

**THE RECOIL OF GUNS—ACTION AND REACTION NOT EQUAL.**

BY PROFESSOR CHARLES A. SEELY.

In my days of gunning, long time ago, one of the mysteries among the boys was the recoil of our guns. We had theories and superstitions about it which are not worth repeating. But out of my experience I have brought a very distinct remembrance that the "kicking" was something that we were afraid of and that there was a great difference in the vicious propensities of our guns. It must be borne in mind that the shoulder of a boy is tender, and cannot easily bear a blow which a stout man might not notice. The kicking power seemed to us one of the most noteworthy properties of guns. There was a gun which was famous all over the county as a great kicker: it was said it could kick us into the "middle of next week," a distance we thought to be very considerable.

During the progress of the rebellion, when every one was a strategist and a critic on the art of war, I assisted in many discussions on the philosophy of the recoil of guns. I found that no one lacked experience or an opinion. But the opinions were generally incorrect, and those which were right were not fortified by good reasons. So I think a renewal of the discussion may be interesting and profitable.

The expansive force of burning gunpowder is the source and the only source of the movement of the shot and the gun. The force of the powder is expended upon and divided between the shot and the gun, and for my present purpose it may be considered that the force of the powder equals the force of the shot plus the force of the recoil. So far all are agreed: there is no difference of opinion. The debatable question is this: What is the relation of the force of the shot to the force of the recoil; are they equal, and if nay, why not? To put the case in its simplest terms: the shot and the gun are two unequal weights acted on at the same time and for the same length of time by an elastic substance pushing them apart.

People generally think that the powder force is equally divided between the shot and the gun, and that the relative weights of the shot and the gun are not to be taken into account. They found their opinion upon a supposed law of motion, that action and reaction are equal, and upon a supposition that the pressure upon the gun is the same as upon the shot. Now as to the law of motion, it is either misunderstood or it is absolutely unfounded. If action implies motion and force, a simultaneous and equal reaction to my mind is inconceivable. If there be a motion, any obstruction or reaction to it, as long as the motion continues, surely cannot be equal to the impelling force. If my neighbor push me down, his action is greater than my simultaneous reaction: I may get up and get even with him, but then there comes into the case a new action and reaction. It may be that all motions will finally cease by reason of reactions, but when the rest takes place, it is hardly proper to say that there is still action and reaction. Is not the alleged law of motion a very imperfect way of expressing a self-evident fact about rest or equilibrium? It certainly is not easy to see how the little truth it embodies has any application to the question of the recoil of guns. The fact is that people who quote this law generally misapply it.

The pressure on the shot and the gun may be considered as equal (if there is any difference it is greater on the gun), and the expansive force acts an equal time on each. But those who infer an equal division of the force, overlook a very essential element in their calculation. The shot moves faster than the gun and the force acts on the ball through a much greater space. Is not the space through which a force acts something to be as carefully considered as the time?

Take two balls of equal weight and place a spring between them which will impel them apart. In this case the force of the spring is conveyed to the balls and is equally divided between them: one moves as far and with as much force as the other. Now place one end of the spring against an immovable abutment, and allow it to expand against a single ball. Here the pressure on the ball and the abutment are equal, but the spring expands to its full length and gives its whole force to the ball: there is nothing lost on the abutment. The force imparted to the ball is precisely twice that which it received in the first experiment. Repeat the first experiment with balls of different weights. For example, let one have double the weight of the other. The force will now be divided so that the light ball will receive twice as much as the heavy. From such experiments the conclusion will soon be reached, that the force of the spring will be divided between the balls in a ratio inversely as their weights: if the weights of the balls be as 1 to 10, they will receive the force in the ratio 10 to 1. If a well-made spiral spring be employed, it may be observed in each experiment that there is a neutral point which does not move at all and that it is the center of gravity of the two combined balls. Thus when two balls of equal weights and sizes are used, it will be in the middle of the spring: in the second experiment it will be in contact with the abutment: in the case of the balls of weights 1 to 2, it will be two thirds the distance between the balls from the ball, 1. Thus this point indicates the division line between the amounts of force going to the balls respectively.

Such experiments may be varied by using a contracting instead of an expanding force. Take two toy wagons, connected by a rubber cord, and use weights of any convenient material. Or the weights may be suspended by cords, to be drawn together by the contraction of a rubber spring. The result will always be arrived at that the forces will be divided inversely as the weights. Moreover it should be observed that the velocities communicated to the balls are inversely as their weights. In the case of the balls 1:2, the corresponding velocities will be 2:1.

