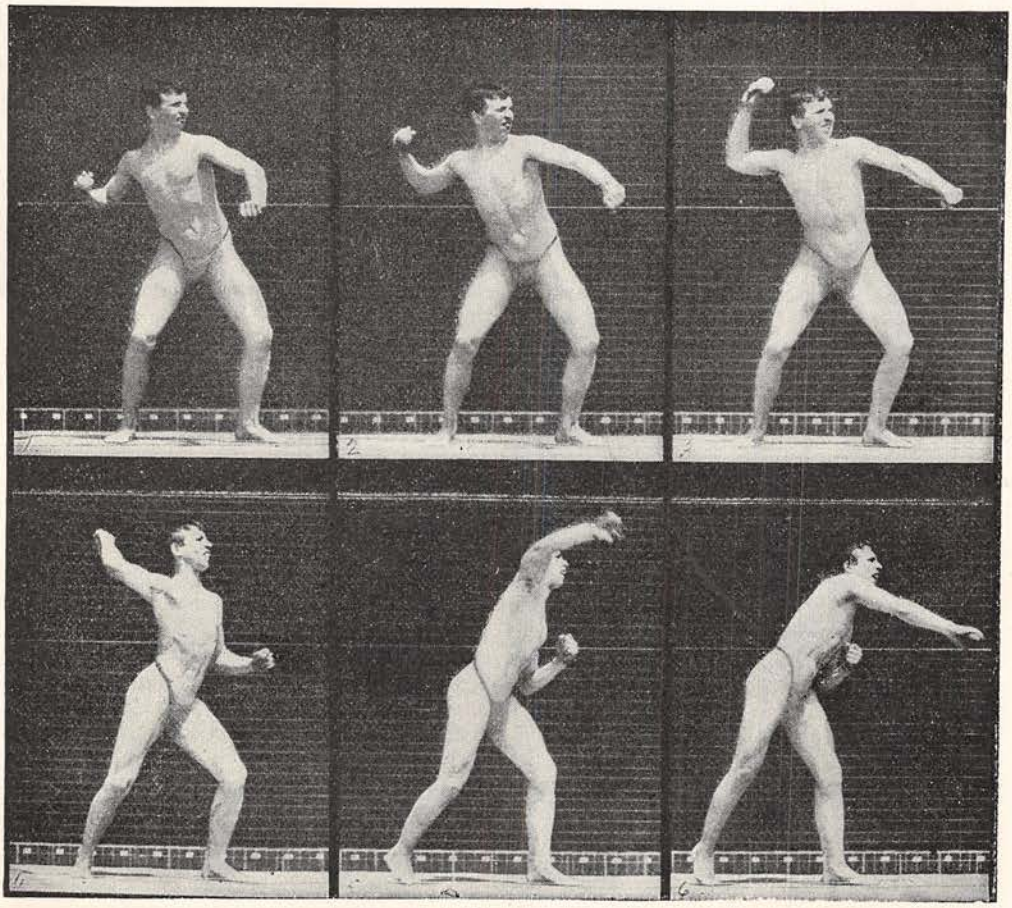


THROWING A TWENTY-POUND ROCK.

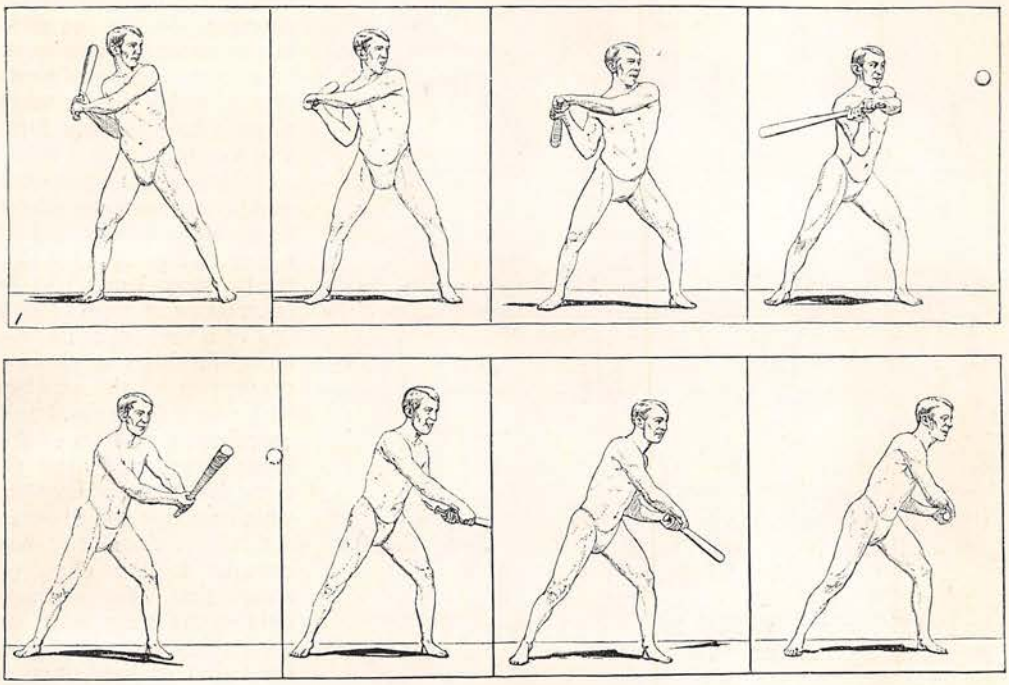
contra, the bird, which is a slip backwards, a "no thoroughfare" in the ascending series of creation, bends its wings upward to the reverse angle of the quadruped. All the progress of specialized motion, as it grows from the simplicity of the hop, through the leap, the canter, the run, the trot, an artificial gait, and reaches in the walk the most intricate of all natural motions, preserves lift and impulse from hind-quarters and the spring-balance and moving support of fore.

