of lines has vanished, whilst the less refrangible set shows a slightly increased velocity, which on the night of June 19–20 was estimated at 1860 km./sec. This accelerating motion reminds one of eruptive prominences ejected from the sun, and, if confirmed, would indicate the action of a repulsive force.

The hydrogen emission bands are very intense and well defined in all the photographs, especially Hα and Hβ, but in the ultra-violet beyond Hδ they become feeble and difficult to distinguish, whilst the absorption lines are strongest and persist longest in the ultra-violet, where they have been photographed up to Hπ on June 18–19. The Hα line stands out isolated and without absorption in all the plates except the earliest one exposed on June 13–14. On this plate the continuous spectrum is faintly visible near it, and the two displaced absorption lines corresponding with the two velocities mentioned above are clearly shown. The Hβ emission band on June 20 extends from λ 4834 to λ 4885, and within it are three maxima at 4857, 4864, and 4880.

The last plate secured was exposed on July 11, the star being then of magnitude 3·6. This photograph shows emission bands only, extending to Hη, and there is no appreciable absorption, even in the ultra-violet. The nebula emission band at 5007 has greatly increased in relative brightness, in accordance with precedent.

Kodaikanal, August 6 J. EVERSHED.

THE "TAYLOR" SYSTEM OF "SCIENTIFIC MANAGEMENT."

DURING the last year or two much attention has been given to the results of analyses of industrial operations obtained by Dr. F. W. Taylor in the United States, and a system of scientific management has been based upon them. Advocates of the "Taylor" system claim that, by the thorough analysis and investigation of the actual practice of manufacture, it has been possible to deduce certain principles applicable to all industry. These principles are not so co-ordinated and developed as the laws of physical science, because, although the result of industry —the production of concrete material things—is physical, the actual process of production by human brains and hands is not a physical, but a social, process. Only those who maintain that social laws cannot be discovered which will explain and govern the actions of society can consistently argue that the "Taylor" principles applied to industry are not scientific.

In the early days of mechanical invention progress was entirely by trial and error. At the present day almost all invention is the result of laborious investigation and research, and the development of invention and design has been greatly accelerated by the application of scientific method. The complexity and minuteness of detail shown in the complete working drawings of a modern engineering firm would have been beyond the comprehensions of our forefathers, who could not decide such things on paper, but had to work by rule-of-thumb methods. The application of science to engineering design has made all this development a matter of course to the present generation. Science has made most headway in design, because a knowledge of the laws of the strength of materials, and of magnetism and electricity, are essential to the design of steam and electric machines; and once a man is forced to use science as the basis of his work, he is more likely to evolve scientific methods in connection with the numerous details and routine of actual production. In this direction, however, there is still much that can be done, but the fact to realise is that in this field of human effort scientific method is accepted by practically all.

When we come to the actual purchase, storing, and handling of materials required for production, we find no equivalent to the modern scientific designer and draughtsman. We find a varied collection of buyers, storekeepers, and clerks. It is safe to say that very few of these types of workers have the haziest notion of what scientific methods are, or how they could be applied to their work. It is probably unfair to expect this, as they are all highly trained by rule of thumb. Planning and co-operation, which are among the basic principles of scientific management, are usually glaringly absent, and where production is not held up by lack of material, this is accomplished by prodigal expenditure and, consequently, inefficiency in the use of material. Nevertheless, method is accepted in this direction also, without much controversy. It is agreed that works should be built so that they can be easily expanded without mixing up all the departments, and laid out so that material can travel as continuously as possible from one process to another, until completed, with the minimum amount of cross or backward travel. It is agreed that materials should be purchased with some relation to the output, the time required to deliver, and the number of times to be repurchased in the year, so as to guarantee material when required, without at the same time locking up more capital in stocks than is necessary. It is agreed that stores should be large, roomy, and completely closed in, and nothing issued without proper requisition; and that men from the store should move material to the shops so that the time of the skilled men is not wasted seeking after material.

There are hundreds of systems for doing these things—in fact, each firm must evolve the one most suitable for itself; but the principles underlying all these varied systems are the same; and once a manager has a grasp of these principles he can quickly plan a system, and with time and continual care will get it to work. Buyers, storekeepers, and clerks have no scientific training, and, consequently, they seldom see the principles involved. To unscientific minds there is little or no co-ordination or correlation; everything is more or less in watertight compartments; they cannot see the extraordinary interdependence of all sections of industry. As, however, this type of labour is not numerous, and has no organised objection to improved methods, it is possible to improve matters comparatively quickly with a reasonable expenditure of will and mental energy on the part of the management.