In these experiments we have a fair representation of the case of the gun: the spring is the expansive force of the powder, the large ball is the gun, and the small ball is the shot. Can the conclusion be doubted that the force of recoil is to the force of the shot as the weight of the shot is to the weight of the gun. If the weight of the gun be 100 lbs. and the shot 1 lb., then the force of the shot will be 100 times that of the gun.

Those who are well skilled in mechanics will reach the same conclusion by a shorter road. The formula  $MV^2$  expresses the value of the force of a body. The weight (M) of the shot and of the gun of course are known, and as soon as it is determined that the velocities of shot and gun are inversely as their weights, the problem is solved. Thus, let the weights be as 1 to 100, then the velocities will be as 100 to 1, and the expression for the force of the shot will be  $1 \times (100)^2 = 10,000$ , and the force of recoil  $100 \times (1)^2 = 100$ . But  $10,000 : 100 :: 100 : 1$ .

It is a plain result of the theory above given that the force of the recoil is directly proportioned to the amount of powder used. And in a given gun is proportioned to the weight of the shot, or if the shot be the same, to the weight of the gun. By doubling the weight of the shot the recoil is doubled.

If the prevailing notion about recoil were true, we should have a very different system of warfare, for the danger in battle would be to those who fired the guns. It involves, also, other absurd consequences, such as that in the steam engine half of the force of the steam is lost on the end of the cylinder, and that we can never utilize the whole of any force.

In conclusion, I am obliged to say that the guns and shot I have spoken of are model and theoretical guns, and that there are difficulties in the way of directly applying the theory to actual practice. The force of the powder does not show the whole of itself in the shot and in the recoil. A notable amount is lost in the concussion of the gun, windage, and in overcoming the friction of the shot. This last is a very important circumstance, as it holds back the shot, giving the gun a longer time than due to it to absorb the powder force. The ratio of recoil to shot will always be greater than by the simple formula I have given. The guns need more lubricators. And it will be seen that there is plenty of room for practical experiments; nothing to-day would more please me than to read reports of intelligent practical tests.

**PROVING A GREAT GUN.**—The second big gun (20 inch) cast at the Fort Pitt Foundry has been tested with charges of 60, 80, and 100 pounds of powder, and shot weighing 1,020 pounds. The trial was under the inspection of Commodore Taylor, of the United States Navy, now on inspection duty at the works, who was well satisfied with the trial and pronounced the gun thoroughly fitted for duty.



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**61,304.—CABBAGE CUTTER.**—Henry Aeter, Muscatine, Iowa. First, I claim the manner substantially as herein described and shown of arranging a series of scroll knives on a rotary bed, and beneath a stationary hopper, so that two or more knives are made to cut at the same time, under the same hoppers, as shown.

Second, The arranging with a cabbage cutter bed, such as described, of the frame, A, B, with box, K, hinged legs, G, G, guard board, F, and bracket extension, substantially as described, and for the purposes set forth.

**61,305.—MELODEON.**—Charles Austin, Concord, N. H. I claim as my invention the arrangement as well as the combination substantially as above specified, of a lever, E, and one or more additional reeds, I, and the operative apparatus thereof, as explained, with the exhaust chamber, D, and a main reed key, A or B, thereof, the same being so that on pressing down the said key for the purpose of opening the main reed valve thereof, the lever, E, shall be moved so as to put in operation each additional reed operative apparatus, whereby its reed or reeds may be sounded simultaneously with the main reed.

**61,306.—FAN TOOL FOR CUTTING MOLDINGS.**—Edwin C. Austin, Monroe Village, Wisconsin. First, I claim the knives, C, constructed with the projections or bearings, c, pressing upon the surface of the wood in advance of the cutting edge, substantially as and for the purposes specified.

Second, The tool here described for cutting rope or screw molding, constructed and operating substantially as described.

**61,307.—DOUGH MIXER AND ROLLER.**—J. Bailie and J. Gervers, Cincinnati, Ohio. First, We claim the combination of the rolls, D, D, with the worm or screw dough mixer, A, in the manner and for the purpose set forth.

Second, We claim the combination of the carrying band or belt, I, and the rolls, D, D, with a worm or screw dough mixer, in the manner and for the purpose substantially as specified.

Third, We further claim the combination and arrangement of the spur and worm gear as shown for regulating the speed and giving a positive motion to the screw, A, snabbing rolls, D, D, and carrying band, I, for the purpose and in the manner substantially as described.

**61,308.—BILLIARD CUSHION.**—A. Bassford, New York City. First, I claim in a billiard cushion the use of metal c ribbon or other hard and elastic strip interposed between two pieces of vulcanized india rubber of different degrees of elasticity, or within a rubber cushion substantially as herein set forth.

