TARGET PRACTICE AT AN OLD BATTLESHIP.

THE REMARKABLE GUNNERY EXPERIMENTS ON THE HULK OF THE "HERO."

It will be remembered that, several years ago, the British government, in order to secure data as to the action of modern projectiles on the armor and hull of an armored ship, anchored the old battleship "Belle Isle" in a suitable position, and then had several battleships open fire on her with their large-caliber guns. It was claimed that valuable information, which otherwise could have been gathered only after an actual sea fight, was thus placed at the disposal of the Admiralty. The experience thus gained was incorporated in the later ships built for the British navy.

The experiment has lately been repeated with another old battleship, the "Hero." This vessel was built in 1888, in the days of compound armor, of which she carried 12 inches on her waterline, 11½ inches on the bulkhead, and 12 inches on the turret which contained her main armament of two 45-ton 12-inch guns. The belt, which extended to within about 40

feet of the stern, and tapered from a maximum of 12 inches down to a minimum of 8½ inches, was narrow, judged according to modern ideas, and reached only a foot or two above the normal waterline. Amidships, reaching from the belt to the level of the fore-castle deck, was a central box battery, in which were mounted two 6-inch guns. Two other 6-inch guns were carried astern, one on each quarter. The turret is placed at the level of the fore-castle deck, at the low elevation of not more than 9 or 10 feet above the sea. From about amidships to the stern the freeboard was raised by the height of one deck, giving a maximum freeboard in this portion of the vessel of about 16 or 17 feet. She had a single smokestack, in front of which, below the bridge, was a conning tower, and astern of the smokestack was the one mast carried by the ship.

In these experiments an effort was made to ascertain the action of modern gun fire upon the typical positions of a modern battleship. To this end, a dummy fire-control platform was rigged at the correct height on the mast. The hull of the ship was marked out in separate sections, all duly numbered, and in each of these was placed some of the various instruments and appliances peculiar to a modern battleship, and dummies to represent the men. The various sections of the ship were connected up by telegraphic and telephonic means of communication, such as will be used by a ship when under fire under modern battle conditions.

The "Hero" was attacked by some of the latest and most powerfully-armed ships of the British navy, using the latest pattern of long-caliber guns. Although the government made great efforts to preserve absolute secrecy as to the results, it is known that it took but a very short time to riddle the hull, silence the guns by complete disablement, and upset or destroy the dummies so fully, as to make it evident that under such conditions the crew would have been decimated. It is notable that a successful shot completely wrecked the fire-control station on the mast. So completely does the efficiency of the shooting now depend on the observations from the fire-control platform, that the carrying away of the latter, as in this case, would be about the most serious blow that could be struck at a ship. There are other positions, it is true, from

carrying loads from a few ounces running at 35,000 revolutions per minute to mammoth loads in excess of 1,500,000 pounds.

The smallest bearing weighs one-fourth ounce, the largest 7,500 pounds.

Some evidence of the range in values in the steel ball business alone, is shown in the range of commercial sizes which are from 1/32 inch to 6 inches, inclusive. One ton of crucible, high-carbon steel, made into 6-inch balls, will sell for about \$2,000, while of 1/32-inch balls, a ton would make a value of \$24,000.

Great progress has been made in ball making, in many ways, during the past five years, during which time the accuracy of size and sphericity has improved from a possible limit of 0.002 inch plus or minus to a difference now in the best of balls of 0.0001 inch, plus or minus. An equal improvement has been secured in the strength and durability of balls, due to the use

Drawn by Norman Wilkinson from sketches supplied by an eye witness.

From Illustrated London News.

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which observations of the fall of the shots may be had and the firing directed; but being low down on the structure itself, they do not afford the accurate results the firing platform does.

PROGRESS WITH BALL AND ROLLER BEARINGS.*

By S. S. EVELAND and HENRY HESS.

It is probable that with the possible exception of the automobile industry, no business has developed so rapidly during the past five years as is the case with the ball and roller bearing business. In 1902, there were several small concerns making ball bearings, employing a total force not exceeding 100 men, women, and children; while at present, fully three thousand are employed, and the industry has grown so rapidly that over \$5,000,000 capital is invested in the business.

