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By L.T.D. Williams

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By: L.T.D. Williams

I suppose that a convenient way to start this talk is to recall a couple of quotations which could be matched by similar statements in nearly every history of the war. "The Confederacy never lost a battle for want of ammunition". "So far as munitions were concerned, the Confederacy seemed able to carry on the war for an indefinite period". Well now, how did the agricultural South manage to bring off this industrial near-miracle? It is really very remarkable that only few writers, such as Frank Vandiver and Ralph Donnelly, have tried to find out, although several very distinguished historians of the war have pointed out the need for a study of this sort. What I would like to put before you tonight is a strictly amateur and incomplete examination of one aspect of this problem - how the South got its explosives. I must emphasize the incompleteness of my efforts for, as I expect most people know, the records of the Confederate Ordnance Bureau were burnt in the last days of the war, probably at Charlotte or Fort Mill, and what one has to work on is a motley collection of scraps and ledgers, plus the very scanty accounts written by survivors of the Confederate services many years after the war, mainly, I think, from memory. And, I have to admit that I have not had the time to do all the searching that I should have done before coming here to talk to you.

The first point we might look at is, I think, the production capacity and stocks the South had at the beginning of the war. The answers to this are a little unexpected. As is fairly well known, there were a good many powder mills in the South before about 1845; for example, there were no less than 31 mills in Tennessee around 1810, but these were all very small, and the whole lot together produced less than 50,000 lb a year. Virginia, Georgia, Louisiana, North Carolina, they all had their little mills, but only Maryland, so far as I know, had a substantial output, reaching some 670,000 lb in 1840; but virtually all this had shut down by 1860. The difficulty was that these small mills could not compete with the three or four large Northern producers in terms of quality, and when they blew up, as too often occurred, the capital needed to rebuild them was hardly ever forthcoming. And it was not only the smaller Southern mills that were in trouble, for in the late 1850's DuPont brought out their cheap and excellent blasting powder made from Chile saltpetre, which was not suited to military purposes but which had nearly swept the market for blasting powder clean by 1860.

So Jefferson Davis could write "There was before the war little powder or ammunition stored in the Southern States, and this was a relic of the war with Mexico ..... Powder, save perhaps for blasting, had not been made in the South ..... On June 1st, 1861, there was probably 250,000 lb only, chiefly of cannon powder ....."

Well now, that was reasonably accurate as regards manufacture. Only three mills are known to have been in existence at the beginning of 1861: the Sycamore mills, near Nashville, Bowen & Co. at Pendleton, South Carolina, and J.M. Ostendorf at Walhalla, South Carolina. All three were very small indeed, and in fact the last two together could only make some 300 lb a day. The Sycamore mills were slightly larger, and were able to claim that they had made the Confederacy's first powder, but I am doubtful if any of these three were working at the time Fort Sumter fell. But the Southern stock is another matter, for it is certain that there was far more in the South than Davis reported - although whether he knew it is pretty unlikely. Fairly substantial amounts were picked up in the various arsenals and forts in the States as they seceded, and in addition the States bought quite large amounts from Northern manufacturers and from abroad between December 1860 and April 1861. When, rather late in this period, DuPont was approached, the firm thought war was in the air, and they refused to sell, but some of the other firms, approached earlier, did deliver a good deal, notably to Governor Pickens of South Carolina, who managed to lay in some 300,000 lb. However, the most surprising thing is the large amount of powder which was in the hands of agents; by examining old records of the DuPont Company, Dr. Norman Wilkinson, of the Hagley Museum, has found that agents of the company in the South were holding - and owing for - no less than 640,000 lb in the early part of 1861. Of course, some of this was blasting powder, not well suited for use in arms, and I dare say that the Confederate authorities never got a chance to lay their hands on a fairly large proportion of this amount - for instance, the records of the Executive Council of South Carolina report some pretty short answers to requests for powder (except damaged stuff!) from the central government. However that may have been, it is, I think, the fact that there must have been something like one and a half million pounds of powder, of one kind and another, in the Southern States at the outbreak of war.