This theory of animal motion being a reaction from the first position assumed on the subject, it is not impossible that the ultimate decision will rest somewhere between. Without assuming to pass upon an issue whose decision requires special training, I question whether any one who has felt, under the edges of his saddle-leathers, the powerful action of a horse's fore-quarters at high speed will be ready to admit that these surging muscles merely stiffen and hold in place the bending fore leg. An observant eye will catch also, in the figure on page 366, such a swing of the rider as suggests that the fore leg as it left the ground has given an impulse of its own. May it not be that while the hind-quarters in a sense overcome inertia, and start the stride, the muscular office of the fore-quarters is to preserve it?

But apart from scientific results whose full measure can be known only after the careful study by many investigators of these plates, they have an interest of their own in the light they give the ordinary observer, and still more the artist, upon the usual facts of nature. Flight is a daily puzzle, and the instantaneous photographs of the pigeon and the American eagle (pp. 362, 363) tell more of the secrets of flight than any group of illustrations accessible outside of a special paper or two in "transactions." The "sharp stroke and long recover" which has revolutionized college boating because it used speed and a sharp "catch" where force was exerted, and wasted none of the energy of action in hasty preparation, is apparent



BASEBALL-THROWING.

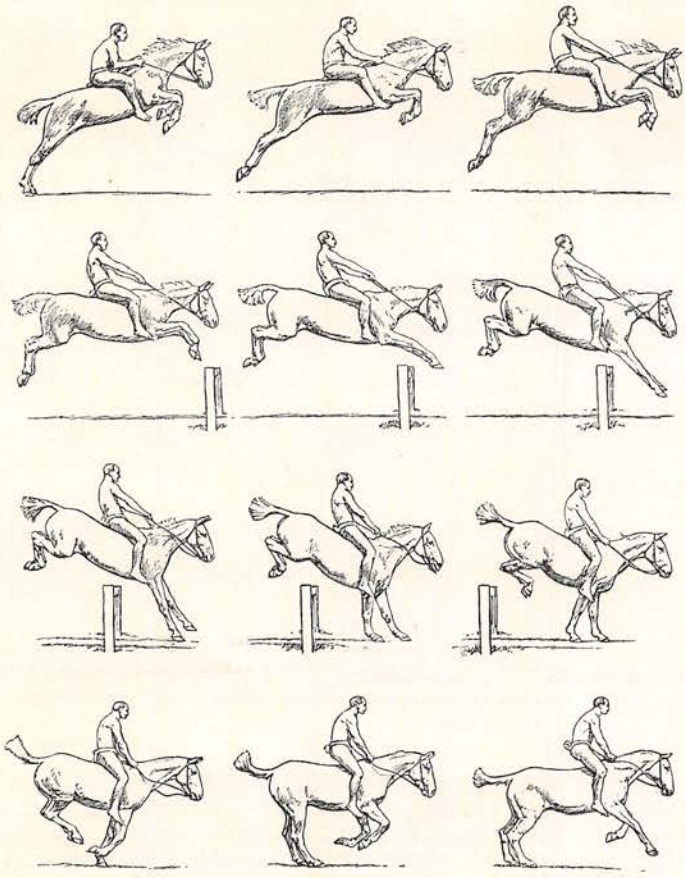


BASEBALL-BATTING.