The general and almost universal use of some form of anti-friction bearing makes it difficult to select applications of the principle having especial merit, although a few cases may be mentioned where their use has been notably successful. The field is too large to enter fully into detail, which can be more readily understood when it is considered that anti-friction bearings are sold for as little as one cent and as high as \$6,000 for a single bearing, and they are in use

of special alloys of crucible, high-carbon steels. By the use of these special standard alloy steels, the crushing strength of balls of the highest grades has been raised over 100 per cent; a ball of a given size that would formerly have crushed at 25,000 pounds now requires 50,000 to 55,000 pounds to crush it. In consequence of this improvement in the strength of balls, they may now be applied and used where formerly it was not possible, owing to lack of sufficient space for the use of the proper size, for it is now practical to use a smaller size than formerly, to accomplish the result desired. Some evidence of the importance and size of the ball business is shown in the number of balls made in this country, which exceeds 600,000,000 per annum.

A new development in the use of steel balls is in roller skates, which used over 100,000,000 during the last year, and will probably exceed that amount this year.

In ball bearings of a special type, the greatest development is in the form known as the annular ball bearing, which consists of two concentric rings having grooves in the inner and outer face, in which the balls revolve and have a bearing surface of a considerable part of their radius. There is no adjustment, which was formerly a feature of all types of ordinary cup and cone form of bearing, but which is not necessary or desirable, in the improved type of annular

* Abstracted from the American Machinist.

ball bearing. This bearing is made of special alloy steel, and has been used successfully for many purposes where the old cup and cone, made of case-hardened machinery steel, failed in operation. Bearings of this character have been used successfully on motors and generators and have added 10 to 15 per cent to the efficiency of the electrical apparatus on which they were used.

In roller bearings, even a more rapid development has taken place than in ball bearings. Among the uses to which they have been applied during the past five years with exceptional success is on trolley-car journals.

The theoretical saving to be secured by the use of roller or ball bearings has long been fully understood, but the practical and actual benefits derived in practice are not so well known. Many tests have been made showing their value on machinery, but it is only recently that their use on trolley cars has proved not only successful but of practical value in many ways.

A trolley car has been run in Syracuse, N. Y., for over four and one-half years, fitted with roller bearings, which has shown remarkable results.

The roller bearings at the end of four and one-half years, and after running 250,000 miles, are in such condition that they may be relied upon to run many years longer. The rolls show an average reduction in diameter or wear of 0.005 to 0.008 inch, and it is evident that with the rollers, axle sleeve and car box or housings all properly hardened, as used in this construction, very little wear will take place.

One test made by the federal government some time ago of an army wagon fitted with and without roller bearing axles, demonstrated a saving ranging from about 52 per cent up hill to as high as 75 per cent on an asphalt drive, as shown in the table:

	Pounds Pull.
Asphalt test with common axle	100
Asphalt with roller bearing axle.....	25
Asphalt with common axle, starting load.....	450
Asphalt with roller bearing axle, starting load...	220
Asphalt with 8 per cent grade common axle.....	400
Asphalt with 8 per cent grade roller bearing axle.	170
Belgian block, common axle.....	165
Belgian block, roller bearing axle.....	75
Dirt road, common axle.....	260
Dirt road, roller bearing axle.....	100
Dirt starting, common axle.....	850
Dirt starting, roller bearing axle.....	400

It has been shown that an electric cab will run from 25 to 35 per cent farther on one charge with roller or ball bearings than when using plain bronze bearings. In using shafting hanger bearings a recent test showed that 18 heavy grinding machines, using 49 horsepower with the plain habbitted bearings, used only 27 horsepower when roller bearing shafting hangers were used.

One very considerable advantage that should be taken into account in the use of roller bearings, may be the adoption of motors of smaller size and consequent lower cost than are required at present. This results not only in the first cost saving, but in reduced weight of the complete car with a corresponding reduction in wear and tear of all parts, including the rails, etc.

Probably the largest anti-friction bearing of any form that has ever been made is a plain roller thrust, applied to a generator of 5,500 horse-power capacity, at Niagara Falls, where it has proved very successful after a commercial test exceeding two years and carrying a load of 200,000 pounds at 500 revolutions per minute, during which period it has developed no trouble of any character and has displaced the oil pump, brass pipes, and daily attention of various employees, all of which are required on ordinary oil pressure bearings.

