help. The men in the shop were interviewed. They proved to be 100 per cent American and agreed to work all the overtime that human endurance could stand. The first lot of chronographs were ready for delivery to the proving grounds almost before the contracts had been signed.

The company equipped the Sandy Hook Proving Grounds, the Aberdeen Proving Grounds (the largest in the world), the Nitro and Old Hickory powder plants, the American ordnance base in France, the big-gun range at Panama, the inspection division, the Erie Proving Ground, and the Springfield Armory, as well as the private ranges of the Du Pont Co., Peters Cartridge Co., Aetna Explosives, We tern Cartridge Co., and others with muzzle velocity instruments, turning out about 100 complete units of equipment, besides many spares and accessory instruments, and completing all the requirements that the Ordnance Department had outlined in this branch of work before the armistice was signed. This was not one of the spectacular things that made an impression on the public mind, but it was one of those things without which neither guns nor ammunition could be supplied to the troops.

STARTED $50,000,000 PLANT.

Another brief anecdote will illustrate the sense in which the instrument-making industry is a master key:

The public at large now know something about the huge smokeless powder plant at Nitro, W. Va. The smokeless powder grains as turned out for any given size and type of shell must have a definite burning rate in order that a definite charge of powder may have a definite predetermined explosive force, which, of course, is one of the factors in obtaining the required uniformity of muzzle velocity essential to fire control. This rate of burning is determined by the size of the grain of powder, the number and size of the perforations in it, as well as by its chemical composition. This forming of the grains to the required size must be done with the most minute accuracy, and is done by forcing the powder in a plastic state through specially constructed dies. The tolerances allowed in the construction of the dies were very fine, on some parts being plus or minus one ten-thousandth part of an inch.

On the Friday before Labor Day, 1918, an Army officer and a Government inspector walked into the shop of the Precision Thermometer & Instrument Co. and told them that the Nitro powder plant, which cost $50,000,000, was finished and ready to run, and that 30,000 men were there ready to go to work, and that the plant could not turn out a pound of powder because nobody had yet succeeded in making satisfactory powder dies. All the company had before it were the blue prints. Special tools, jigs and gauges had to be made. Special composition steel had to be obtained.

The company started on the job that day; they worked the next three days, Saturday, Sunday, and Labor Day, 12-hour shifts, without even stopping to eat, on the finest and most difficult kind of work. On the Tuesday after Labor Day the inspector inspected and accepted the tools, jigs and gauges, the special composition steel had been obtained, some from Chicago, some from New York, and some from Philadelphia, through the cooperation of the Midvale Co. and the telegraph companies. On the 15th of September, practically two weeks after the proposition was put before the instrument makers, the first lot of dies were inspected, they were all accepted, sent to Nitro by special messenger and on the 16th of September, Nitro was making powder. Many hundred additional dies were made in the next few weeks. A 75-millimeter powder die isn't much larger than man's thumb when assembled complete. There is nothing spectacular about it, it didn't run into carload lots or millions of money, but they couldn't make powder without them and it was an instrument shop in Philadelphia that met the situation and solved the difficulty.

The big powder plant at Old Hickory, near Nashville, Tenn., also had to fall back on the instrument shop. In the nitrating of cotton or wood pulp, temperature is a very important factor. To measure the temperature in a nitrator required the construction of specially designed thermometers. The Precision Co. was asked if it could supply the nitrator thermometers for the Old Hickory plant; they could and they did. When the order was placed the raw material was not in hand nor even in sight, but the complete equipment of nitrator thermometers, from glass blowing to the calibrating and graduating, as well as the making of the special steel and silver casings, was finished, tested, and shipped to Old Hickory just 31 days after the Government engineers asked if the company could do the work.

THERMOMETERS AT $900 EACH.

In the nitrating department of one of the largest powder makers, chemical conditions were such that no thermometers that had been designed up to that time were suitable for the purpose. Instruments were specially designed to meet this requirement, and it was necessary that the casings and fittings be made of pure silver; sterling silver was not good enough. The silver had to be at least 98 per cent fine. These thermometers were successfully made, however, by the Precision Co., and were so totally different from the layman's conception of a thermometer that it is hard to convey a description of them without going into technical details. They cost about $900 apiece to make, but they paid for themselves, and the Precision Thermometer & Instrument Co. kept the powder makers supplied with them throughout the period of demand.

In fact, there was scarcely any process employed in the manufacture of supplies for the Ordnance Department which did not require the use of thermometers for control at some stage. This held good all the way from smokeless powder to soldiers' campaign hats.

When the supervisory and control laboratory of the Ordnance Department was established in Philadelphia, it was found that the various stations which came under its direction were having difficulties in making correct temperature measurements. The chief of the laboratory asked the Precision Co. to help them out in this matter, as a result of which the company produced and supplied to the laboratory a number of series of extremely accurate thermometers, against which as standards the other thermometers in the service were checked up and standardized, and the trouble which had been experienced thereby eliminated. These instruments were used for innumerable purposes, from testing the flash points of oil to the determination of the melting point of T. N. T.