in the oarage through the air of each of these birds. In every flying-machine, the "recover" is all the battle. The lifting stroke is easily dealt, but to get the wing back has overtaxed the invention of two centuries devoted to the problem. In the bird, through all the period in which the pinion is brought forward for recovery,—and this occupies three-fifths of the time employed in the acts,—the wing slides along tail-end down, front edge raised, and the bird passes up kite-fashion on the impulse which the stroke has given. The real recover only begins when the head has been almost hidden by the arched and hooding wing, and then — every feather whirled about like the slats of a Venetian blind by a single pull of the muscle lying at the quill-pits— the wing is thrown over the head by a single twist of wrist and elbow: feathers are only finger-nails, ready for the next stroke. Up to this point the bird has been rising. Here for an instant it drops, to begin rising again with the next stroke, giving the wavy line of progression, apparent in the series, but lost to the eye in the straight path a pigeon usually seems to follow.

The flight in these photographs is nowhere swift. As it is, moving slowly, the downward rush of the pigeon's wing, catching the air in a curving line like a propeller flange, has outstripped the speed of an instantaneous plate. The bird in this flight is moving through the twelve views only a yard or so (one meter) in $\frac{231}{1000}$ of a second,— about thirteen feet a second, or a mile in a little over seven minutes. A pigeon under favorable circumstances is equal not to ten but to sixty and eighty miles an hour. The constant habit in drawing a wing is to present it as a plane of simple form and curve, which a wing never is, and to overlook the separate action of the long quill-feathers. The Japanese do neither. The rudest sketch of bird-flight made in Japan by an artisan rather than an artist, which can be picked up for a few cents, gives the wing its double screw curve and opens the moving feathers, which, at every stroke, turn backwards and forwards. To find an eagle whose ragged and opening feathers give the impression of life and action apparent in the figure on page 363, we must turn back to the vigorous eagle whose spreading wings fill the space on the coins of an early Ptolemy. Ragged, unkempt, and weak as the great bird was from long confinement when he winged his brief flight across this field with neither "the pride nor ample pinion that the Theban eagle bears," there is still about the stretch and sweep of these great vans, their easy curve and sharp recover, such suggestion of free flight as it would be hard to match in any drawing, familiar though the subject be and tried of scores of pencils.

The lesson of this extended series illustrating animal motion is in the lower animals one



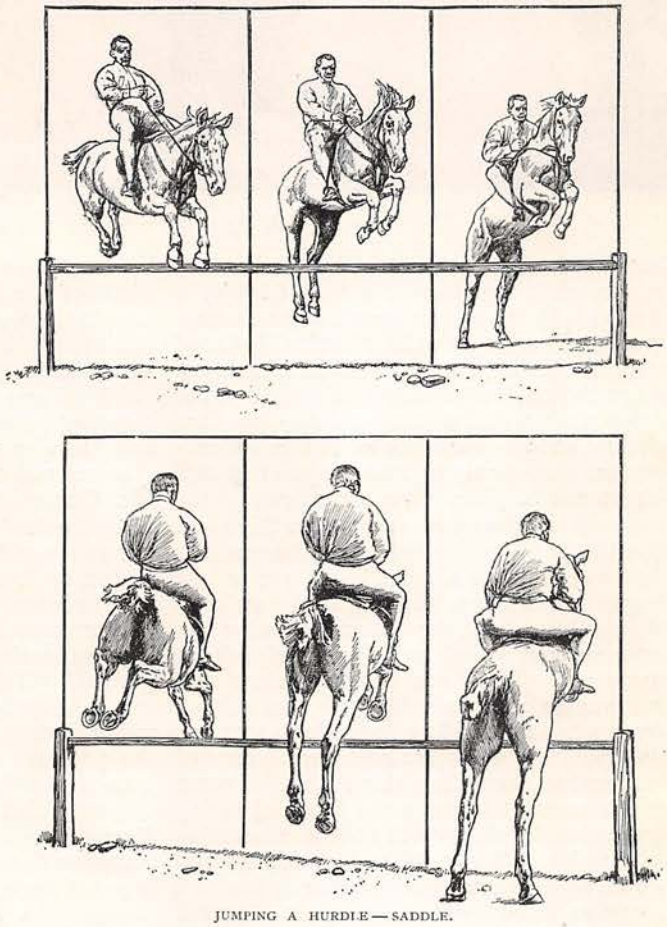
JUMPING A HURDLE-BARE-BACK.

