years, by Holtzer, the St. Chamond and Firminy Companies, and other French makers, of the hardened chrome-steel armor-piercing projectiles having only small cavities (without which their production would probably be practically impossible), is a remarkable illustration of the control which has been acquired over the treatment of steel, and especially of varieties, such as this chrome-steel, to which a very exceptional degree of hardness may be imparted without detriment to tenacity, by carefully elaborated processes of hardening and tempering. Experience in the application of these appears to have conquered, at any rate, in very great measure, the originally considerable tendency to the retention of a state of unequal tension by the finished material for long periods, and the frequent yielding of the mass to the disruptive force thereby exerted.

In visiting, in 1886, the several works at and near St. Etienne, where the chrome-steel projectiles were being produced (their successful manufacture being then of comparatively recent date) Sir Frederick saw, at more than one establishment, a large number of projectiles which had sustained spontaneous fracture. In one store where the finished shot were stacked, after the lapse of the period during which the tendency to the development of cracks or to rupture was stated to diminish gradually, he saw the head of one out of a pile of projectiles which had quite recently been projected to a distance of many feet by the violent spontaneous rupture of the metal. Instances of the development of flaws in these projectiles are now, so far as experience at Woolwich goes, exceedingly rare.

The address next proceeded to point out the importance of rest in bringing about a diminution, if not an entire disappearance, of internal strains; and he referred to the analogous case of steel dies for coining. Sir Thomas Graham had written the president a letter in 1865, in which he stated that, if kept in store a year or two, these dies became less apt to crack when in use, and coined more pieces than dies newly tempered. The more important question of internal strains in masses of steel composing the tubes or barrels of guns next received attention in the address. The condition in which the steel might have been, in such instances, when subjected to the action of the exploding powder charge, may be illustrated by reference to the behavior some years ago of the tube of a large gun, in which, after the third proof-round was fired, a circumferential crack was found to have become developed in the front threads of the breech screw. Upon removing the jacket from the tube, the crack extended forward along the chamber and into the rifling, and when the tube was placed in the lathe with a view of cutting off the injured portion, the crack suddenly developed itself with a loud report, and ran along to within eight feet of the muzzle; a spiral crack at the same time ran completely round the tube, which fell in two upon removal from the lathe.

The tempering with oil hardening of steel guns has been demonstrated to result in the development of more or less severe internal stresses in the mass, which can only be removed by subsequent careful annealing; and until this latter practice was largely adopted, instances occurred from time to time at Woolwich, and at other gunmaking establishments, of the fracture of tubes and hoops of guns, either during their treatment in the workshop, or when at rest, or when, in the built-up condition, they have been for the first time exposed to the shock produced by the firing of the gun. One effect which the oil-hardening treatment has occasionally exercised in the case of particular qualities of steel is that of developing minute fissures or cracks in the metal, either superficially or in the interior of the mass. This could not be rectified by any annealing process, and it is still a question, to be determined by the teachings of experience and the results of investigations, whether any definite or reliable modifications in the composition of steel used for guns, tending to secure the desired combination of hardness and tenacity, may not be introduced, with the result that a method of treatment of the metal may be discarded, which — however carefully applied, and however efficient the means adopted for reducing or neutralizing any possible prejudicial influence upon the physical stability of the parts of which a gun is built up — carries with it inherent elements of uncertainty and possible danger.

Turning to another branch of this subject, the president next dwelt upon the investigations of Mr. Thomas Turner and Mr. Keep upon the influence of silicon and other impurities in cast-iron, a question which Sir Frederick had taken up in 1855. The work of Gautier, Ledebur, and others, based upon Turner's information, and the investigations of German experimentalists, have combined to establish on a sound footing the value of ferro-silicon in connection with the treatment of cast-iron. Jüngst's experiments seem to indicate clearly the conditions under which silicon will contribute to the production of dense and homogeneous castings.

Sir Frederick then made some observations on the development of the basic process, and also the effect of aluminum and of manganese as alloys of iron. The question of nickel-steel also occupied a good deal of the address, Sir Frederick giving an excellent *résumé* of what has already been done in this direction chiefly in connection with armor-plate construction.

EPIDEMICS OF CHOLERA FROM 1830 TO 1890.