Second, In billiard cushions constructed substantially as set forth, I claim the arrangement herein described and represented, whereby one block of india rubber is backed and supported by the other.

Third, I claim the two blocks or strips of vulcanized rubber, of unequal degrees of elasticity as described, in combination with the spring steel ribbon and rubber packing, arranged substantially as and for the purposes herein set forth.

**61,309.—APPARATUS FOR CARBURETING GAS AND AIR.**—John F. Boynton, Syracuse, N. Y.

First, I claim in a carburating box or vessel a tube or tubes, whether flat, cylindrical, or of other form, filled with fibrous or capillary material, and so arranged with openings at the bottom that the carbonizing fluid will be constantly drawn by capillary action from the lower and heavier strata, and subjected to evaporation in the upper portion of the vessel, substantially as described.

Second, In a carburating box or vessel constructed and operating as herein described, I claim so arranging the capillary tubes that the gas in its passage through the vessel will move slowly in a thin stratum over the ends of the wicks containing the carbonizing fluid substantially as described.

Third, I also claim dividing the carburating vessel into two or more compartments, by soldering one of the plates forming each of the double partitions or wick tubes to the bottom and sides of the vessel, so that two or more different carbonizing fluids may be used in the same vessel, without mixing previous to evaporation.

**61,310.—THRILL COUPLING.**—John F. Bridget, Washington, D. C. I claim the combination of the set screw, G, and socket plate, H, and spring, E, operating to raise the end of the thrill in its bearings, substantially as and for the purpose described.

**61,311.—BASKET ATTACHMENT FOR PISONS OF DEEP WELL PUMPS.**—Erasmus D. Brown, Buffalo, N. Y. I claim the slitted flaring basket, A, for the purposes, and substantially as described.

**61,312.—BOAT DETACHING TACKLE.**—Samuel Brown (assignor to the Brown and Level Life Saving Tackle Company), New York City. I claim a boat-connecting apparatus, composed of the ring, a, hook, c, and chains, b, g, and which is disconnected from the block by slacking the chain, g, in the boat to be launched, substantially in the manner and for the purpose described.

**61,313.—MANUFACTURE OF BRANDY.**—D. Jay Browne, Cambridge, Mass., and Steuben T. Bacon, Boston, Mass. Antedated Jan. 14, 1867.

First, We claim the blending of brandy or spirits distilled from sorghum with brandy distilled from fermented grape juice, water and sorghum sirup, or glucose, substantially as herein set forth.

Second, In the production of brandy from the combination of the above-named materials, we also claim the mode of fermenting in close casks, or vats, furnished with tubes or coils within, for regulating the temperature of the liquids while fermenting, substantially as herein specified.

Third, In the production of brandy from the above-named ingredients, as necessary to secure success, we also claim the process of distilling in vacuo, substantially as and for the purposes herein described.

**61,314.—PROCESS OF MAKING SUGAR.**—Duncan Bruce, Rossville, N. Y. Antedated Jan. 17, 1867.

First, I claim the combination of the vacuum chamber and condensing chamber, with one or more evaporatory chambers, having steam or hot water heaters applied to them, substantially as described.

Second, The combination of one or more air-tight vessels with one or more air-tight evaporators and a condensing chamber, B, which communicates with a vacuum chamber, E, substantially as described.

**61,315.—APPARATUS FOR DECOMPOSING ANIMAL AND VEGETABLE SUBSTANCES, FOR CURING MEAT, TANNING, ETC.**—Duncan Bruce, Rossville, N. Y. Antedated Jan. 17, 1867.

First, I claim an apparatus consisting of a series of air-tight vessels communicating with a condensing vessel, and also with a vacuum reservoir, having a forcing and exhausting engine applied to it, the whole to be used substantially as described in the treatment of vegetable and animal matters.

Second, Curing meat by the means and in the manner substantially as herein described.

Third, The process, substantially as described, of obtaining grease from fatty substances, by subjecting these substances to the action of moist heat in a vacuum.

**61,316.—PRESERVING GREEN CORN.**—S. John Carroll, Baltimore, Md. I claim preserving green corn in the manner substantially as herein set forth and described.

I also claim the new article of manufacture and commerce, green corn preserved substantially as herein set forth and described.

**61,317.—BUTTON.**—Henry T. Carter, Portland, Me. I claim a button provided with a slitted and pointed shank, c, in combination with the disk, d, and washer, b, substantially as described and for the purpose specified.

**61,318.—MACHINE FOR PRESSING FUEL INTO BLOCKS OR BRICKS.**—John B. Collen, Philadelphia, Pa. I claim a machine constructed, arranged, and operated substantially as herein described and represented, for the purpose of pressing artificial or natural fuel in a fine or granular state into blocks or bricks for transportation and for burning, as set forth.