They also supplied many special thermometers that were used in tempering the steel for rifles, guns, and shells.

Another service which this company was able to perform and which it succeeded in doing only after considerable risk and expense, was to manufacture in Philadelpria and supply where needed thermometers for the measurement of very low temperatures. The so-called Toluol thermometer, for measuring temperatures to 95° below centigrade, and the Pentane thermometer, for measuring temperatures as low as 200° below centigrade (which is equivalent to 328° below zero Fahrenheit), had never before been made in America. Pentane is dangerous stuff to handle, and the Precision Co. had to discover through its own initiative the technique of their manufacture, as no one in America knew how to do it. After two weeks of experiment and research, they were able to supply all that were required and have some left over for souvenirs.

Certain manufacturers of shrapnel shells had great difficulty in accurately graduating the time-train rings of the fuses. The Precision Co. made master gauges for this purpose, and there was not more troube. There is a certain part of a shrapnel fuse known as the base charge. In the shell factories these charges were loaded by hand by girls; it took a girl about 90 seconds to load a fuse. The Precision Thermometer & Instrument Co. built machines for the shell makers, by means of which one girl could load 16 fuses in 60 seconds. They also built special machines for the Government for testing primers. Just before the close of the war a new instrument was invented by experts of the Ordnance Department for testing the recoil of guns. The instrument was termed a velocimeter, because of the record that the company had made in building the instruments required by the Government for measuring muzzle velocity, the velocimeter job was intrusted to them; the details of design were perfected in their shop, and while these instruments were scarcely started when the armistice was signed, they have since been completed and delivered.

It was extremely important to test the hardness of steel used in making shells, projectiles, and Liberty motors. Many hundreds of microscopes were made in this Philadelphia shop for the manufacturers who were making the hardness testing machines, of which the microscope was an integral part.

Before the war the chemical laboratories in this country were mainly dependent upon Germany for the special types of thermometers used in laboratory work. The war both cut off the German supply and created a vastly increased demand for such thermometers. The Precision Co. also went into this, trained a special force of empyoles in the work, and thermometers of this type literally issued forth in a constant stream, running into thousands and housands of instruments.

The word "thermometer" does not mean very much to the layman, but the

purposes are very different affairs from the layman's conception. During the war the Precision Co. turned out about a thousand different types of thermometers for almost as many purposes; for instance, certain special types are used in the Navy Department by the Bureau of Steam Engineering. Many times war vessels would have been delayed in sailing from navy yards or shipbuilding plants if the company had not worked day and night to provide the necessary steam engineering equipment of specially designed thermometers.

One of the big supply houses in Philadelphia took an order from a locomotive works making shells for a micrometer of a somewhat unusual character, and then found themselves in a predicament because there wasn't such a micrometer to be had in the United States, and the corporations who regularly make micrometers couldn't supply it. The official of the supply house, who had taken the order, happened to mention it to a representative of the Precision Co., and it had then been burning his fingers for about four months; one week later the Precision Co. delivered the micrometer.

Mr. FISHER. Mr. Pilling has decided that rather than take your time he will submit a prepared statement.

STATEMENT OF MR. CHARLES J. PILLING, OF THE GEORGE E. PILLING CO., PHILADELPHIA, PA.

Mr. PILLING. The recent European war revealed astounding conditions regarding the supply of surgical instruments, for in time of war surgical instruments are as vitally necessary as ammunition.

Mr. Crowell, the Assistant Secretary of War and Director of Munitions, made the following statement: "Before 1914 four-fourths of all the surgical instruments used in the United States were imported from Germany."

The tariff for many years was only 45 per cent, then in October, 1913, it was reduced to 20 per cent and for a few months during 1914 importations came into the United States at the new (present) tariff of 20 per cent.

Many new agencies of German makers were opened and flourished here.

Of course, the beginning of the European war temporarily stopped these importations, otherwise the industry would have been dead as a door nail in another 12 months.

Germany, in the surgical instrument line, is congratulating herself because she has, while destroying industrial France and Belgium, kept intact her surgical instrument factories as well as all of her special machinery, dies, tools, and other facilities for making surgical instruments, and already is soliciting business from the American dealers, and German-made instruments are now arriving here in large quantities.

The official records of the United States Department of Justice show the dastardly, inhuman, underhanded methods of Germany's supercriminals used against the United States in her endeavors to destroy the honest efforts of the American skill to produce the medical and surgical supplies needed so urgently for the equipment of our Army of 4,000,000 men, and the 211,000 graves of American soldiers in France and the United States probably would have been multiplied many times had the United States entered the war at the time of the sinking of the Lusitania for it would have been utterly impossible to have supplied our large Army with the needed surgical instruments on such short notice.

Now regarding Japanese competition. A large part of the cost