contracts. There will be a change in the size of the main battery of warships. Admiral Melville contends that the 12-inch gun is too heavy and cumbersome for existing needs, and that the new 10-inch weapon, which is more powerful than the 12-inch gun of five years ago, is the largest piece that should be mounted on a modern warship. He also draws attention to a phase of the armor and gun controversy which has not been investigated to the satisfaction of naval engineers, although they have called attention to its importance, namely, the indirect damage within the interior of the ship by the impact of 8-inch or larger shells upon armor which they fail to penetrate. The continued impact of heavy shell upon the armor protecting the machinery compartments will, Admiral Melville considers, be certain to disable some important auxiliary engines. Moreover, the effect upon the hull itself may be greater than is anticipated. "Structural and machinery steel will withstand strain and pressure, but it will not resist shock, and not only will the auxiliary connections in the way of piping and electrical conduits be damaged, but it is extremely probable that some sections of the hull riveting will be greatly impaired, since experience has shown that the rivets can be easily sheared by shock."

This last point is unquestionably a most important one, and we have recently had practical evidence in the high-explosive shell tests at Sandy Hook, when 12-inch armor supported by a section of the side of the "Iowa" was attacked, that the structural material of the steel backing, even where penetration is not effected, will suffer serious injury, just where Admiral Melville indicates, by the shearing of rivets and opening up of joints. At the same time, we are free to admit that the point thus raised somewhat nullifies the Admiral's advocacy of lighter guns; for the racking effect of a 12-inch gun is enormously greater than that of the lighter 10-inch piece which he would substitute for it.

STEAM BOILER INSPECTION.

It is only in the presence of a fatal and destructive explosion that the public fully appreciates the tragic possibilities that are wrapped up in every one of the two or three hundred thousand boilers that nestle among the teeming multitudes of our cities, or speed to and fro on steamboats and locomotives. Steam boiler explosions date from the very first use of steam under pressure, and the records of the early growth of steam engineering are punctuated with many a sad accident due to faults of material or design in the early boilers. With the increase of pressures which came at the time of the introduction of multiple expansion engines there was a call for special care in the testing of the materials and in the construction of steam boilers, and there is no doubt that measured against other forms of constructive mechanical work the boiler of to-day will hold its own on any point of comparison.

If the security of the user stood solely upon the quality of his boiler, and there were no such thing as rapid depreciation due to neglect or unsuspected decay, there might have been relatively but little work for the steam boiler inspector, and no development of the great steam boiler insurance companies whose organization and operations mark them as among the most perfect insurance institutions in the world.

The absolute necessity of inspection is so fully realized that, in some States, the inspection of boilers is compulsory, and the State provides inspectors for this work. In such cases, a fee is charged by the State for the service. In other States, there is no compulsion about inspections; and in all cases, if the boilers are inspected regularly by a boiler insurance company in good standing in the State in question, additional inspection by the State is not required.

In most of the States, locomotives on railroads are expressly exempt from State inspection. It is presumed that the railroad owning the locomotive will provide a master mechanic or other expert, who will be competent to pass upon the fitness and safety of their locomotives. This presumption does not appear to be altogether realized in practice, for railroad locomotives constitute a class of boilers which explode almost as often as any other class that can be mentioned. Omitting city elevated railroads, the total number of railroad locomotives in the United States on December 31, 1900, was 38,065.

Steamboat boilers are inspected by the United States government, and are therefore exempt from inspection by the State, or by any other authority. For this service the United States government employs sixty-three inspectors of boilers. There are over 7,000 steamers in the deep sea, coastwise and river service of the United States.

The total number of stationary boilers now in use in the United States was not ascertained in the last census. Neither are they enumerated in the census of 1890; but the census of 1880 shows that at that time there were 72,304 stationary boilers in this country. It was estimated by The Locomotive that on December 31, 1890, there were approximately 100,000 stationary boilers in the United States. The same authority estimates that at present there are about 170,000 boilers under insurance.

The methods of inspection adopted by the various companies, though they vary in detail, are carried out upon the same general lines. We have been informed by Mr. J. M. Allen, president of the Hartford Steam Boiler and Inspection Company, that at the present writing this company has 83,907 boilers under insurance, and the system employed may be taken as representative of the best modern practice. The inspection, as such, is divided into three classes: (1) hydrostatic tests, (2) external inspections, and (3) internal inspections.

The hydrostatic test consists in applying a cold-water pressure to a boiler that is completely filled with water. The pressure is usually applied by a pump that the inspector carries with him. The usual test pressure that is applied, hydrostatically, is 50 per cent greater than the working pressure at which the boiler is run. In Philadelphia, however, the law states that "a hydrostatic test of one-third greater than the boiler is rated to carry" will be considered sufficient.

When the boiler is under hydrostatic pressure, the inspector looks it carefully over, in all parts, to see if there are any signs of leakage, or of distress of any sort. This test is usually applied to new boilers, or to boilers upon which extensive repairs have recently been made, or upon boilers the interiors of which are not accessible, either because of their small size, or for any other reason. In some places, however (notably in the city of Philadelphia), a hydrostatic test is required by law on all boilers. Authorities differ about the advisability of applying the hydrostatic test, some maintaining that it is much better than the "hammer" test, to which we shall presently refer, because the actual pressure may develop a defect that the inspector, armed only with his hammer, might overlook. Other authorities claim that there is danger of straining the boiler by subjecting it to a test 50 per cent greater than it will ever have to withstand in practice. The hydrostatic test is not considered to be injurious to the boiler, when it is applied by a man with good judgment, but the hammer test is preferable when that can be applied.