This guess of mine is so much out of line with what is usually supposed to have been the case that I would like to quote what Major Rains, of whom I shall have a good deal to say in a minute or two, wrote in a pamphlet he circulated in the summer of 1861 - his words were "..... we cannot be too thankful that this gigantic war was entered upon with large supplies of ammunition". Still, whatever the exact figures were, these were only stocks, with no guarantee of replenishment, and Jefferson Davis, who had so recently been U.S. Secretary of War, was certainly not the man to overlook the need for assuring continuity of supply. In fact, on February 21st, 1861, only three days after his inauguration as President of the Provisional Government of the Confederate States, he told Captain Semmes to buy up machinery and munitions, insisting in particular on the setting up of a powder mill. His idea was to buy know-how and equipment from one or other of the Northern manufacturers, but this did not work out as war came too soon. However, only a few days later he made a move which turned out to be much more important: he appointed Josiah Gorgas to be Chief of Ordnance.

Now men are always more important than machines, and if your resources are small, it is more important than ever to choose good men to exploit them, for they will contrive to get returns which lesser men would not even dream of. This indeed is what Davis managed to arrange. With Gorgas there were, in time, Isaac St. John of the Nitre and Mining Bureau, George Washington Rains and John Mallet of the Army's Ordnance Bureau; there were also Joseph Anderson, who ran that remarkable self-contained and self-supporting private empire, the Tredegar Iron Works, and

John M. Brooke of the Navy's Office of Ordnance and Hydrography - it was such men as these, with their small band of picked associates who (in Frank Vandiver's phrase) beat the plough shares into swords, who equipped powerful armies seemingly out of nothing, who made it possible for the Confederates to dream for four years of victory and an independent and rejuvenated South. Of course they could not succeed, the odds against them were always too great - but one may indeed ask whether history has given these men their due.

I do not have to tell you that these men had to work against the most enormous and the most frustrating difficulties. There were always transportation difficulties, and even if the railroads managed to cope, more or less, with demands, there were often no wagons strong enough to haul heavy items away from the railroad depots or, if there were, it was terribly difficult to get harness for the transport animals to pull them, or to get iron for horse shoes. There was a Southern Telegraph system operating, but in all the turmoil of setting up the machinery of government, it often took a tremendous time to get answers. Many of the states had been justly famous for their hard liquor, but laws passed to conserve breadstuffs for the armies by preventing the diversion of grain for fermentation brought about a constant shortage of alcohol, without which the mercury fulminate needed for percussion caps could not be made. Everything to do with the control of manufacture was lacking: to pick on one or two things whose availability one would ordinarily take for granted, there were no timing devices to control the manufacture of time fuzes (the unreliability of which was a constant source of complaint throughout the war); there were not even reliable sets of weights and measures until someone discovered a fine set of standards made years before for the U.S. Coast Survey, from which duplicate sets were made for the various arsenals and laboratories. Indeed, everything, literally everything, from the rarest to the most commonplace was hard to come by - and not least, satisfactory labour. There is on record a striking memorandum from Brooke, in charge of the Office of Ordnance and Hydrography, to Mallory, Secretary of the Navy, reporting that the quite considerable facilities that then (1865) existed for the production of naval ordnance supplies were working well below capacity owing to the shortage of labour, due largely to bad planning of manpower, and to excessive dependence on foreigners who were liable to disappear when times became harder than usual: and there is much more in the same vein on record.

Well now, to return to these very remarkable men, Gorgas was a Pennsylvanian who had married the daughter of John Gayle, a former Governor of Alabama, and, whatever he may have thought about slavery, he certainly hated the abolitionists, and he went with the South in consequence. He had been an Ordnance officer in the Mexican war, and his experience as officer in charge of the ordnance depot at Vera Cruz led him to swear that if he ever rose to command, he would make very sure that the troops never called on him in vain. In the circumstances of the Confederacy, he could scarcely have achieved this, and the Southern troops had all too frequent cause for complaint about their equipment - perhaps particularly the cavalry who received poor carbines, poor swords, and, rather surprisingly, shockingly ill-fitting saddles which were forever causing sore backs - but the troops who were complaining were thinking, not of the meagre resources with which Gorgas had to work, but of the weapons in the hands of the men they were fighting. The Federals themselves, however, looked at things rather differently, and the contemporary accounts rarely record

them as dismissing the Confederate fire as insignificant. Anyone who wishes to question this might care to look up the accounts of, say, Fredericksburg and Cold Harbour. But I have neither the time nor the knowledge to go over the whole field of Gorgas' achievements. Let me just talk a little about the explosives side.

