The Duke de Montpensier is accused by Paris newspapers of plagiarizing a book he recently published.

Ups and Downs.

"I think the office force has been doing some shaking down."

"Yes, it does need a shaking up."

Her Interest.

"Your mother asked me if I smoked cigarettes. Does she disapprove?" said the fiance.

"Not at all. She's saving coupons," said the fiancee.

A Heroine.

"Is she ardent in the suffragette cause?"

"She is. I know for a fact that her father asked if she wouldn't rather have a French poodle than the ballot, and she refused."

Oh, That Was It.

"Where'd you get the black eye?"

"He was bragging that he had the finest boy in town."

"But a man should be excused for a little vanity——"

"But he was making his brag to a man who had a boy of his own."

Ready Thrift.

Kirby Stone—I hate to mention it, dear, but I must tell you that business has been awfully poor lately. If you could economize a little in dresses—wear something plainer.

Mrs. Stone—Certainly, dear. I shall order some plainer dresses tomorrow.—Puck.

Foolish Self-Condemnation.

No comfort for the living or the dead can be won from vain self-condemnation. No consolation can be gained while you nurse the imagining that a certain trouble might have been avoided. What we have to do is to try to escape from other troubles that are truly avoidable—troubles of a useless remorse, a present neglect, a listless apathy that will not reach forth for the good things still to be gathered.—Exchange.

Vacillating.

At a dinner not long ago Thomas W. Lawson was talking on the subject of success.

"Success in Finance," said Lawson, "is due in a great measure to prompt action. The doubting, hesitating, Hamlet type of man had best keep out of finance. He is quite sure to be swamped. The street hasn't much use for him. I had a boyhood friend of this type named Grimes. He was a falterer, a doubter, a Hamlet of the most exaggerated type.

"One evening I stopped to call on him and found him in a deep study, bent over a white waistcoat, lying on a table.

"'Hello, Grimes,' I said. 'What's the matter?'

"'This waistcoat,' he replied, holding the garment up to my view, 'it's too dirty to wear and not dirty enough to send to the laundry. I don't know what to do about it.'"—Everybody's.

The Physics of Baseball

By Hugh S. Fullerton

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The first law of physics is that all goes up must come down; always excepting the cost of living. The first law of baseball is not to let it come down.

The difference between the physics of the classroom and of the diamond is that the student learns the laws governing inertia, velocity, dynamics, the curvilinear trajectory of projectiles, resisting power of air, attractive power of masses; and the ball-player, by experiment, deals only with the freak variants of these laws. Many times the student who makes his college team is apt to think that the prof. was stringing him when he laid down the laws of motion, mass and velocity. For a baseball under skilled manipulation and control seems, like a trust, to come as near violating all the laws as possible. The ball always is striving to do exactly what the laws of Physics say it should do, with half a dozen other forces striving to compel it to do something else, and with the bad boys in uniform trying to invent new methods of making it violate the law.

If the supreme court should find the law of gravitation unconstitutional, or if the ball player could breathe in an absolute vacuum, baseball would be a simple proposition. The ball would keep on going in a straight line until some one stopped it. Line hits would continue to travel in a straight line until some fielder, standing on the needle point of infinity, jumped and pulled it down with one hand.

There is a professor of physics in a great eastern university who wrote me inquiring as to the physics of the spit ball, and who later lectured to his classes upon the subject. I asked several great pitchers to demonstrate for the benefit of the professor how they held the ball, swung their arms, released it with their fingers, and how much power they applied and to what point on the surface of the sphere. Among them was Clark Griffith, a master in theory, who used to be past-master in practice. I asked him to take the professor to the grounds and show him things. The result was a note from Griffith, in which he said:

"Don't send any more bugs to see me."

The point is that the players do not care what scientific phenomena they develop so long as the opposing batsmen take their healthies (i. e., swings) at the ball and miss. The college professor does not care much whether Walsh strikes Collins out three times with runners on bases so long as he can demonstrate that the laws governing rotation, air pressure, friction, retard and accelerated motion, etc., etc., are proved by the actions of the ball. So physics and baseball as studies have kept aloof from each other.

Yet every move in a ball game affords a problem. There are basic conditions which, in themselves, are worthy of study. Consider atmospheric pressure. Did you know that a man

Clarke Griffith.

who can throw a baseball 350 feet on the Polo grounds, New York, on a dead calm day, can throw the same ball almost 400 feet on the Denver ball park?