"External inspections" are those made by merely looking the boiler over from the outside, to make sure that the attendant is not running it at a higher pressure than is allowed; that he is carrying plenty of water in the boiler; that the safety valve will blow off freely, and at the pressure that is allowed; that the water gages are in good condition; that the boiler is not showing any signs of leakage, nor any bulges over the fire sheet, nor any signs of distress of any kind. Of course, the attendant is not notified in advance when the company makes an inspection of that kind; for the object of the visit is, to see the boiler in the condition in which he usually runs it, without giving the attendant any opportunity to "fix up" for the inspector's benefit.

"Internal inspections," or hammer tests, as they are sometimes called, are made by the inspector entering the boiler through the manhole, and looking the interior over very carefully. He makes a similar examination, also, of the outside of the boiler, crawling into the furnace and all about, everywhere that he can go. Among the things that he has to look out for are these: Deposit of sediment or muddy matter, hard incrustation or scale on the tubes and plates, corrosion of any part of the boiler, both inside and outside, fractures of the plates, heads, headers, etc., leakage around the tube ends, seams and all other places where such leakage is possible, defective bracing of the flat parts of the boiler, grooving of the plates or heads, burned or blistered parts, and defective accessories of all kinds; water gages, feed pipes, blowpipes, safety valves, pressure gages, and everything else that can get out of order in any way whatever.

As an example of the magnitude and extent of the work of insurance and inspection it may be mentioned that the company above referred to employs a regular force of 198 inspectors, and in the year 1900 made 92,526 complete internal and external inspections (i. e., "hammer tests"), and in addition subjected 10,191 boilers to hydrostatic pressure; while from the beginning of the company's business down to January 1, 1901, 1,176,097 complete internal and external inspections were made, and enough external inspections to bring the total up to 3,049,203. Also 162,586 hydrostatic tests were made and 13,215 boilers were condemned as unsafe, good and sufficient reason for the condemnation being given to the owners in every case. During this time there were discovered and pointed out to the owners 2,226,256 defects of one sort and another, 245,210 of which were quoted as dangerous.

It is upon data of this sort that a steam boiler inspection company bases its claims to be considered as a great public safeguard. We have no way of knowing how many explosions work of this kind may have prevented, nor how many lives it may have saved, but the claim can fairly be made that the total number of lives saved has been great, and that the loss of property that has been prevented has been enormous.

OUR FORTHCOMING AUTOMOBILE AND OUTING NUMBER.

To those who are interested in the automobile—and who is not?—it will be a pleasure to know that we are bringing out a Special Automobile and Outing Number of the SCIENTIFIC AMERICAN. The Editor is making every effort to render this issue so comprehensive and detailed that it will put our readers in touch with the very latest developments of automobilism, considered both as an industry and a pastime. The issue will open with a number of special articles on such subjects as the Chicago Automobile Exhibition; the history of automobile racing; the best form of outfit for touring; the question of proper storage, repair and supply depots, both in the city and country; and a history of the rise and growth of automobile shows in this country and their influence in promoting the development of the automobile. Following the general discussion of the subject, there will be a series of elaborately illustrated articles descriptive of the leading types of automobiles manufactured in this country. The machines thus treated of will be grouped under the three heads of steam, gasoline and electric automobiles, and between fifteen and twenty different types will be described in this section of the issue. Under the head of Special Devices will be shown a large number of the latest types of motors, transmission gears, carbureters and storage batteries. There will be a lengthy article on the subject of automobile tires, showing their construction and the different methods adopted in making emergency or shop repairs. While the issue will be devoted chiefly to the automobile, there will be articles illustrating the latest types of houseboat, and one or two of the fastest pleasure craft that are now under construction for the forthcoming yachting season.

SCIENCE NOTES.

One of the latest novelties in the boot and shoe line are rubber boots for dogs, which are sold by several dealers in leather goods in New York. They cost about $4.75 for a set of four. The idea comes from Paris.

One of the omnibus lines in London has adopted the system of using acetylene for lighting their buses. Owing to the keen competition of the underground electric line, the omnibus lines were compelled to adopt radical innovations to retain their patronage.

The plow is certainly the oldest and probably the simplest of agricultural implements, being represented among the hieroglyphics on the ancient tombs of Egypt, dating back more than 4,000 years. As early as the year 1000 B. C. the plow was described by a Greek historian as consisting of a beam, a share, and handles.

The New York Zoological Society has received $3,000 from Miss Caroline Phelps Stokes for the nucleus of a fund looking toward the protection of our native birds. At the present time there are 1,674 live animals in the Zoological Park, of which 416 are mammals, 659 birds and 599 reptiles. During last season more than half a million people visited the park.

It is announced that the British War Office will abandon the khaki uniform with the termination of the war in South Africa. The khaki was originally intended as a working dress in addition to the regular dress uniform, but it became so popular that it in a great measure supplanted the other. It has now been decided to adopt a working uniform of drab color, which is of a more neutral shade and, it is said, more adapted for the uses of the army.

The work of the Jesup expedition into the extreme northwestern part of Siberia has ended, and according to a dispatch from St. Petersburg, the members are on the way to their respective homes. The expedition was under the leadership of Norman C. Buxton, and the object was, if possible, to trace the American Indian to some Asiatic origin. The party has collected one hundred boxes of specimens, which will be turned over to the American Museum of Natural History in New York.

With regard to the glass hospital which is to be erected at Philadelphia for the cure of consumption, with isolation for each patient and a constant supply of rarefied air, a similar experimental hospital is already in use in London. The patient sits in a glass cubicle, breathing an atmosphere specially treated by ozone. The value of oxygen, or ozone, in the treatment of ulcers, burns, wounds, lupus, etc., has been proved there by several cures of hitherto incurable cases during the past five years. Great as has been the actual relief thus afforded, this oxygen hospital exists equally for purposes of demonstration and experiment.