Royal United Services Institution. Journal

Publication details, including instructions for
authors and subscription information:

<http://www.tandfonline.com/loi/rusi19>

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Published online: 11 Sep 2009.

To cite this article: Major C. H. Powell (1896) The Use of Aluminum for Military
Purposes, Royal United Services Institution. Journal, 40:226, 1511-1515, DOI:
[10.1080/03071849609416299](https://doi.org/10.1080/03071849609416299)

To link to this article: <http://dx.doi.org/10.1080/03071849609416299>

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THE USE OF ALUMINUM FOR MILITARY PURPOSES.

By Major C. H. POWELL, 1st Goorkha Rifles.

I PROPOSE, in this paper, to make a few remarks on the subject of aluminum—a metal which is making rapid strides at the present time; although it is only within the last three or four years that this has been the case.

Aluminum is one of the most widely distributed of metals, but the cost of extracting it from mother-earth has hitherto been prohibitive.

In 1827, a man of the name of Wöhler succeeded in producing aluminum in the form of a grey powder by the aid of potassium. He was followed in 1854 by St. Claire Deville, who was the first man to really extract the metal in a state of purity. This result was obtained by reducing aluminum chloride by electricity.

In 1882, Mr. Webster succeeded in very considerably reducing the cost of production; and a few years later, he and Mr. Castner, from the United States, started the Aluminum Company. They erected works at Oldbury, and spent a considerable sum on plant. But they completely failed to produce the metal at a price which would bring it into commercial use.

In 1888, Heroult invented a process which is being carried out by the Aluminum Industrie Actien Gesellschaft, at Neuhausen, Switzerland. Here and at Niagara are the only places where the metal is extracted at the present time. Our English workers obtain the metal from these two places in the form of ingots, bars, sheets, rods, wire, tubing, etc.

A company has been formed in England, titled the British Aluminum Company, which is erecting works at Foyers in Scotland, with a view to utilising the water-power of those falls.

The two minerals most used for producing aluminum are *beauxite* and *cryolite*. Electricity is used in the reduction of aluminum by Herault's process, the details of which I shall omit, as being too technical and beyond the scope of this paper.

One of the chief advantages of aluminum for military purposes is its remarkable lightness. For comparison, I give below the specific gravities of the following metals:—

Aluminum ..	..	..	..	..	..	2·587
Brass ..	..	..	..	..	..	8·386
Iron ..	..	..	..	..	..	7·775
Copper ..	..	..	..	..	..	8·880
Steel ..	..	..	..	..	..	7·848

It will thus be seen that aluminum, in round numbers, is three times lighter than iron and four times lighter than brass or copper.

Pure aluminum is harder than tin, but softer than zinc, and can be cut with a knife. It is as malleable as copper, and takes a polish like silver.

Unfortunately, it has not been found possible to solder the metal successfully, although numerous attempts have been made in this direction. This is one of the great drawbacks to the development of the metal.

With this introduction, I now come to the object of my paper, which is to advocate the use of aluminum for military purposes.

For over three years I have studied the metal from a practical point of view. While serving in the Gilgit District I used cooking-pots made of aluminum for over a year. My plates, cups, and saucers were also of this metal. In Waziristan and Chitral we used only aluminum cooking-pots in the mess of my regiment. They were satisfactory in every respect, being perfectly sanitary, and were much admired by every officer who saw them on account of their remarkable lightness. To cleanse them they are merely washed out with hot water and wiped dry—no scouring is necessary. After using the vessels for a short time a brownish film coats the inside. To the uninitiated this would appear objectionable; but as a matter of fact this film has absolutely no injurious properties—in fact, acts as a preservative to the metal. It is unwise, therefore, and quite unnecessary to try and scour off this coating. Aluminum vessels should, however, not be washed with soda, as chemical action is set up, which causes the metal to be corroded, and also turns it black. This warning applies to England rather than to India, where soda is never used.

I have inspected pure brandy, whiskey, gin, and vinegar, which were separately put in aluminum bottles for a period of twenty-one days. Brandy was discoloured to a greater extent than the other spirits. Gin was hardly affected, and vinegar apparently not at all. The discoloured liquor, due to chemical action being set up, can be drunk with impunity, although one would naturally turn from doing so. This fact makes it desirable to abstain from putting pure spirits into aluminum vessels. But so far as this defect may appear by some as a reason against the introduction of the metal for military purposes, I think the argument may be refuted by saying that the water-bottle is used almost exclusively for water and weak tea by the soldiers. The German soldier puts coffee into his.

DISADVANTAGES OF ALUMINUM.

The only apparent disadvantage to cooking-pots made of this metal is, that a damaged vessel cannot be repaired, as aluminum cannot be successfully soldered as yet; so that a badly damaged vessel could only be sold as old metal. In England no difficulty would be experienced, but in India there would be no sale for the metal. Aluminum firms in England will take back old metal at the rate of 1s. a pound, which is

equal to $\frac{1}{2}$ the market value of the metal. I do not anticipate, however, that ordinary care being taken, renewals of cooking-pots would assume very large proportions. In any case, so far as British troops in India are concerned, the cost would never amount to the enormous sum annually expended in tinning the Flanders kettles (twice a month it takes place) for the 75,000 troops which garrison that country. I think, therefore, we may dismiss the one disadvantage to the metal as not a very grave one.