DR. WILLOUGHBY, in a paper before the Epidemiological Society of London, condensed in a recent number of the *Lancet*, after alluding to the doctrine of epidemic influences, telluric and atmospheric conditions, and other unknown agencies, as at once baseless and needless, and to the opposite delusion, prevalent in the south of Europe, of its being infectious in the same sense as small-pox, asserted that all the independent and scientific students of the subject in Europe and America were now agreed that the vehicle of contagion was contained in the evacuations, that it was thus carried by fomites as soiled clothing, etc., while persons suffering from the disease, even in unrecognized and mild forms, infected the soil and water of places through which they passed. Insanitary conditions favored its development, but the most insanitary towns — as Rome, Seville, and others — had escaped, since they had been provided with pure water supplies.

The incubation period he believed to be, as a rule, from one to two days, four being an ample limit for quarantine purposes. Its transportability and conveyance wholly and solely by human intercourse was proved not only by the progress of every epidemic having followed the great routes of trade and pilgrimages, but by the rapidity of this progress having corresponded to the facilities for travel, whether by caravans, river boats, railways, or ocean steamers, quoting in this connection Dr. de Renzy and others as to the altered circumstances of travel in northern India; and he thus explained the immunity of Australia and Chili, virtually the most isolated communities in the civilized world.

It was, he said, in 1821 that cholera, so far as was known, first advanced from India westward, reaching Astrakhan in 1823, but subsiding until 1827, when a fresh wave swept over Persia, entering Russia in 1829. In 1830–31 it was fomented by the war in Poland; in 1831–32 it spread over the whole of Europe, and in 1832–33, over North America, lingering in each continent for about two years longer. It was remarkable, and totally inconsistent with the theory of conveyance by winds, that, though some cases had occurred on board ships in the Medway as early as July, 1831, it did not reach London till February, 1832, having effected a landing at Sunderland and travelled via Newcastle, Edinburgh, Glasgow, Belfast, Dublin, and Cork, whence it was at length brought to London.

A wave rolled over Persia, Arabia, and Syria between 1836 and 1839, but retired again. In 1840 it entered China, then passed westward through Central Asia, re-entering India from Afghanistan and through northern Persia, reaching the Caspian and Black Seas in the summer of 1847. Following the military road then in course of construction from the Caucasus to Moscow, and the river highway of the Volga, it was intensified and spread by the fair at Nijni Novgorod and the massing of the Russian, Austrian, and insurgent Hungarian armies on the Danube, and in the course of 1848–49 had attacked every country in Europe except Denmark and Greece, which were saved by stringent quarantine. It extended to America in 1849, but died out in the course of the following year.

The epidemic of 1854 was not strictly a separate invasion, but rather a resuscitation of the last, which had lingered in the south and east of Europe and the west of Asia until called into fresh activity by the Crimean war. Every country in Europe and America was again invaded. The incidents of the outbreaks in America threw great light on the conveyance of the disease by fomites. The epidemic of 1865–66, which was the first to come wholly by the Red Sea, spread rapidly over Europe and America; but had scarcely subsided when a fresh explosion occurred at the Hurdwar fair in India in 1867, whence it was carried to Persia and Russia, being re-intensified *en route* by the pilgrimage at Great Mesched in 1868, and the fairs at Nijni Novgorod in 1869 and 1870.

At the close of the Franco-German war every country in Europe was attacked except Great Britain, and America succeeded in averting its importation until 1873. By 1874 it had, however, disappeared everywhere on this side of India. In 1881–83 it prevailed in Arabia and Egypt; in 1884 it made its appearance in France, and soon raged throughout Italy and Spain. The influence of pure water supplies was brought into special prominence, not only in the case of single towns in Italy and Spain, but in the almost complete immunity enjoyed by Germany, which had previously suffered heavily in every epidemic.

Cholera lingered in the south until the end of 1885, since which date it had been absent from the continent of Europe until the isolated outbreak in Spain in 1890. This, Dr. Willoughby was convinced, was not imported from the East, but was a recrudescence of the epidemic of 1884–85, brought about by excavations in infected ground. Still cholera had, since 1888, been slowly but steadily advancing by the Persian Gulf and the extensions of that route. It had last year reached the shores of the Caspian and Black Seas, and had raged at Mecca, though Egypt had almost miraculously escaped, and it had persisted at Aleppo and the Syrian ports certainly as late as January of the present year. He had little doubt, that, as its march had closely corresponded with that in 1845–47, we might expect history to repeat itself in an invasion of southern and eastern Europe during the coming summer, unless, as in 1823 and 1839, it should retire, after having thus approached the confines of Europe. If, however, it had not already really died out, the vast increase of communication between the two continents rendered such recession less probable than it was fifty years ago. The paper was illustrated by a number of maps showing the great routes and the course of each epidemic in Asia, Europe, and America.

NOTES AND NEWS.