A development of the past few years is in the use of the roller thrust propeller bearings on steam vessels. The same bearing that proved so successful on the Niagara Falls generator has been used with even greater returns in saving of power on many vessels.

The roller thrust propeller bearing consists of two washers of tool steel, hardened and ground, and a set of rollers in a cage or retainer, which runs between the rollers, all being mounted in a horseshoe form of housing, which is recessed to receive them.

Several advantages are gained by the use of the roller thrust propeller bearing, the principal one being a material saving in fuel consumption, or an increase in speed, or a combination of both, while in addition, there is a considerable saving in oil consumption. No pump is required as with the old type, to force water through the bearing, and a very considerable reduction in vibration is secured. The exact cause of the latter fact is not fully understood, but it is quite possible that the old form of bearing "hugs" or sticks to the shaft collar, so that in actual practice it runs in the equivalent of a succession of jerks, due to the sticking and releasing referred to, in this way causing a certain amount of vibration. In the roller bearing, this cannot occur, as it is always running with a full

rolling action, and there can be no such frequent releasing as may occur with the old form bearing.

The saving in power or increased speed, secured by

the use of rollers, is so great that several vessels have shown an increase of speed of over one knot per hour, while in several cases the saving in coal has been from

From Illustrated London News.

THE "HIBERNIA'S" AFTER-TURRET DURING THE FIRING AT H.M.S. "HERO."

From Illustrated London News.

1. THE RIDDLED HULK OF THE "HERO" LISTING TO PORT AFTER THE FIRING; A TRINITY HOUSE STEAMER, WITH INSPECTING OFFICERS, IN ATTENDANCE. 2. WHERE THE SHOTS FELL THICKEST: THE HULL OF THE "HERO" RIDDLED TO A SIEVE. 3. THE WRECKED UPPER WORKS AND BARBETTE OF THE "HERO."

The old British battleship "Hero," which was prepared as a target for heavy guns, was fired at on November 30 by the "Dominion" and the "Hibernia." After five minutes' firing the "Hero" was listing heavily to port and settling by the stern, where she had been struck by a twelve-inch shell. There was hardly a whole piece of deck left. The firing began at a range of five miles. The accuracy of the practice was extraordinary.

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five to ten tons daily, according to the size of the vessel.

The earlier ball bearing was simply a series of balls introduced between a fixed and a rotating machine part; the outlines of the surfaces carrying the balls were generally due to the whim or fancy of the designer. Later came a recognition of the necessity for so arranging the ball tracks that theoretically pure rolling as dissociated from sliding was secured. Even to-day there are to be found many ball bearings violating this fundamental requirement.

Broadly, all ball bearings may be divided into classes characterized by the number of points of contact between the ball and the supporting surfaces or races. The simplest form provides only two contact points, then come three and finally four. So far as I know, no attempt has ever been made to provide more than four bearing points. By far the most generally used, up to a relatively recent date, was the three-point ball bearing that found employment in countless numbers in the bicycle trade. Only by gradual elimination has the present highest development of the two-point bearing been reached; as that is the acme of simplicity and, as made by the best specialists in the field, has carrying capacities and reliability of a very high order, it is safe to say that further development will not be in type but in details of manufacture and material. The defect of the older three and four-point type of correct outline was the great cost of so shaping the parts that the correct relationship of the contact points among one another and with the axis of rotation of the shaft was secured; with incorrect designs all benefit of the most painstaking workmanship was soon dissipated by the grinding action of the consequent partial sliding.

In the two-point type of that class in which the con-

tacts lie in a plane at right angles to the shaft axis, close attention must be paid only to the correct sizing of the races by processes which are simple and not unduly costly. The correct relationship of the two contact points is even more readily secured by modern manufacturing methods. Next in order of importance came the development of suitable materials. In the early history cast iron was frequently employed and may even yet be found in an occasional turntable; needless to say it was only a slightly greater ease of working of rough machinery and not precision or great load capacity that was secured.

