



#### HOW A 42-CENTIMETER SHELL WORKS.

This illustration, from the Graphic, shows the progress of a big shell at work. The shell is discharged from the gun by nitro-cellulose, in which cotton is the main ingredient. The shell flies through the air and strikes a piece of concrete work. When it strikes the soft nose of the shell bends in and explodes the fulminating mercury. This explodes the picric acid and it in turn explodes the trinitrotoloul or trinitrotoluene, as the English term it.

## Why Canada Cannot Make More Shells

And Incidentally Why Canada Would Last Two Weeks in a "Great War"

By CHEMIST

MUCH abuse is being handed out to the British Government, to the Canadian Government, to General Bertram's Shell Committee, and to the ubiquitous D. A. Thomas because Canada did not get more of the shell orners placed on this continent by the Allies. It is interesting to note that these charges are answered by arguments which reveal not only our limited ability to help in this crisis, but our previous unpreparedness in case of a war in which we might have to fight alone.

The truth is simple and clear that Canada would have had more orders for shells if this country had been further advanced in chemistry. There was a shortage of picric acid and toluol. There was no demand for these substances in Canada and naturally no manufacturers had erected a two million dollar factory to make them. Yet these substances were absolutely essential to the making of shells, as shall now be explained.

Before picric acid was adapted in 1886, all explosives for military purposes were gun cotton and nitro-glycerine. In 1901 the aromatic nitro-compounds were discovered.

Gun cotton was discarded as a shell filler because of premature explosions. It is still used in "under water" explosives because, unlike gunpowder, dynamite and picric acid, it will explode even when wet.

Nitro-glycerine cannot be transported pure, and even when mixed with infusorial earth, is affected by frost.

Picric acid is made from phenol or carbolic acid. Phenol is treated with sulphuric acid and later with nitric acid. This gives picric acid or trinitiphenol. Picric acid attacks metals, and the projectile into which it is introduced must be varnished inside. It is soluble in water, and, therefore, cannot be used in mines or torpedos. It can be used only in small shells. In large guns the pressure at firing is so great that the picric acid explodes prematurely. Consequently a new explosive had to be found for big shells.

This was discovered in the hydro-carbon toluol. It is treated as phenol was, with nitric acid, and trinitrotoloul results. Toluol is made from coal, a ton of coal giving up a gallon of toluol. One hundred pounds of trinitrotoloul is used in every 750-lb. shell.

Phenol + nitric acid = trinitiphenol or picric acid.  
Toluol + nitric acid = trinitrotoloul.

Trinitrotoloul is neutral and corrodes no metal and it is insoluble in water. These are the two characteristics which gave it popularity. It is less sensitive to shock and friction than picric acid, and may be used in the largest shells. The Germans use it for the 42-centimetre shells.

Trinitrotoloul, being less sensitive to shock, requires more fulminating mercury in the caps of the shell. In the shell, as described in the accompanying illustration, the toluol or toluene is used as the explosive, and both picric acid and fulminating mercury as detonators. This is done to delay the final explosion and allow the shell to penetrate

farther before doing its final work.

Ammonal used by the Austrians is a combination of gunpowder and modern nitrates. It consists of an intricate mixture of ammonium nitrate, charcoal, trinitrotoloul and aluminum. It is not waterproof, but neither is it sensitive to shock or friction. A shell charged with ammonal and fired at armourplate will not explode until after it has pierced the plate.

All disruptives in shells are ignited by an explosive fuse consisting of fulminating mercury and 15 per cent. of potassium chlorate.

This brief description of shell explosives shows what the ammunition worker is "up against." He must get picric acid or trinitrotoloul in addition to fulminating mercury to complete his shell. When war broke out, these substances were not made in Canada except in insignificant quantities. The British Government could not get them, either. A charcoal manufacturer in a neighbouring State is said to be building a plant for the British Government for the making of picric acid. This plant will cost about two million dollars and will supply a considerable quantity. No doubt there are other sources being created which the Governments concerned are not divulging.

Great Britain's failure to get shells was as much due to a shortage of picric acid and trinitrotoloul as to anything else. Canada's inability to get shell orders was largely due to the same cause. We could not supply the completed shell.

How serious this situation was and is may be realized if we consider the possibility of an unthinkable attack from the United States. At the present moment Canada could not make a thousand complete artillery shells a week. This is our state of unpreparedness. Of course, it doesn't matter, because Britannia still rules the waves. But without Britain's help, we would last as a nation at war approximately a fortnight.

## Why Russia Retreated

BY A MILITARY CORRESPONDENT.

EVERY "man in the street" is asking why the Russians have retreated and allowed the Germans to over-run their country. Imagine the Dominion of Canada, abandoning Toronto and Montreal and Winnipeg to the enemy, after removing the money from the banks, the goods from the big warehouses, the machinery from the factories and the locomotives and cars from the railways. What a tremendous national sacrifice? What a sad blow to our national pride? What a terrific waste and disturbance?

And yet Russia has done this very thing. Warsaw, Lodz, Grodno, Kovno, Bielostok are gone, with hundreds of smaller towns, and the great fortresses of Ivangorod and Neo Georgievsk. Why did they do it? Why did they not stand and fight it out to the bitter end as the Canadians did at St. Julien? Of course,

"He who fights and runs away  
Will live to fight another day."

But surely this does not apply when you are defending your home and your hearth and the sacred soil of a nation! That they should abandon Galicia was understandable, that they should elect not to defend Poland west of the Vistula was thinkable, but that the Russians should give up so much of "White Russia" without a decisive battle is not what we expected.

LET us go back. When the war broke out, Russia was unprepared. Germany and Austria has been working, as we know, for three years on the accumulation of arms, guns and shells, but even Germany and Austria underestimated their needs for this war. After it began, they came to a standstill because their supplies began to give out, and it was necessary to wait until their machinery was speeded up. Britain underestimated what was needed and is only now beginning to draw even with her enemies. France speeded up early and has made the best showing. Italy took a year to gather supplies before she was ready. Russia was not only short of supplies, but Russia was short of the machinery to make supplies.

Where would France be without her machine shops? Where would Britain be without her machine shops? Where even would Germany be without her machine shops which she got in captured Belgium and Northern France? Why, then, marvel that Russia fell down? Russia to-day is buying rifles and guns, ammunition and shells from all the neutral world that makes them. Russia needs tremendous quantities of supplies, and they are slow in coming. It will be the spring of 1916, before Russia is in a position to drive the enemy from within her borders.

Knowing the unfortunate position of Russia, the Germans decided to seek a decision in the East, while holding the French and British in the West. They had planned to crush the Western Allies first, but that plan failed at the Battle of the Marne. Now, nearly a year later, they resolved to try the plan again, to crush one enemy at a time, and they chose Russia because of her lack of big guns, large ammunition and swift transport. On April 30th, with the four beautiful months ahead of them, they began their drive through conquered Galicia. During May,