DURING the early part of May, according to the Cairo correspondent of the London *Times*, there have been in Upper and Lower Egypt large swarms of locusts, which have caused much alarm, as it is believed that they originate from eggs laid last year. The damage done to the young maize, sugar, and cotton is as yet insignificant, though some individual growers have had to re-sow cotton patches which had been devastated. The provincial mudirs have received orders to do everything in their power to secure the extermination of the locusts. The correspondent says that this is the most serious reappearance of an old Egyptian plague that has been recorded for about forty years.

— The National Geographic Society was organized in January, 1888, "to increase and diffuse geographic knowledge." It is incorporated under the laws of the District of Columbia, and has at present an active membership of about four hundred. The publication of a magazine was early determined upon as one of the means of increasing and diffusing geographic knowledge, and two volumes of the *National Geographic Magazine* have been published in the form of a quarterly journal. During the past two years it has been found that the form of publication adopted at the outset meets but imperfectly the needs of the society. In the first place, since the season of active work in the society includes the winter months only, there was an excess of material for the two earlier numbers and a dearth of material for the two later numbers of the volume; and in the second place, the necessity for holding articles until sufficient material for a number was received sometimes led to delay in publishing interesting and important matter. Accordingly it has been decided to discontinue the quarterly form and to publish the magazine in the form of a series of brochures, each issued as promptly as possible after reception of the material. While the *National Geographic Magazine* is edited by and constitutes the organ of the National Geographic Society, it is not limited to this function; and, as was announced in the first number of the journal, "its pages will be open to all persons interested in geography, in the hope that it may become a channel of intercommunication, stimulate geographic investigation, and prove an acceptable medium for the publication of results." The aim of the founders has been to form a continental rather than a local society. That this aim has measurably succeeded is indicated by the fact that although the National Geographic Society is only three years old there are fifty-seven non-resident members, distributed over twenty-seven states and territories. One of the means adopted by the National Geographic Society for increasing geographic knowledge has been, as is well known, that of exploration.

— The annual report of Daniel Draper, Ph.D., director of the New York Meteorological Observatory for the year 1890, shows that during the past year the daily work of the observatory has been uninterruptedly kept up, and complete registers have been obtained of the temperature and pressure of the air; of the direction, force, and velocity of the wind; of the total amount of every rain, the temporary variation of every shower, and the depth of every snow. Not a day, even including Sundays and holidays, has been lost. The registers containing all this large amount of information have been properly arranged and filed away in suitable books. Readings are taken at Smithsonian hours, and also hourly readings from self-recording instruments. Eye observations of clouds are recorded, and the daily and monthly means, etc., are calculated from the instrumental records.

— Bulletin No. 49 of the Ohio Agricultural Experiment Station contains a communication from Mr. G. B. Strong of Cuyahoga County, Ohio, giving an account of his experience in spraying plum-trees the past season. He sprayed forty trees with London purple, at the rate of one pound to 150 gallons of water. Three applications were made, the first one being applied when the fruit was about the size of a small pea. The spray was put on until the leaves began to drip. Twenty-five bushels of plums were gathered from the forty trees, and not one per cent of the crop was stung. Two trees in the vicinity that were not sprayed had all their fruit stung. The foliage was injured somewhat, so Mr. Strong says that the solution was too strong, and that hereafter he will use one pound of London purple to 200 gallons of water, spraying more lightly, and applying only twice unless a third application becomes necessary. It is probable that Paris green would be better for spraying plum-trees than London purple, as it usually contains less soluble arsenic, and consequently is less liable to injure delicate foliage. It may be used at the rate of three ounces to fifty gallons of water. Some spraying experiments were also made by Mr. William Miller, a leading fruit grower of Ottawa County, Ohio. Having two pear orchards several rods apart, the fruit of which had for some years been greatly injured by the plum curculio, he determined to spray one of them. The larger orchard, containing several hundred trees, was accordingly sprayed twice with London purple — four ounces to fifty gallons of water. The fruit in this orchard was very much less injured by the curculio and other insects than that in the other orchard, which had not been sprayed. Mr. Miller also found the spraying machine a decided help in fighting the curculio in his plum orchard, although he did not rely upon it altogether, but used the jarring method part of the time. In 1888 the station sprayed a number of pear trees with London purple in the proportion of eight ounces to fifty gallons of water. At the same time other trees were sprayed with the same mixture, except that half a peck of fresh slaked lime was added. It was then found that while the trees sprayed with London purple alone had their foliage decidedly injured by the application, those sprayed with the lime and Lon-