Next in order and probably practically simultaneously came the use of case-hardened iron or steel and of tool steel. The latter material found general favor where only a few ball bearings were made, but for a systematic manufacture it was found that tool steel was of too erratic a nature. Steel of carbon content so low as to be generally considered non-hardening could be far more readily controlled in quantities in the case-hardening furnace. While the final bearing did not have as great carrying capacity as its brother of tool steel, yet the immunity of troubles due to temper cracks, too great or too little hardness, etc., caused many to give this material preference. With the advent of the automobile a host of steels of the nickel and chrome series came into prominence and some of these are now finding employment in ball bearings with some resultant improvement.

So far no mention has been made of one of the most essential elements of the ball bearings—the ball. In the early days, balls were either primitively cast and primitively shaped, if shaped at all after coming from the mold, or were individually made from non-casting materials by laborious and painfully slow tooling processes. The next great step was taken almost at a

single stride by the introduction of automatic machinery for truing, the hardened balls by grinding processes in quantities at a time. Just as the material of the ball races has been subject to improvement, so has that of the ball. On the whole the difficulties of hardening have been less with the ball since the sphere is the ideal shape for hardening, owing to its uniformity of shape. It may be safely said to-day that of the two elements of a ball bearing, the ball and the race, the ball is in the lead.

It was the advent of the bicycle that really marked the commercial birth of the ball bearing. With the advent of the automobile the ball bearing again naturally came to the fore, since many of the bicycle builders graduated to this new field and carried the three-point and occasionally the four-point bearing with them. So long as machines were light and the owner of an automobile considered his possession of one a license to pay repair bills, these bearings did as well as the rest of the machine. Builders of heavier machines soon went back to plain journals and many to heavy expense in using hardened, ground, and lapped steel.

When the next step in advance in the shape of the two-point ball bearing of special steel was made the automobile builders avidly seized on it; occasionally a ball bearing of the older types is still met with on light automobiles, but the heavier machines have gradually extended the use of the two-point ball bearing to every element of the car, including even the crank-shaft and connecting-rod. The success of this type under such severe work as the modern road locomotive entails on it, gradually commanded the attention of engineers in other lines, until to-day ball bearings can be found in practically every line of mechanical engineering.

WORKING UP OLD PRINTED PAPER.

HOW USABLE PULP IS OBTAINED FROM WASTE PRINTED MATTER.

USE printed paper and paper cuttings have now an important place among the raw materials of paper manufacture. So much is this the case that large establishments exist for sorting purposes only, and many middlemen occupy themselves entirely with paper-scrap, printed or otherwise.

The chief points to be borne in mind in working up waste printed papers, is, that the new paper must be at least as good as the original paper; i. e., capable of being used as that paper was; that no special plant should be needed, and that the cost of the process should not be prohibitive. If these conditions are fulfilled there is no reason why the same cellulose should not be converted into paper many times over. There must, of course, be an end to this economical procedure, when the fibers are broken up so much that they cannot form a web.

The chief difficulty in the way of obtaining a usable pulp from printed papers is presented by the printing ink, and means have therefore to be sought of getting rid of this substance. The indelibility of printing ink is proverbial, but although it cannot be removed without disintegrating the paper, it can be removed after or during that disintegration.

Taking the chief sort of printed paper, viz., old newspapers, we find an inferior paper made of wood-pulp, cellulose, and fillings. The printing on it may be regarded as the result of the drying of a mixture of finely divided lampblack with an oily vehicle. On examining a printed letter under a high power, the black particles of lampblack and the gray dry residue of the vehicle can often be clearly differentiated.

The principle which underlies the removal of printing ink from paper is thus obviously to employ agents which will destroy or dissolve the vehicle which binds the lampblack, or other pigment (colored printing inks are now in extensive use), to the paper.

The first step is to tear up and disintegrate the waste paper in the ordinary manner. The resulting pulp is sieved, and it will be found that while the fiber remains on the sieve almost entirely, a fine sieve being of course used, a large part of the pigment which has been mechanically loosened from the fiber during the disintegration of the same passes through, together with much of the binding vehicle and nearly all the weighting and filling bodies present in the original paper. This, of course, much facilitates the subsequent treatment, as the pulp from the sieve is already partly freed from ink and other foreign bodies. One process to which it may be subjected is that of Knopf (German patent 127,820). This inventor treats the pulp from the sieve with soap-solution. It is then sieved again, and the soap carries most of the remaining pigment, which it has loosened from the fiber, through the sieve. The amount of soap required

naturally varies within wide limits, i. e., from 3 to 22 per cent of the weight of the waste paper, according to the character of the paper, and the nature and amount of the printing ink present. The pulp on the sieve is rinsed free from the excess of soap with water. It is essential to work the process throughout without artificial heat, especially when dealing with cheap printing inks made from rosin oil. Heat would induce oxidation of the vehicle, and enable it to resist the solvent action of the soap.