Gorgas' first step was to pick a man of his own quality, George Washington Rains, a native of North Carolina, who had a gallant combat record in the Mexican war, who had for a while been assistant professor of chemistry at West Point, and who, in the four or five years before the outbreak of war had been president of some ironworks at Newburgh, New York. Gorgas pulled him in about June 1861, told him to supply the C.S. Army with gunpowder and gave him carte blanche as to how he did it. Once again, a better choice could not have been made; Rains' experience in both chemistry and engineering was exactly what was needed to set up the explosives facilities the South required.

First things had to come first, and this meant assuring adequate supplies of the ingredients of gunpowder - saltpetre, charcoal and sulphur. The most crucial of these was, traditionally, saltpetre, but it was well known that in the War of 1812 the importations of powder had been supplemented by powder made with saltpetre extracted from the nitrate-containing earth found in very many caves in the mountainous regions of the South. (Some of these caves are still shown to tourists, for instance, beside Mount LeConte in the Great Smokey Mountains National Park, and near Natural Bridge, Virginia). Rains, therefore, quickly got out a pamphlet - the one I mentioned earlier - on how to get the calcium nitrate out of the earth by extracting with water, treating it with wood ashes and crystallizing out the resulting potassium nitrate. He quickly saw, however, that he could not continue to supervise the production of nitrates all over the South, and at the same time set up and run a big powder mill, so he got Gorgas to persuade the authorities to start a new bureau to look after the saltpetre. Isaac St. John was put in charge of the new outfit, which became justly famous under his very competent direction as the Nitre and Mining Bureau, responsible not only for obtaining saltpetre but also for exploiting as far as possible the mineral resources of the South. I should say that coal and iron ore were fairly readily available in certain areas; the great struggle was to find enough lead and copper, of which the Confederacy was always in the direst need.

Rains records that at this early stage he had the great good luck to come by a pamphlet describing the manufacture of gunpowder at the British Royal Gunpowder Factory at Waltham Abbey, which he says was written by a Major Bradley. It so happens that for a few years I myself had the honour of being the Director at Waltham Abbey, now long turned from the manufacture of gunpowder to research on explosives, and, by checking back with my recent colleagues, I find that what came into Rains' hands was a pamphlet circulated locally by a Major Fraser Baddeley in 1857. Rains' find was important, because nobody made better powder than the British - and when I say that, I am not just putting in a big plug for my former bailiwick, but quoting the opinion of both Rains himself and of the U.S. Ordnance Manual of 1862.

Well, it certainly was convenient, finding this pamphlet; amongst other things it drew attention to the importance of very careful purification of the ingredients, and it described the process of incorporation in a roller mill, which were two of the main reasons for the high quality of the Waltham Abbey powder. But the find was very far from solving all Rains'

problems. Baddeley's pamphlet described the various processes - mixing, incorporating, pressing, granulating, drying, glazing, dusting - but it contained no drawings at all. So Rains had to sketch them all, and, like many a production engineer in World War II, to do much of his work in railroad cars as he went around on his preparatory work. I might add that contemporary accounts do not suggest that train trips in the South, at that time, were either comfortable or peaceful.

Rains realized from the first that one of his greatest difficulties would come from the fact that he had virtually no experienced staff to work and supervise his mills when he had built them: he had, in fact, just one experienced foreman, a man named Wright who had luckily worked at Waltham Abbey and knew the processes Rains intended to install. He therefore decided to set up, as quickly as possible, a pilot mill which would both serve to train personnel and also to test out his ideas on processes and plant. This he did at Manchester, Tennessee, where he found that a Mr. Whiteman had already been engaged by the State of Tennessee to set up a powder mill, and who was willing to work along the lines proposed by Rains. Meanwhile, Rains was similarly trying out his ideas, and training operatives, in the purification of saltpetre, for which he had a small refinery set up at Nashville. This soon reached 1500 lb of pure saltpetre per day, and by the second week in October had got up to 3000 lb per day. Part of this output went to the Sycamore mills, but these operated on the older and less satisfactory stamper principle, and their output of finished powder did not exceed 500 lb per day. However, it is said that these mills and the two still smaller ones I mentioned earlier had turned out some 100,000 lb before Nashville fell - and this came in very handy for the troops in the West.