The efficient buying, storing, and handling of the raw material of an industry, while they are very important, and will reduce the cost of manufacture, are at best a saving effected on a very small percentage of the total human effort expended in industry. If we realise that everything that man makes is consumed, sooner or later, then we may consider all the products of each industry to be the raw material of another industry. Production we can conceive as the evolution of raw material from a simple to a more and more complex product. Each time it is sold, bought, and stored in the process, we may consider its growth temporarily stopped. It is during this time of lack of change, when the very minimum of human effort is expended on it, that we try to save human effort. During all the numerous definite changes of the product, when the maximum of human effort is expended, we refuse to apply scientific principles. Considering that this is the application of science which affects by far the greatest number of workers, it is very easy to comprehend their opposition to being "Taylorised," as they say.

The "Taylor" method accepts no preconceived ideas of how a job should be done. As a chemist splits up a compound into its elements, so Dr. Taylor says that all jobs should be split up into their elemental operations. These elemental operations are carefully studied and timed by engineer experts, and the useless ones, which we may consider as impurities, are eliminated. The best machine tools and equipment are used, and, therefore, standard minimum times can be found for all standard operations. When data are accumulated giving the time required for standard specified machine work, fitting, etc., then standard operation times can be fixed from the drawings without any timing in the shops, just as the designs themselves may be made without shop experiments. "Time" or "motion" study is scientific in its method, and the accuracy of the result will like all experimental data, depend on the accuracy of the observer. There are definite principles in this "Taylor" method which, when grasped by experts, can be used by them to arrive at accurate results. All other methods of "rate-setting" are non-scientific. Some are pure guesswork, some are more or less so.

The "fatigue factor," which is the time to be allowed in addition to the "standard" time, so that the worker may not be "fatigued," is most difficult to discover accurately; but for this, science is as much at fault as industry. Medical science formerly concerned itself almost entirely with the cure of disease, but it now devotes itself largely to cause and prevention. When we all realise that disease must be prevented, we shall soon begin to realise that industrial fatigue must also be prevented. The "Taylor" system is the only one that separates out the work and fatigue of production, like the analysis of useful work and losses in a machine. It remains for the scientific experts, the engineers, the doctors, and the psychologists to co-operate and co-ordinate their efforts so as to produce as scientifically accurate a result as their combined efforts make possible, and to keep it continually up-to-date as methods improve and knowledge extends.

Dr. Taylor says that the workers must be instructed in the principles of their art by the management, and not left to learn it from others as they see fit. This necessitates that the management should be organised on a functional basis. Brains must be specialised and trained just the same as manual labour, and, therefore, the system does away with the old orthodox foreman and his assistants and under-assistants, and he creates many foremen, each of whom has one specific function, in which he is an expert. The "Taylor" system separates the functions of planning, instruction, and execution. It increases the cost and the size of the management, and greatly increases its responsibility. That is why so few employers will adopt it. It requires much more care, study, and thought than any arbitrary, non-scientific system.

The trade-unions and the men oppose the system because it will not use individual and trade habits and prejudices unless they happen to be scientifically sound. While this attitude excuses the workers, it betrays a lack of vision on the part of the "intellectuals" in the Labour movement, who, so far, are unable to see that the elimination of the enormous amount of useless effort put forth by the working classes must be to the benefit of that class more than any other.

It is the same old battle of knowledge against ignorance and prejudice. Patience, sympathy, and much more education are required. Not education which will give to more and more little uncorrelated scraps of chemistry, physics, and electricity, but an education which will train the mind to think in a scientific manner and grasp the significance of the interdependence of all things, and most especially human effort. If we are to maintain our position as one of the greatest of the world-States, intelligently directed effort on the part of everyone will be obligatory. The same energy put into useful work as is now wasted in useless effort will not only double and treble our production of material wealth, but it will also ease the burden on the workers and enable them to live freer, higher, and happier lives.

J. M. SCOTT-MAXWELL.

GERMAN INDUSTRY AFTER THE WAR.

III.

MM. JAUREGUY, FROMENT, AND STEPHEN conclude their series of communications to the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* (see NATURE for September 26 and October 3) on the influence of the war on German industry with some interesting reflections on its after-effects, temporary and permanent. There can be no doubt that the isolation of Germany for so long a period has occasioned profound modifications in her industrial and commercial position. Whatever may be the ultimate result