Such a process entails loss of finely-divided fiber during sieving, and the conversion of the vehicle and filling into a lye or emulsion which will not only escape through the sieve but carry the pigment with it, is never complete, so that the best result is a pulp of a decidedly doubtful whiteness. The loss of fiber is often a very serious item, and sufficient of itself to make the process unremunerative. On the whole the best procedure is Knopf's, using two sieves, one below the other, and both as fine as possible. In this way, the nearest approach to a white pulp which can be got with a lamp-black ink is secured. The second sieve saves much waste of fiber.

In conclusion, it should be noted that these remarks are concerned with lampblack ink only. Many of the colored printing inks now in vogue are easily destroyed by bleaching agents without any injury to the paper fiber.—Paper Making.

GLASS TELEGRAPH POLES.

AN interesting industry has been founded in Germany for the manufacture from glass of poles for telegraph and telephone lines. For some time past there has been a dearth of wood in Germany for this purpose; and whereas the government formerly insisted that poles supplied for such purposes to their telegraph department should be perfectly straight and free from twists or notches, owing to the difficulty in fulfilling such requirements they recently relaxed the regulations, and now permit bent and knotty poles to be used within certain limits. The department experimented with iron poles, but they were found to be far from satisfactory, the cost of upkeep in regard to painting to preserve the metal from rust, and the high conductivity of the iron which became a serious factor during thunderstorms, combined with the initial high cost, seriously militating against their widespread adoption.

Recently, however, Mr. William Schutz, an architect of Cassel, evolved a reinforced glass pole in which the authorities have evinced a great interest. Glass was selected for the purpose, owing to its extraordinary durability and strength when built up according to his system. Combined with cheapness both in first cost and in maintenance, perfect resistance to climatic

changes, fire, and acid, is its high insulation capacity, rendering it peculiarly adapted to electrical requirements, cleanliness, and possibility of decoration. By his system the poles can either consist of a glass rod strengthened with wire if desired, or reinforced at intervals with round hollow diagonals or cross-bars. The patents were duly taken up by a company, and now the factory is in full operation. The poles are produced by machinery, and as the result of further experiments, it has been found possible to extend the system to a variety of other purposes, comprising supports for carrying electric transmission wires and lamps, posts for fences, mine props, scaffolding, in short, to every application for which wood is at present utilized. At first the brittleness of the substance was considered to be somewhat against its adaptability to such commercial uses, but experiments have shown that when built in such a form as that contrived by Mr. Schutz, it can be subjected to considerable rough usage, though of course, as with cast iron and wooden poles, it can be willfully destroyed or damaged.

The manufacture of these poles moreover does not call for any particular skill upon the part of the glass workers; fairly intelligent labor is quite satisfactory, which is an important point, seeing that skilled glass workers are in great demand. The cost of producing a glass pole for carrying telegraph or telephone lines is only \$2.50, while the market price ranges from \$6 to \$7 per post.

The imperial government is subjecting the poles made upon these lines to severe tests, several having been acquired and erected in various parts of the country. It is felt, however, that the greatest applicability of such poles lies in tropical countries, where the ravages of the white ant or teredo preclude the employment of wooden poles, and where, on the other hand, the cost of transporting cast-iron poles is prohibitive. It is stated that the government intends to adopt the poles experimentally for this purpose in their African colonies, the imperial engineers having been impressed with the great strength of the post.

The success of wireless apparatus of comparatively small power in operating over long distances in the Pacific is phenomenal. Recently the transport "Thomas" established communication with the naval station at San Francisco while she was 1,400 miles away. On the same voyage she intercepted a message from the naval station at Sitka, 2,200 miles distant in a straight line. This is the best performance recorded by the marine wireless. The new small portable wireless apparatus for field use with which the Army Signal Corps is experimenting has given excellent results, communication having been established for a distance of 26 miles overland.