Rains also arranged for the production of powder at New Orleans, and it is said that the output there reached 4000-5000 lb per day, but whether this is true or not, the mills were lost quite early in the war. The fall of Nashville, early in 1862, similarly shut down the Sycamore mills and the Manchester pilot plant, but the machinery from the latter was removed in good time and installed in Rains' main plant at Augusta, Georgia, which by then was getting fairly near production. I should say, by the way, that Rains' choice of Augusta for his plant was a happy one, and not merely because Augusta was the only Southern city of fair size which was never occupied during the hostilities: it was central, served by canal and river transport as well as by rail, had a good supply of the pure water essential for the saltpetre refinery, and it was near to wooded areas providing the raw material for his charcoal kilns.

In working out the designs for this plant, the Confederate Government Powder Works, Rains had two points always in mind: he was determined to make powder of the highest quality and, because he was so lacking in trained labour, he had to devise simplifications and short cuts wherever he could. The Waltham Abbey pamphlet did not help much here, for the Waltham Abbey mills had even then been operating for over 300 years and working in them was a tradition for many local families; it was consequently entirely practicable for the English plant to depend very much on a body of skilled foremen and charge hands.

So, for example, Rains designed a mechanical crystallizer, instead of a manually-operated one, for his saltpetre - I suspect it must have been one of the first

crystallizers which were not hand worked - and with this ingenious machine he achieved a standard of purity of this critically important material which was not bettered by any saltpetre refinery in the world, and which was much better than most. He introduced a simple method for removing the worst of the impurities from his sulphur before distilling it, and, finding it difficult to get the willow or alder wood preferred by most powder makers for making charcoal, he developed a very satisfactory substitute in the cottonwood which, as I indicated just now, was plentiful in that area. Oddly enough, the factory ledger continued to list the material brought in as 'cords of willow', so it is not easy to be sure that he did in fact use only this cottonwood.

With the aid of his architect, Shaler Smith, and his engineer, Pendleton, he set up his mills in the first place to include each of the stages used at Waltham Abbey, but, as I said, he was continually looking for ways to shorten the process. He introduced a machine for steaming the newly-mixed charges before incorporation, which seems to have shortened the subsequent incorporation time by something like three quarters, with an actual improvement in quality; he tried eliminating the pressing stage (incidentally, one of the most hazardous), and found this entirely satisfactory for the finer-grained powders; and he also found it possible, for some grades, to run the drying, glazing and dusting processes into a single operation. It is very curious that, so far as I have been able to ascertain, these processes seem entirely to have escaped the attention of the writers on explosives whose books appeared after Rains' time. Perhaps one reason for this is that, though he patented his process, the patent was of course one of the few Confederate States patents - actually No.259 - and it seems to be impossible to find a copy of this specification today.

I remarked earlier that Rains was insistent on maintaining the highest standards of quality in his material; a striking manifestation of this was that he was not satisfied simply to maintain traditional standards as defined in the specifications of the time. On the contrary, instead of the traditional tests, relying on the feel of the powder, and its ability to be flashed off a piece of white paper without marking it (tests which are more sensitive than one might suppose) plus a rather crude ballistic test by way of firing a standard ball from a small mortar known as an eprouvette, he arranged the construction of the instruments necessary for the sort of tests one might expect to see in use today - ballistic pendulum, electric chronographs, pressure gauges for recording chamber pressures - and he appears to have organized a scheme for the sampling and testing not only of the products of his mills, but also of the other mills in the South, and for verifying the quality of powder which had been in store for some time. Incidentally, this last point was important, because the warm, damp conditions of many of the magazines, especially at the ports such as Charleston, were very unfavourable to good storage. So far, however, I have been quite unable to find how this very sensible sampling and testing scheme worked out - there seem to be no records still in existence, though part at least of the report of a Board of Officers "for determining the proper charges for heavy guns ..... etc." has survived, and this shows quite clearly that the instrumentation which Rains introduced was used to good effect - though one wonders how accurate the pressure recordings were, for some were astonishingly high. But, to be fair, crusher gauges give trouble to this day unless procedure is standardized with extreme care.

Considering all this, it is not surprising that the Confederate Powder Works became something of a showplace during the war, all the more so because Rains had tried to insist on making the central portion "present the appearance of a grand monumental structure", to quote from his own words. Among the many visitors were the two English colonels, Fremantle and Fitzgerald Ross, each of whom was shown around in 1863 and each of whom recorded his admiration in the accounts published of their respective travels in the Confederacy.