In studying the physics of baseball let us commence with the chief implements of the game—the bat and ball. The ball is composed of a small core, with a heavy layer of highly treated Para rubber, then wound with two kinds of woolen yarn, over which is a glue substance, upon which is a horsehide cover. The ball is semi-pneumatic, both the rubber and the glue upon which the cover is pasted tending to hold air. The difference even of a sixteenth of an inch in the thickness of the rubber makes the ball so fast that it scarcely can be handled. The makers experimented for years to get the ball tuned to the proper pitch of elasticity, and appear finally to have accomplished the aim of making a ball not too "dead" and not too lively. The shock of the bat against the ball dispels the air gradually and at the same time causes a molecular change in the rubber so that a ball, after being batted hard, loses much of its resilient power. The disarranging of the molecular force causes a ball which, to an outsider may seem as firm and solid as ever, to become a "mush," dead and lifeless, and likely to slow the entire game if permitted to remain in play. The bats used are almost all of second growth ash of the finest and straightest grain, and carefully dried. They are supposed to retain their resilient qualities indefinitely, but after a month or two of hard usage the bat no longer possesses the "drive" necessary for hard hitting. Yet bats that have lost "life" often will, when kept in storage a few months, recover their lost "ring" and be as good as ever, although the second time they "die" more quickly. This sense of feeling and hearing among players is a wonderful thing.

The object of each batter is to "hit it on the trade mark" with that part of his bat between four and six inches from the end. He does not express it that way, but he aims to hit the center of mass of the ball with the center of percussion of the bat—so he says, "square on the nose." The center of percussion of the bat varies according to the grip of the batter's hands, and it is the object of the pitcher to force the ball to revolve so as to avoid meeting the center of percussion.

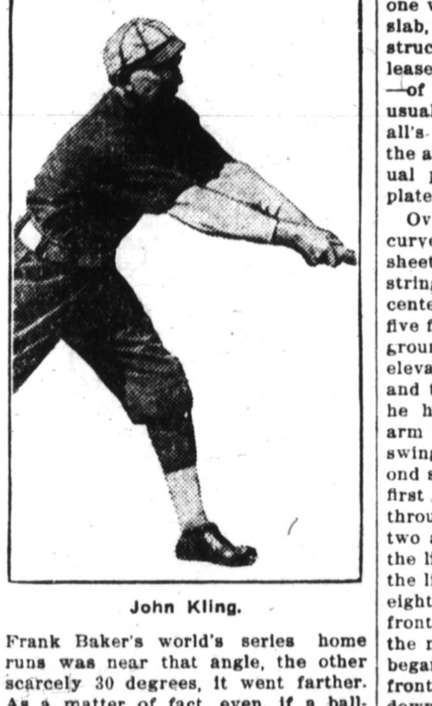
A ball weighing five and eight ounces and with a circumference of nine inches, pitched at an approximate velocity of 280 feet a second over a distance of 60 feet, is struck squarely upon the center of percussion of a bat weighing 40 ounces and swinging at a velocity of 1,250 feet per second, will travel how far? Perhaps the professor of physics can figure it out, but if he does he is wrong. He would have to know more than these statistics before he could make the correct calculation. He should know the forearm strength of the batter, the muscle leverage, the meeting angle of ball and bat, the rotary motion of the ball, the condition of the atmosphere, direction of wind and a few other things. It is much easier to have Vean Gregg shoot up a fast one, let Larry Lajoie hit it, and measure the distance, than to take a post-graduate course and calculate it.

Every ball that is pitched, or thrown, or batted has some rotary or oscillatory movement all its own further to complicate attempts to solve problems in baseball physics. The ball has a wonderful ability to absorb and retain motion no matter how imparted. The spit ball, which was so fully and exhaustively treated in the lectures of my friend the professor that I expect to see about 120 Walshes graduate from his school in the next two years, is the result of skillful applying of an unnatural force to counteract the natural rotation of the ball. The professor disputes this. Possibly he does not know that a ball, gripped with the thumb and two fingers, and thrown directly overhand, has a natural tendency to rotate upward and "hop," as the pitchers say. All good fast balls rotating this way take a sudden jump in the air. The spit ball pitcher wets the surface of the ball, grips the lower side tightly with his thumb, lets the ball slide off the fingers. The effect is that two conflicting forces cause the ball to "wobble" for a distance, and then, yielding to the influence of the thumb pressure and the attraction of gravity, it darts downward. When a ball thus pitched is hit it still refuses to surrender its inclination to rotate. It starts toward the infield with two forces still struggling for mastery. Each time the ball touches the earth it takes a different English. The infielder scoops the ball and throws. If he clutches the ball hard enough to kill all motion, all is well. If he seizes it lightly and throws with the same motion the ball takes fresh and renewed English as it leaves his hand and is more likely to shoot out of reach of the batsman toward whom he throws.