COOKING-POTS FOR BRITISH AND NATIVE TROOPS.

The British Service in India is supplied with Flanders kettles, which are oval in shape. It is not possible, except at a prohibitive price, to make this shape in aluminum. Round vessels are most easily made, they are "spun" out of a blank sheet, and are constructed with neither join nor solder. The pots "nest." The gridiron, and ladle supplied to each Flanders kettle can also be made in this metal, but not the chopper.

I have samples of sound cooking-pots from London and German firms. The standard pattern I required the firms to estimate for was a "nest" of twelve pots, the largest being $12'' \times 7\frac{1}{2}''$. This is the pattern of field service cooking-pots used in many native infantry regiments in India. They can be obtained wholesale at from £3 to £3 15s. a "nest."

The pots can be fitted with sockets and removable handles if desired, but these are superfluous in India, as native cooks will not use them. The cooking utensils are invariably made of the purest aluminum sheet. The thickness of metal used for the four largest is 14 wire gauge; for smaller vessels 16 wire gauge.

THE SOLDIER'S WATER-BOTTLE.

Germany is the only country in the world where water-bottles are made. The cost of machinery necessary to stamp them out is so expensive that it will not be worth the while of any English manufacturer to purchase it till our Government decides to introduce bottles into our own Army.

I have obtained samples from different firms in Germany. The best of all is one weighing:—

$7\frac{1}{2}$ ozs. empty.

4 lbs. 7 ozs. filled with water.

Holds 3 pints.

This can be obtained for the sum of 2s. 4d. for quantities of 50,000. This bottle has a flat base, a wide mouth, and is supplied with a cork having an aluminum cap; and, if required, a felt cover and strap can be fitted at additional cost.

Another bottle, which I have by me, is a fac-simile of the enamelled iron one supplied to British troops in India. It is an excellent shape, but only holds two pints, which I do not think is sufficient for India. It costs 3s. 1½d. covered with felt and strap attached. There is, however, a very serious objection to this bottle. They have not been able to make it out of one piece of metal like the others: the top piece is lapped on to the lower portion and joined by machinery, but is neither soldered nor welded. A blow here would very likely splay the join, and so render it likely to leak. I tested one bottle of this kind, and it leaked badly. Till a successful solder has been invented, the only bottle suitable for issue to troops is one which is "spun" out of a single sheet of aluminum.

ADVANTAGES WHICH ALUMINUM POSSESSES.

I will briefly enumerate the several advantages which this metal possesses and makes it so superior to other metals for cooking utensils:—

1. Great lightness; $\frac{1}{3}$ the weight of steel, iron, tin, or zinc. Many will wrongly suppose that because cooking-pots made of aluminum are light they will not wear well.
2. Non-liability to rust, non-corrosive for all practical purposes.
3. Not attacked by food acids, as is the case with copper and tinned-lined vessels, which waste fairly rapidly, and are liable to verdigris. On the other hand, an impervious coating is formed on the inside, acting as a preservative to the metal.
4. Owing to the metal possessing great heat conductivity, food is cooked quicker.
5. With ordinary care, aluminum vessels will stand very considerable wear and tear, as I know from practical experience. They are easily cleaned, requiring only to be scalded out. Very occasionally they may be scoured with *fine* sand.

I have read some interesting data from the report of a German military commission, which testify to the excellence of aluminum for culinary purposes. Sir Frederick Abel and Professor Dupré, undoubted authorities on this subject, are of opinion that there is nothing injurious in the metal so long as pure aluminum is used in the manufacture of water-bottles and cooking utensils.

I am given to understand that the Union Steamship Company has fitted up the whole of its fleet with aluminum cooking utensils, and speaks highly of them. I think it is only a matter of time, and we shall find this metal taking the place of copper in our kitchens.

ADVANTAGES FOR MILITARY PURPOSES.

I have already stated that aluminum is three times lighter than iron, and practically three-and-a-half times lighter than brass and copper—the metals from which the cooking-pots in the British and Native Armies in India are made. It stands to reason, therefore, that the saving in transport for the carriage of aluminum cooking-pots would be very considerable. Take, for instance, a British corps of 1,000 men. 125 Flanders kettles are required, which would take ten-and-a-half mules for their transport. Whereas aluminum pots would require three-and-a-half mules—bulk, of course, always taken into consideration.

Following the same argument, a greater saving would be effected in the case of the heavier metals, viz., brass and copper used by the native corps.

With a large army on field service this reduction of carriage could not fail to be very considerable, and would prove a very great saving in a country where the feed of men and animals is a difficulty and an expense. But this reduction would not only take place on field service, but during annual reliefs in India, and the marching of troops to and fro camps of exercise. The saving to Government would, therefore, be constant, and not merely occasional; and would in a short time recoup the initial cost of outlay.

If the German Government has so fully realised the many advantages of this metal, in view of reduction of transport, and of lightening the already heavily-laden soldier, I cannot but feel that we ought not to be behindhand in grasping the importance, and adopting this forward step in military equipment; and more especially in India, where our difficulties, both in peace and in time of war, are so much greater than are those of the German Army.