Surprisingly little seems to be on record about the other powder mills in the South. Selma, Alabama, which of course made a wide range of munitions in the second half of the war until it was wrecked in the Wilson raid of April 1865, had a small mill turning out about 500 lb a day; and since the Selma-made cartridges were reported on several times as very well made, it seems likely the powder was well-made, too. Richmond eventually had a rather larger mill, making about 1500 lb per day by 1865, but I know nothing more about it at present. A private firm, Waterhouse and Bowes, had a mill at Raleigh, with a capacity of some 600 lb per day, which I suspect worked through a good deal of the war; however, it had a pretty serious explosion in 1862, and I have seen no reference to its being rebuilt, although I think it must have been. Incidentally, its powder was not as good as it should have been, because it tended to be of too high a density. There was, I think, also a privately-owned mill, run by a man called Davis at Charlotte, planned to produce 1000 lb per day.

Speaking of the accident at Raleigh reminds me that quite one of the most astonishing features of the operations of Rains' mills at Augusta was their relative freedom from trouble of this sort. Rains says that there were only three explosions, two of which were very minor, in the incorporating mills, and one serious one, which caused the death of nine people, in the granulating plant; this last appears to have been due to the age-old difficulty of preventing men from smoking when not actually at work and the foreman was not around, as was the case on this occasion. For a new mill, worked almost entirely by inexperienced labour, that is a really remarkably good record. I think DuPont had some ten accidents in roughly the same time, for an output which was not much bigger.

Scanty as may be the information about the activities of the Ordnance Bureau of the C.S. Army, that dealing with the Navy's Office of Ordnance and Hydrography is scantier still. It, too, picked up a few men of very high qualifications; in particular, Matthew Maury and John Brooke were internationally known in several fields connected with oceanography and navigation, and Catesby ap Rhys Jones was an ordnance man of quite exceptional ability and initiative.

So far as production of gunpowder for the C.S. Navy is concerned, I have been unable to trace any firm data for the first year of the war. There certainly was a small mill working for the Navy at Petersburg, Virginia, but what went on there seems to be not merely unknown today but also to have been unknown at the time to the Army's Bureau of Ordnance. In any case, the mill had to be abandoned for obvious reasons in the spring of 1862; it is sometimes said to have been set up for a while at Charlotte, but I doubt this. As I said a moment ago, there was a project to set up a private mill at Charlotte, but I am not sure when its construction (reported as going on very slowly) was completed. There was a small but vitally

important sulphuric acid plant set up in the same town, making 4000-5000 lb per month, but I do not think there can have been a Naval powder mill there too, for the South Carolina State records show Lieut. T.A. Jackson was seeking permission to build a new naval powder mill in Columbia near the canal as early as June of 1862. Authorization was given in July, and in August, George Minor, who I suppose may have been the Lieut. Minor who had been wounded in the fight between the Virginia and the Monitor, wrote to tell the Secretary of the Navy that the new mills were coming on nicely. I do not know when production started, but when it did, the mills were being run by a man called P. Baudry Garesche, of whom virtually nothing seems to be recorded. Dr. Norman Wilkinson, whom I quoted earlier, has made the very interesting suggestion that he might just possibly be the grandson of one of the original partners of the DuPonts. If he was, then there has been a confusion in spelling, but since the name Garesche itself is sometimes mis-spelt anyway, that does not rule the suggestion out of court. I rather suspect, however, that P.B. Garesche came of a Cuban family, and was related to the Colonel J.P. Garesche who was killed at Murfreesboro, fighting in the Union army.

In November 1863, and again in April 1864, John Brooke reported very favourably on Garesche's work, but in point of fact we know from several other sources that the powder he was turning out at the time was not too good, being of excessively high density. It seems that he had been using a pressure of 250 tons on his 14-inch square press, when Mallet, of whom I shall speak in a minute, warned him of this density trouble, and, later on, the record shows that Garesche had brought this down to 75 tons. This is an interesting point, for it may be that the defective powder which is said to have contributed to the defeat of the Alabama by the Kearsage may well have come from this mill; to be fair, however, it may simply have deteriorated owing to damp conditions of storage.

There are two or three references to these mills being improved and extended, and being brought up to the point where they were able to supply the entire needs of the C.S. Navy, so it is not easy to guess what their average rate of output was. We do know positively, however, that they were rated at 20,000 lb per month late in 1864, and that they were due to have had their capacity doubled just about the time Columbia was captured.