**61,319.—PUMP.**—H. Comstock, Seneca Falls, N. Y. I claim, First, The combination of the rubber cup or flange, f, with the metallic leather packing, c, operating substantially in the manner and for the purpose specified.

Second, The groove, g, in the bottom of the cylinder, in combination with the valve yoke, C, operating substantially as and for the purpose set forth.

**61,320.—DENTIFRICE.**—John G. Cook, Lewiston, Me. I claim as a dentifrice a chlorate compound, made up of ingredients, substantially as described.

**61,321.—SAFETY PAPER.**—L. M. Crane, Ballston, N. Y. I claim, First, The inserting or incorporating of one or more threads or strips of gutta serena, or a material possessing like properties, into the pulp or fiber of paper during the manufacture of the same, and in such a manner that said threads or strips will be softened and firmly united to the fiber under the heat of the drying cylinders, substantially as set forth.

Second, I also claim, as an improved article of manufacture, a safety record paper, made substantially as herein shown and described.

**61,322.—MACHINE FOR PREPARING COTTON, ETC.**—W. Crighton and F. W. Crighton, Manchester, Eng. Patented in England April 3d, 1861.

We claim, First, The arrangement hereinbefore described consisting of placing the beaters or openers on a vertical axis, and forming the place or opening for the delivery of the cotton at the top of said case, or at a point higher than that at which the cotton is fed into the machine, said machine being also constructed and its parts so arranged that a considerable portion of the dirt will be delivered either at the bottom of the beater case or cone, or through openings at a lower point than that at which the prepared cotton is delivered, substantially as hereinbefore set forth.

Second, The combination with a beater case, and beaters, or other similar apparatus for cleaning cotton, of the carrier or series of dirt boxes, d, substantially as hereinbefore set forth.

**61,323.—BLAST FOR IRON AND OTHER FURNACES.**—Felix A. T. de Beauregard, Paris, France. I claim surrounding the furnace by a tank the water within which is converted into steam by the heat of said furnace and then discharged through suitable pipes or conduits arranged substantially as herein described, so the discharge of the said steam shall induce a blast within and through the furnace, as set forth.

**61,324.—STEAM GENERATOR.**—Jules Delery, St. Bernard Parish, La. I claim the isolating check valve, b, connecting rods, E and L, and lever, J, in combination with the generator and water communication pipe, substantially in the manner shown and described.

**61,325.—TELEGRAPHIC CABLE.**—A. J. B. De Morat, Philadelphia, Pa. I claim the construction of telegraphic cable by means of insulated tubes or continuous cylinders, formed of helically wound strips in such manner as to preserve uninterrupted linear conduction in case of stretching, as herein set forth, or any other substantially the same, and which will produce these intended effects.

**61,326.—WHEAT DRILL.**—Geo. W. Doolittle, Lincoln, Ill. First, I claim the jointed frame, A, C, to which the compressing wheels, D, E, are attached, in combination with the funnels, L, L, depositing tubes, K, angular bars, I, I, cutter blades, H, H, substantially as arranged for the purpose set forth.

Second, I claim the arrangement of the standard, P, lever, m, carrier, n, for controlling the depth of the drills, K, or lifting them out of the earth in combination with the drills or delivery tubes, and the mechanism for regulating the quantity of seed, substantially as herein described for the purposes specified.

**61,327.—WASHING MACHINE.**—George H. Dow, Freeport, Ill. I claim the arms, E, E', roller upper board, C', and pressure board, F, in combination with the concave washboard, H, lower roller board, C, and springs, D, arranged as and for the purpose set forth.

**61,328.—BARREL BUNGS.**—M. S. Drake, Newark, N. Y. I claim, as a new article of manufacture, a bung for barrels, casks, or cases, constructed substantially as specified.

**61,329.—TAIL BOARD FOR WAGONS.**—Joseph O. Farrell, Chicago, Ill. I claim providing the tail boards with a double latch, constructed substantially as described, that is to say, consisting of a rod and two rack bars rigidly connected and vibrating in journals in or on the tail board under the impulse of the hand, or of the spring, so that they shall traverse the openings in the braces, I, as the tail board is moved, and when abandoned to the influence of the spring shall afford support to the tail board by the engagement of the notches, substantially as described.

**61,330.—SAFETY VALVE.**—John H. Fitz Simmons, Susquehanna Depot, Penn. I claim the combined valves, F and E, with valve seats, A and C, the steam pipes, G, G', together with the releasing screw, X, as herein described and for the purpose set forth.