of mechanism rather than form; in man it is one rather of form than of mechanism. There is no one of the plates given in this article, for instance, if the figure on page 360 be excepted, in which a new attitude is presented. There, the sharp ingathering of all four limbs, in a manner which suggests the cramped legs of a racer between strides, varies widely from the conventional type of a running jump, which represents the jumper as shooting over the bar, bent, but with arms and legs straight. The others, vigorous as they are in their speaking attitudes, give no new positions; but they emphasize the difficulty of exactly catching and fixing, without the memoranda offered by photographs like these, the successive changes of pose and muscle which the simplest physical act brings about or the new posture in which it leaves the body. The series on page 364 cover in time a half second from first to last, and the alterations in posture, which modify so wholly the profile of the figure, are separated from each other by a tenth of a second each. The trained eye misses much of the rapid swell and subsidence of muscle and flex of trunk in these brief intervals; the untrained eye misses both altogether. All are recorded in this accurate portraiture. The complete transformation of figure which takes place in batting, from Figs. 1 to 8 on page 365, is worked in three-quarters of a second. When we speak of nervous energy transmitted at a speed of 90 feet (30 meters) a second or a muscle contracting in from $\frac{8}{100}$ to $\frac{9}{100}$ of a second, the statement furnishes a shallow conception of the rapidity with which the trained and coördinated muscles of the human trunk and arms go through the myriad changes which are needed in some act which familiarity has brought to the edge of automatism. Yet in these swiftly changing relations are hidden the secret and revelation of living action as it is. It were bald error, open to ridicule, to suggest that the notation of the photograph can compare with the study of these changes in the living figure; but the data furnished by these series of photographs give material for the study of the altering positions of action akin to, and, within just limit and in its proper place and station, comparable with the familiar knowledge obtained by the study of artistic anatomy carried on in the only method in which its lessons can be adequately acquired.

It is well to be mindful of the value of the records here presented and provided on a still larger scale by these researches of the University of Pennsylvania, because a sense of surface and of the precise forces at work beneath it is one of the broad marks of difference which separate modern sculpture, if a few examples be excepted, from ancient. The eye grows accustomed to what it sees fully, frequently, and in freedom. Its capacity for appreciation — turning aside from the point of view involved in production to a more general and generous attitude towards art — grows by what it feeds upon. Limited as is the teaching and narrow the lesson given by these sharply defined shadows of action caught and crystallized by the camera, they are still broad enough to suggest, I venture to say, a somewhat new measure and method of criticism for much hitherto overlooked and little understood by recep-

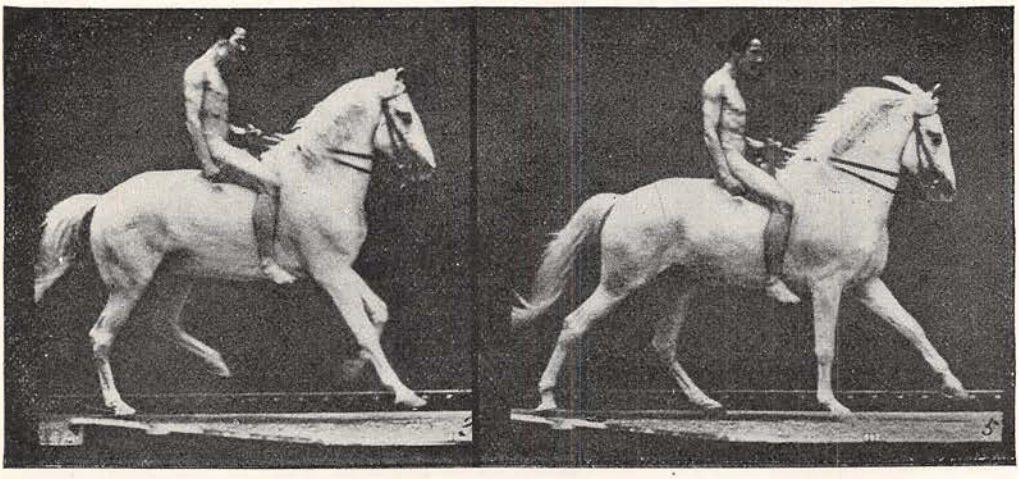
tive but untrained laymen; and art, if it is to succeed at all, must be built up on a broad foundation of lay appreciation. Its plant withers or grows to distorted shapes, if it is denied this soil in deep and well-cultivated measure. The resemblance between the last figure on page 363 and the familiar Mercury of John of Bologna is a trite matter, interesting, but not important of itself. But I question greatly if, in this most suggestive series, any one will follow from the start in putting the stone the changes which finally launch the twenty-pound weight, without a new sense, not merely of the light, airy, and splendid figure so long admired, which the sculptor of the Renaissance poised on the breath of the west wind, but of the truth and vigor with which that masterpiece suggests and expresses swift, continuous, and powerful motion. In that appreciative anxiety to admire the right thing at all pain and hazard to past predilection which is at once the curse, characteristic, and, in due season, let one hope, promise, of the present average American attitude towards most art, the training of perception in such matters as these is indispensable to progress in public taste.