I have now mentioned all the powder mills I have been able to trace, so perhaps I should try to make some guesses about how much they managed to make altogether. Rains' big mills at Augusta dwarfed all the others, of course, for at a pinch they seem to have been capable of making 10,000 lb per day, though I do not think they did this more than twice. Rains said that they were more than capable of meeting all demands, and that consequently they only worked day-shifts. As far as I can see from the factory ledger, they rarely exceeded 5000 lb per day. Rains says that the total output, between April 10th 1862 and April 18th 1865, was two and three-quarter million lb, but as a matter of fact he did not quite do himself justice. He was writing, I imagine, from incomplete records, since it was many years after the event, but it is clear from the ledger - incidentally, by no means a model of clarity - that the output exceeded three million lb. Adding up the weekly figures of issues gives a total of nearly 3.4 million, but this includes about 100,000 lb of imported powder. The mills' busiest year was 1863, when they made nearly one and a half million lb; it is interesting that in that year just over three quarters of the output was coarse-grained powder, for cannon, a proportion which

shrank to only just over half in 1865.

All in all, it seems to me that the Southern mills may have made something like four million lb, or a little more, during the war. The next question is - how much did they succeed in importing? One can find quite a lot of figures, but it seems to be impossible to eliminate double counting. For instance, there is a letter of Gorgas to the Secretary of War dated February 3rd, 1863, saying that the famous Confederate buying agent, Caleb Huse, had ordered and shipped 483,600 lb, but we do not know how much of this was delivered; Vandiver's records of the blockade running through Bermuda can be added up to show some 200,000 lb getting through between April 1862 and April 1865. The Official Records refer to some 240,000 lb coming in by early 1862, but the extent to which these three figures overlap is, I fancy, impossible to ascertain now. There are references to large orders being placed in Mexico, but again one doubts if transportation conditions enabled much to come from that source. I am inclined to think that a reasonable guess, which may be a little low, would make the total imports about one million lb. A figure of over two and a half million has been quoted, but I doubt this. So there we are, with the guess that the Confederates acquired by manufacture or importation something like five to six million lb of powder - a figure which seems to me to be more or less in line with their production of ammunition, which I think was fairly near to 150 million rounds of small arm ammunition (this figure is due to Gorgas) and about one and a half million rounds (my guess) of gun ammunition of all calibres, which I suppose would also run out between five and six million lb of powder of all kinds.

Now in these days we talk so glibly of megatons that these figures may seem to be too small to be taken seriously. So let us try and see if we can get an idea of what they meant at the time.

We might start by looking at an estimate, made, I think, by Gorgas, and quoted by Jefferson Davis, which lists 600,000 lb of powder for the heavier guns, 125,000 lb for field guns and 125,000 lb for small arms, apparently to cover the year 1861. That made 850,000 lb - and it wasn't a bad guess, at that, but let's look around some more. The natural comparison is with the amount procured by the U.S. Ordnance Department. This, of course, we know exactly: it was a shade under 26½ million lb. However, all of this was made by contractors, and many of the smaller firms turned out very poor material, about which the Chief of Ordnance had to complain a good deal. The three best firms were DuPont, Hazard and Oriental, and the historian of the DuPont Company says that, as the war went on, the Ordnance Department came to rely more and more on DuPont - who, contrary to the usual supposition, found war production less profitable than peacetime trade, but perhaps I should remind you that their newly-introduced blasting powder based on cheap Chile saltpetre had just about cleaned up the market in the years immediately before the war. Well, I think, a fair measure of Rains' genius is to note that the mills he set up in a bare year could compete both in quality and in output with what was certainly the leading firm in the industry.

Let us look at these figures in another way. How much powder did an army need? The answer seems to be, much less than one might suppose. Every contemporary account of almost every major action in the civil war speaks of the unbelievable intensity of the fire - and heaven knows the dreadful casualty

