

# UNITED STATES PATENT OFFICE.

HAYWARD A. HARVEY, OF ORANGE, NEW JERSEY.

## GUN.

SPECIFICATION forming part of Letters Patent No. 460,261, dated September 29, 1891.

Application filed October 21, 1890. Serial No. 368,769. (No model.)

*To all whom it may concern:*

Be it known that I, HAYWARD A. HARVEY, of Orange, New Jersey, have invented a certain Improvement in Ordnance, of which the following is a specification.

The object of this invention is to produce a steel cannon or other piece of ordnance the barrel or tube of which, while in other respects homogeneous, presents upon its interior a cylindrical stratum of steel which is excessively hard upon its concave surface, but which gradually diminishes in hardness as the depth from the concave surface increases, and is adjoined by a cylindrical stratum of steel of any desired thickness which is of considerable toughness and which is incapable of being hardened so as to be brittle, but which is surrounded by an exterior cylindrical stratum of steel of prescribed thickness excessively hard upon its convex surface and also gradually diminishing in hardness from its exterior surface to the place of its union with the tough and comparatively soft steel of which the inclosed cylindrical stratum is composed.

The objects of this construction are as follows: first, to provide an interior surface for the tube or barrel which is so hard that it is incapable of being cut or scratched by the action upon it of the projectile when the gun is fired; secondly, to provide a cylindrical stratum of steel which possesses tenacity and toughness without the brittleness, which is the unavoidable characteristic of hardened steel; thirdly, to provide upon the exterior of the barrel a cylindrical stratum of steel which is so hardened as to give it the quality of elasticity without excessive brittleness and which acts as an inextensible hoop, which completely surrounds the body of softer steel and effectively prevents it from being permanently expanded by the force of the explosion when the gun is fired. The cylindrical stratum of comparatively soft steel acts as a buffer to protect the exterior stratum of hard steel from the immediate shock of the explosion, which, but for the interposition of the stratum of comparatively soft steel, might be sufficient to burst the exterior stratum of hardened steel. These results are accomplished by treating the barrel or tube of the gun, after the same has been cast or forged

and turned to the desired shape and dimensions, by filling the gun to the muzzle with finely-powdered charcoal and embedding the barrel of the gun in an external body of finely-powdered charcoal contained in a receptacle from which the air is excluded and which is constructed of refractory material, such as fire-brick, and which is contained within a furnace-chamber, in which there is maintained a heat sufficient to melt cast-iron for a period of such duration as will suffice to cause those portions of the metal which are in contact with the charcoal to absorb prescribed percentages of carbon in addition to the carbon originally contained in the steel from which the gun has been made. This process of treatment is analogous to that described in Letters Patent of the United States No. 376,194, issued to Hayward A. Harvey January 10, 1888.

The duration of the described treatment will of course vary according to the size of the gun and also according to the efficiency of the furnace and the character of the fuel employed. The necessary data for determining the duration are ascertainable by observing the effects produced by the use for an observed period of a given fuel in a given furnace. The longer the high heat is maintained the greater will be the depth of penetration of the added carbon and the greater will be the quantity of carbon absorbed by the strata of metal in contact with charcoal.

In view of the multiplicity of furnaces, the variety of fuels, and the various sizes of guns, no general prescription can be given which will be of universal applicability. For illustration, it may be stated that a prolongation of the heat for a period of thirty hours, after the furnace-chamber has been brought up to a temperature high enough to melt cast-iron, will usually be sufficient for the effective treatment of guns of, say, four inches caliber. By such treatment a gun composed of steel originally containing, say, one-quarter of one per cent. of carbon will be supercarbonized upon its interior and exterior surfaces to such an extent that the surface strata of metal will each contain from one to one and one-tenth per cent. of carbon. The next adjoining annular strata will contain, say, nine-tenths per cent., the next seven-tenths per cent., the

next five-tenths per cent., and next three-tenths per cent., until at depths of, say, three-quarters of an inch from the exterior and, say, half an inch from the interior surfaces, the metal will contain only its original quarter per cent. of carbon. Upon hardening the gun by removing it from the furnace, allowing it to cool down to a dull red color or other desired color, and then plunging it into water or other tempering-fluid, the supercarbonized strata will take the variable degrees of temper incidental to the variable distribution of carbon in them. The greatest percentage of carbon being present in the strata of metal adjoining the surfaces which have been in contact with the charcoal, those surfaces will be so hard that they cannot be cut or scratched by an ordinary cold-chisel or file. The next adjoining annular stratum will be slightly less hard, the next still less hard, and so on. It will of course be understood that the expressions "stratum" and "strata" are herein used merely for convenience, and that in any supercarbonized stratum of given thickness there will be a regularly varying distribution of carbon, the quantity present gradually diminishing from the side nearest the exposed surface toward the side farthest therefrom. The resultant gradual diminution in the degree of hardness in the metal as the distance from the exposed surfaces increases is a feature of great importance, for if a stratum of excessive hardness, owing to the presence in it of a large percentage of carbon, immediately adjoined a stratum containing so little carbon as to be incapable of being hardened the highly-carbonized hard stratum would be liable to be chipped or cracked off by the force of the explosion. This feature is made use of in the construction of the armor-plate described in H. A. Harvey's application, Serial No. 364,887, filed September 13, 1890. In the present case it is desired that there shall be a comparatively shallow depth of supercarbonization of the metal upon the interior surface of the gun-barrel, the object being to make the interior

surface of the gun-barrel capable of taking so hard a temper that it will not be abraded by the contact with it of the projectile when the gun is fired. For the strengthening effect the external supercarbonized stratum is mainly relied upon, and as the external portion of the gun is that which is most nearly exposed to the heat of the furnace-chamber there is no difficulty in so regulating the duration of the treatment as to effect the desired greater depth of supercarbonization of such external portion.

What is claimed as the invention is—

1. The herein-described gun, composed of a mass of steel which, while otherwise homogeneous, contains variably-distributed percentages of carbon and the barrel of which is composed of an annular stratum of metal containing a relatively low percentage of carbon inclosed between internal and external annular strata of metal excessively hard upon their exposed surfaces and gradually diminishing in hardness as the depths from their exposed surfaces increase, as and for the purpose set forth.

2. A steel gun the barrel of which is composed of a body of steel homogeneously united to the exterior of an annular stratum of metal containing variably-distributed percentages of carbon and which is excessively hard upon its exposed concave surface, but gradually diminishes in hardness as the depth from its exposed concave surface increases, as and for the purpose set forth.

3. A steel gun, the barrel of which is composed of a body of steel homogeneously united to the interior of an annular stratum of metal containing variably-distributed percentages of carbon and which is excessively hard upon its exposed convex surface, but gradually diminishes in hardness as the depth from its exposed convex surface increases, as and for the purpose set forth.

HAYWARD A. HARVEY.

Witnesses:

E. GATTERER,  
J. E. BURNS.