Suggestions of this order, although nowhere else linked to so remarkable and typical an example, run through the instances of more swift and violent and therefore less familiar action in the photographs of the running, straight high jump (page 360), and of the back somersault (page 361). In the jump, as in putting the heavy weight, the models in each case were university students whose success in contests was the best test of their fit proficiency, a circumstance of which the reader can scarcely fail to be sensible, even before he is informed of the fact. The running high jump, involving a high lift rather than a far throw of the body, is less rapid than most violent exertions. From first to last one second elapses for all the illustrations. With this time the subject is often enough attempted by clever English draughtsmen; but even here where the camera has least relatively to tell, there is fresh suggestion in the fashion, already touched upon, in which the gathering of the legs and arms follows the same act in the mid-stride of four-footed animals; and the straight line in which the body shoots towards the ground, tense as a crucifix, gives sense of movement not easily surpassed. But if the jump is slow, the somersault is not. The span of time, from the instant the ground is left until the feet touch the ground again, is less than half a second; and in this space the body has been whirled around in air through the moving arc of a ball shot forward, twisting as it goes.



JUMPING A HURDLE — SADDLE.

The advance of instantaneous photography in recent years, not less than the excellence of the method employed in this inquiry, has its best measure in the figures of a gray mare taking a hurdle in a single easy flight, smooth and straight as a swallow's (page 366). The impulse for this leap has already been given before this series opens. Its character, the swelling strain of the hind-quarters, is better caught in another leap (page 367). The seven exposures which carry the mare from the time



CANTER-BARE-BACK.

her hind feet leave the ground until her fore legs catch it again cover a bare third of a second ($\frac{60}{1000}$ to each interval). The twenty-one feet of the leap from hind hoof to hind hoof are passed in half a second. So far as mere position and outline go, this is an old story, but the modeling, the balance, and the action are all new, and all dependent for interest on evanescent phases only apparent to the camera's supersensitive plate. The rigid swell of the powerful muscles which sheathe the thigh and give the lift to both leaps lasts, at longest, less than one-tenth of a second, and yet on the proper portrayal of this rests the vraisemblance of the flight, the ocular persuasion of a force exerted equal to its successful doing (page 367). M. Taine has somewhere said that human progression lost the possibility of grace when the yielding arch of the foot was shod with the stiff-soled and heeled boot of modern life. Something akin to this will occur at the contrast between the flexile changing grace of the leap bare-back and the same spring in a saddle. The rigid pad of leather and wood, light as it may be, is a bar to free and common action by horse and rider. The full meaning of this shines in each figuring of the horse and his nude bare-back rider on this page. The slender youthful rider and his horse give us again the Greek seat of the frieze of the Parthenon, with its drooping hand and swaying motion, its simplicity of outline, of treatment, and of poise. Nor can I better emphasize and express the value and worth of these photographs of living motion in directing criticism and stimulating appreciation, than by saying that so well trained an observer and conscientious a critic as the late Mr. Charles C. Perkins, in his "Historical Hand-book of Italian Sculpture," did not hesitate to say of Donatello's equestrian statue, at Padua, of Eramos di Narni, that "it shows the closest study of nature in all but one particular; namely, that the horse moves by lifting his two right legs simultaneously from the ground." "This error, common to other sculptors, both ancient and modern," as Mr. Perkins writes, is the position caught above; and it is the position selected by keener and better-trained eyes than Mr. Perkins's,—the position of Verocchio's colossal bronze of Colleoni at Venice; of more than one of the figures in the Panathenaic procession; of the statue of Balbus found at Pompeii; and of that matchless semblance of a matchless man, the equestrian statue of Marcus Aurelius.

Talcott Williams.

[The illustrations in this article are taken by permission from "Animal Locomotion," an electro-photographic investigation of consecutive phases of animal movements, by Eadweard Muybridge, published under the auspices of the University of Pennsylvania.]

DIVINE PARADOXES.

IT seems impossible to understand
How Joy and Sorrow may be hand in hand
Yet God created when the Earth was born
The changeless paradox of Night and Morn.

William H. Hayne.