figures prove that these statements are not unjustified. Yet the actual amounts of ammunition expended were much less than one might have supposed. This, of course, is something Gorgas - unlike his opponents - had to watch very closely indeed in order to ensure that his supplies were used as effectively as possible. He found that the consumption of ammunition at First Manassas was 19 to 26 rounds per man, and this encouraged him, almost from the start, to cut down the traditional scales of issue very considerably. What is more surprising still is his assertion that the consumption at Gettysburg was still only about 26 rounds per man. Now, the smooth bore muskets, calibre 0.69 in., which many of the troops carried in the early days of the war, used a charge of 100 grains, that is, one lb of powder made nearly 70 cartridges, and the Enfield rifle-musket which was so extensively used by both sides - incidentally, I am assured by my former neighbour, the Director of the Royal Small Arms Factory at Enfield, that very few of these Enfield-pattern rifles were actually made at Enfield - used a charge of some 70 grains, a lb making 100 cartridges. If this figure of 26 rounds per man is to be taken as averaged over the whole 75,000 that Lee had at Gettysburg, that means that in the greatest battle of the war, the Confederate forces used just under 19,000 lb of small arms powder, that is, some ten days' output from Augusta alone, even though the mills at the time were mainly turning out cannon powder.

I have not been able to find quite so convenient a check for the artillery, but Jennings Wise, in his book 'The Long Arm of Lee', does provide some interesting figures. For instance, he speaks of the exceptionally heavy expenditure of gun ammunition at Second Manassas, and says that one battery reached 150 rounds per gun. Supposing this were a six-gun battery of captured 3-in. rifles, that expenditure would correspond to 900 lb of powder, and if they were Napoleons, the figure would be 2250 lb. Now this certainly was a high rate of consumption; by way of comparison, Wise seems to think the European 19th century record was put up by some Austrian batteries which got off 217 rounds per gun at Königgrätz, the year after the Civil War ended. However that may be, it seems to me unlikely that some 240 guns, the number the Confederates actually had at Gettysburg, could possibly have shot off more than 60,000 lb or so, and this figure can be compared with the issues of cannon powder from Augusta in the three months preceding Gettysburg, which were: April, 93,000 lb; May, 127,400 lb; and June, 91,000 lb.

Now I think you may feel I am not making a fair point, because even if Gettysburg was the biggest battle of the war, many people would maintain that one of the main reasons for the failure of Pickett's charge was the inadequacy of the artillery bombardment which preceded it, and I am sure that you will all recall Porter Alexander's famous message to Pickett, "For God's sake come quick or my ammunition won't let me support you properly". Well, that's a fair point, of course, but two points have to be remembered: firstly, the Confederate artillery was very poorly handled on this occasion, so much so that Hunt, the Union artillery chief, is on record as having said to Long, who had been under him for instruction in gunnery before the war, when he met him at Appomattox, that he was disappointed to see a pupil of his mismanaging his guns so badly. Apparently the chastened Long replied "I know. I'd hoped you hadn't noticed". Secondly, the shortage of ammunition was a shortage at the battery position, and in fact no more than one-half of Lee's ammunition had been used up in the three days. Incidentally, this is one of the reasons - that Lee still had a substantial mass of artillery shewing convincing signs of life - which discouraged Meade from any undue impetuosity in chasing after Lee during the latter's retreat.

Another example which gives one a feel for relation between consumption and output, and the one which Rains himself quotes, is the action at Charleston in which Admiral DuPont's attack was beaten off by General Ripley; in this, 22,000 lb were used up, and the Augusta mills replaced this with just over two days' work.

I think that this very crude examination of consumption figures does show that Rains' claim to have met all demands is reasonably well justified. Indeed, the remarkable thing is that the mills never had to be worked all out; their output was varied to meet the calls made on them, and in fact fell to quite low levels in many weeks.