The pitched ball, manipulated so as to revolve unnaturally, takes "English" in the air just as a billiard ball does against cloth and cushion. Many persons have told me that the atmosphere on a still day offers practically a uniform resistance to a projectile. It does not. We know now that the air is filled with eddies, currents and pockets, even on the calmest of days. But admitting that it is uniform in density, a ball does not follow the physical law of constant decrease in speed in ratio to the resistance of the air. It even is capable of accelerated motion, and of both in the same 60 feet. That is, a ball may be made to slow up and then resume a faster rate of speed. The professor of physics doubts this, yet it is a fact that any experienced ball-player will vouch for. They have seen a ball seem to hesitate, and then proceed at an accelerated gait. It may sound impossible but at some spot in the path of every spit ball, slow ball or knuckle ball, it suddenly changes pace.

We experimented once with a pneumatic gun the rifling in the barrel of which gave it heavy rotation in any desired direction. It was merely an exaggeration of the curve. We shot balls under 30 pounds of pressure, making them curve sometimes a hundred feet. Putting the up curve motion on the ball (which always tends to curve in the direction of its rotation), we aimed the gun at a target exactly on a straight line, and the ball, going straight for perhaps a hundred feet, suddenly seemed to slacken speed, then it leaped upward and rose at a terrific rate until it passed over the cross bar of the flag-pole in the center field, 70 feet above the ground. Yet the ball was not disobeying the laws of physics, rather proving them. In its terrific speed it had encountered an air billow which it could not penetrate, and it had bounced off this denser bunch of air and rolled upward.

One would think that if a baseball is hit into the air is will follow a ballistic curve in ratio to the angle of ascension reduced by the amount of air pressure. Physics says it should. It will not, and no man can draw the ballistic curve that any fly ball will follow. The greatest range of any projectile in theory, is gained by an angle of 45 degrees. Military authorities know that, owing to air resistance, the greatest distance is attained at an angle just under 40 degrees. Having both the theory and the practice, therefore, ball players to make home runs should hit the ball at an angle of 40 degrees minus. One of



John Kling.

Frank Baker's world's series home runs was near that angle, the other scarcely 30 degrees, it went farther. As a matter of fact, even, if a ball-player could hit a ball at any desired angle, he could not be certain where it would go. It would depend too much upon the rotary motion of the ball. Last summer I saw a hard line hit driven straight at Charlie Herzog of the Giants. He put up his hands to catch the ball, then suddenly threw his head aside just in time to avoid being hit in the face, the ball missing his hands by two feet. The ball had "shot" suddenly from its true path. In a game between Washington and Chicago late last fall, Walter Johnson hit a ball at an angle of close to 40 degrees, and with terrific force. I should estimate that it was nearly 90 feet high, at its greatest elevation. Had it followed the true ballistic curve, it would have passed over the center field fence. The ball suddenly stopped, started to drop straight downward, then caught in another current of air, and Bodie, who was running after the ball, overtook it coming toward him, as if the batter had hit it from center field. Under conditions such as these a study of aeronautics would help players more than physics would.

The outfielder who "gets the jump" on the ball at the crack of the bat figures its trajectory at a glance, sprints desperately outward and turns exactly upon the spot where the ball will alight, then catches it, has all the calculations ever devised beaten.

Physics assumes that balls, thrown with equal force, following the same angle of projection over the same range, will be alike. I never doubted it until I practiced at second base with Malachi Kittridge and the lamented Tim Donohue throwing the ball down to me. Donohue threw faster, and seemed harder, yet the ball came into the hands as lightly as if tossed. Kittridge's thrown ball came more slowly, but it jarred and bruised the hands. This peculiarity of throwers is understood well by players, and one of the first inquiries concerning a new player is whether he throws a light or a heavy ball, which refers to the striking force of the ball, and not its weight. A ball revolving naturally, and thrown over the finger tips, as a fast ball is thrown, has a tendency to lift, is light. One that loses its rotary motion, and oscillates rather than rotates, is "dead" and heavy. Every player throws a different kind of ball, the variations depending upon the size of the hands, the length of the fingers and the manner of holding the ball.