So far, I have talked almost entirely about powder for guns and small arms, and the work of Rains and Gorgas. I would now like to slip in a few words about John Mallet, an equally remarkable man. Of course, in our modern parlance, he would undoubtedly be called a white mercenary, for he was Dublin-born and never renounced his status as a British subject - but at the time he was thought to be a pretty good chap. He was pulled in by Gorgas in 1862, with a mandate to stop the very serious situation caused by the production of defective ammunition. It was his intention to set up, at Macon, a large central laboratory (in the modern sense) which was to serve as the permanent inspection service of the Confederate armed forces, not only during the war, but also after peace had come about and the independence of the South accepted by all. In fact, his laboratories were never completed, but despite all the difficulties of the time he did run an extremely effective inspection service, examining samples from all the arsenals at regular intervals, and also making constant visits to the arsenals to check standards of operation, safety precautions (often very poor, with the individual units much too close together) and generally act as scientific consultant and trouble shooter; the records of his laboratory show him answering a steady stream of the most varied technical enquiries. We find him guiding the design of the sulphuric acid plant put up at Charlotte, apparently basing himself on a French textbook by Payen; he sketches the plant for using the sulphuric acid to make the nitric acid needed for making the mercury fulminate needed for percussion caps (they seem to have made something like 2500 lb of fulminate, in itself a notable achievement for essentially inexperienced personnel); and he is constantly trying to think up ways of getting around shortages which would have completely stumped a less resourceful man. Oddly enough, although he was a chemist, and after the war was president of the American Chemical Society one year, there is no record of his ever doing any chemical inspection. At various times, when acids were desperately short, he spent some time devising alternative cap compositions based on potassium chlorate, which never seems to have been seriously short, although it was all imported, since the actual amounts required were very small. Incidentally, this shortage of acids made it impossible for the Confederates to go into the production of guncotton, although they did make a few tens of pounds at great cost. Some 30 lb cost no less than $1500. This was just as well, for neither the stabilization of guncotton, nor the trick of gelatinizing it were known at the time, and so, if they had tried to make it, they would certainly have blown up either their plant, or their guns, or both, before long.

But I suppose that the most interesting item in the use of explosives by the Confederates was their use of torpedos or, as we would call them today, for the most part, mines.

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Probably their interest in this form of naval warfare, which had been rather extensively used by the Russians in the Crimean War, was first aroused by Maury, but he was sent to England fairly early in the war, and it was the enthusiasm of Gabriel James Rains (an older brother of G.W. Rains), who became Superintendent of the Torpedo Bureau in June 1864, who got this campaign really going. Incidentally, when, at the time of the Seven Days, G.J. converted some shells to act as land mines which proved unexpectedly effective, this was thought to be very ungentlemanly and he earned the disapproval of Longstreet amongst others. But as the war got rougher and tougher, these qualms disappeared and, from December 1862 to the end of the war, more than 30 Federal ships were sunk or damaged by these Confederate devices.

These mines were of many different forms, being improvised out of various sheet metal drums, or even wooden barrels waterproofed by pitch linings; the great problem, apart from waterproofing, was to devise suitable fuzes. The first models depended on what was essentially a musket lock, firing a fulminate charged cap, but many used the "chemical" fuze invented by the Russian Professor Jacobi and used at Cronstadt. In this device, of which variants remained in use for many years in most countries, a glass ampoule of sulphuric acid is crushed on impact, and the acid released reacts sufficiently violently with a mixture of sugar and potassium chlorate below it to cause it to inflame and so to fire the main powder charge. Rains did a good deal of work with electric fuzes, but he thought they were unreliable, for, quite apart from troubles with the primitive batteries which were at first the only source of current, there was the trouble of wires being accidentally cut and, in fact, the Confederates lost a major prize when Admiral DuPont's flagship drifted over a large mine which failed to go off because the wires had been cut by wagon wheels. Later, some Wheatstone Magnetic Exploders were imported, which were very reliable in themselves, but Rains is most famous for his "sensitive fuzes" which are referred to in many books, but about which the Confederates were naturally very secretive. Several variations of them are, however, described in a notebook in Rains' handwriting which is conserved in the Confederate Museum in Richmond. The fuze was, in fact, quite a simple affair built up in a paper wrapper rather like an ice cream cone; the bottom part was a narrow paper cone filled first with fine grained gunpowder, and then gouged out at the top to let in a mixture of mercury fulminate and gunpowder. This was held in with a paper disc with a hole in its centre, on the top of which was piled some more fulminate mixture, and the whole then covered with a wider and shorter paper cone. In some case, he appears to have used a notably dangerous mixture of silver fulminate and sand, which however probably aged badly. Unlike his younger brother, G.J. Rains was very much of the amateur inventor type, while his brother seems to have been a much more systematic scientist. G.J. seems, indeed, to have gone on thinking about torpedoes and explosives long after the war. His notebook, which I mentioned a moment ago, was I think written entirely after the war, though this has to be inferred from odd details because it is not dated. Like many an inventor of weapons, he seems to have thought that the adoption of his ideas would bring wars to an end, for he remarks "The object of these pages is to secure peace, by immunity from war, by rendering the latter too horrible to be followed!"

(This speech was delivered by Mr. Williams to the Civil War Round Table of the District of Columbia at its meeting in Washington, D.C. in January, 1962)