The man who knew enough about physics, and also about baseball, could fill a book on the physics of pitching. It is simple, while seeming complex. It was not so very long ago that Tyng, the Harvard pitcher, developed a curve ball that started a protracted argument which finally resulted in a group of learned professors gathering to decide whether a ball actually could be made to curve in the air. The professors who doubted the possibility of a ball curving based their doubts upon the alleged insufficiency of air resistance. They admitted the theory, and doubted the fact. Every curve, shoot, "hook," "fadeaway," and slow ball depends upon the same principles, revolution and air pressure. The way a ball curves depends upon the force with which it is thrown and the amount of rotation. Its direction depends upon the amount of friction applied by the fingers to a given point on the surface of the ball. The ball always curves in the direction of the heaviest friction applied by the hand, and away from the heaviest air friction. The curve increases in the ratio of the amount of its revolution.

Perhaps the most frequent question asked of a baseball writer is, "How far can a ball be made to curve?" Of course they mean by a normal pitcher not using mechanical assistance. I never have been able to find the limit of the curve, nor, indeed, to calculate the curve accurately, although I have made some experiments. I refer to the actual curve of the ball due to its rotary motion and air resistance. I do not think that the real curve of the ball in 56 feet (distance from the pitcher's hand when he releases the ball, to the home plate) can be more than 20 inches. I have heard ball-players declare the ball curves from six inches to five feet. I tried it once with Orval Overall, who had, I believe, the most sweeping and widest fast curve ball I ever saw.

We placed 12 big sheets of tissue paper between slats, 8 of them at short intervals over the first 15 feet in front of the plate, the rest scattered at wider intervals until the last one was 6 feet in front of the pitcher's slab, and, to my surprise, his hand struck the paper as the ball was released, proving the actual distance of the pitch is much shorter than usually supposed. Of course Overall's reach was much greater than the average, but I do not think the actual pitching distance, from hand to plate, is more than 56 feet.

Overall pitched his wide overhand curve. The ball entered the first sheet four feet to the right of the string, which was placed through the center of the two plates at a height of five feet, and almost six feet above the ground (he was pitching off a slight elevation). His hand hit the paper and tore a hole a foot lower, showing he had released the ball before his arm reached the extreme limit of its swing. The ball went through the second sheet, which was 10 feet from the first just four inches lower than through the first, and a little over two and a half feet from the right of the line. It was less than a foot from the line when it struck the first of the eight sheets placed closely together in front of the plate, and it tore through the next one a trifle higher. Then it began its true curve. Nine feet in front of the plate it "broke" and shot downward and outward and crossed the sheet at the home plate ten inches above the ground and nearly twelve inches to the "outside" (that is, for a right-handed batter) of the center of the plate. The ball had dropped five feet two inches downward, through the force of gravity, the angle at which it was pitched and the curve, and had angled and curved practically five feet. The closest calculation we could make was that the ball actually curved, as a result of its rotary motion, approximately 17 inches.

The air resistance, which was disputed at Tyng's experiments, has, of course, became a known factor with the study of the science of aeronautics. The amount of resistance can be computed closely by the use of the barometer. The ball curves in the direction in which it revolves. The amount of the curve depends upon the

Christy Mathewson.

rate of rotation and the weight of air. The entire science of pitching consists in the deft application of friction upon some point of the ball which makes it rotate in a certain direction, or, which counteracts its natural rotation and cause it to "wabble" or float with little revolving motion. The slow balls, fadeaways, knuckle balls, all have as their object the prevention of rotary motion, or to give false rotary motion of "reverse English." The ball that presents the most air surface to the resistance of the atmosphere slows up quickest and yields more rapidly to gravitation. The one that spins oftenest (not necessarily fastest) curves most.

Poor Fellow.

The pretty storekeeper was unpacking and assorting some new goods when her best young man entered. She stopped behind the counter a moment and arose with flushed face.

"I'm glad to see you're stocking up," he said.

There's an unaccountable coldness between them now.

They Seldom Brag About It.

"Mis Dobble is very modest about her painting."

"Ahem! I believe most women are like her in that respect."

The Reason.

"There is a great deal of snap and go about Jimson's business methods."

"How so?"

"He makes rat traps."