of astronomical observation was otherwise sufficiently advanced, to recognise the fact that all the heavenly bodies move in conic sections, of which discovery Newton's law of universal gravitation, with all its important consequences, was the immediate offspring.

There are hundreds of similar facts to be met with in the history of science. Yet people still continue to laugh at the apparently trifling and useless researches of philosophers! As Swift, in the voyage to Laputa, satirized the contemporaries of Newton, Peter Pindar quizzed those of Watt. Hook's pendulum experiments, in which the measure of the earth originated, were ridiculed under the name of swing-swangs, and Boyle's observations on the elasticity of air, one of the steps towards the steam engine, were the objects of contemptuous sneers. The steam engine itself, the mighty power of the nineteenth century, was, in its first germs, little better than a scientific toy. What, indeed, could appear more useless than experiments consisting of rubbing pieces of amber, or sealing wax, or glass, and remarking the manner in which they attract little straws, or bits of paper? Yet in these the science of electricity took its rise. Even when Franklin had to some extent advanced the study, his practical countrymen thought it but learned trifling, and asked, "What is the use of it?" Franklin answered, "What is the use of a new-born baby?" When we look at the electric telegraph extending its wires all over the globe, and the countless applications of electricity to almost every branch of science and art, we may well exclaim that that baby has, in less than a century, expanded into a full-grown man, whose use no one would dare to question.

The whole history of science abounds in instances of great discoveries founded upon the simplest observations, and mighty effects resulting from unimportant properties of matter. Franklin had the true spirit of an inductive philosopher: he was always inquiring into something or other. In a voyage across the Atlantic he was engaged, as usual, in trying experiments, and, having no other present field of inquiry, he kept dipping his thermometer into the sea as he proceeded. I dare say the sailors and his fellow passengers laughed secretly at the philosopher, but these experiments resulted in ascertaining the fact, that the different ocean currents have very different temperatures, the great Gulf stream being as much as 12° higher than the surrounding ocean, and the thermometer is consequently now a most useful instrument in helping the mariner to shape his proper course.

A soap-boiler finds a peculiar corrosion in his boilers, and applies to a chemist for an explanation. The chemist analyzes the refuse formed by the corrosion, and discovers a new substance, which, from its violet colour, he calls iodine, after a Greek word. He argues, that it must have come there in some of the substances employed by the soap-boiler, and finds it in the alkali which was used. He next traces it in the marine plants from the ashes of which the alkali was extracted, and finally he discovers it in sea water, and almost all marine substances, amongst which are sponges. A physician now remembers that burnt sponge has long been a popular remedy for goitre (a swelling of the neck, accompanied, in the worst cases, by a peculiar form of idiocy, which is a common complaint in Switzerland, and other mountainous countries), and he tries the effect of pure iodine. The consequence is the discovery of an almost certain cure for this most distressing and heretofore nearly intractable disorder.

Antimony is a metal long known, and abundant enough in nature, though of very limited use in the arts: but it has a peculiar property, which might easily escape notice, without a knowledge of which the art of printing would never have attained its present perfection. You know that all substances expand with heat and contract with cold; but this general rule has a very few partial exceptions. The most conspicuous one is water, which follows the general rule in the shape of steam, and as water it continues to follow it till cooled down to 39½° of the thermometer. Beyond that point, every additional degree of cold expands the water instead of contracting it, till, having experienced another sudden expansion in the act of freezing, it continues ever after, in the form of ice, to contract with cold and expand with heat like other bodies. The consequences to us of this exception are most important; for, were it otherwise, water would begin freezing at the bottom, and not on the surface, and no summer's sun could penetrate to thaw the ice once formed: every piece of water would become a solid lump of ice, and the earth would be uninhabitable. It is not, however, of water that I would speak, but of antimony, which is another partial exception, increasing in dimensions like water in the act of becoming solid from a melted state. Now, the types used in printing must be cast: to form them by carving or punching would make printing almost as expensive as writing; but if cast in any ordinary metal, the fine lines of the mould would not be copied, and the impression would be coarse and indistinct. The addition of a little antimony to the lead, of which types are principally formed, makes the whole expand as it becomes solid, sufficiently to force the metal into the sharpest indentations of the die.

But it is said by some that you may leave such studies to the professionally learned, and that working men have no time for them; or if the nature of their occupation requires some knowledge of scientific results, it is sufficient for the mechanic to know the facts, and to work upon the rules which the philosophers have laid down for him. It has even been contended that the true principle of division of labour requires that the philosopher should devote himself to perfecting theory, and that the practical mechanic should confine his attention to attaining mere manual dexterity. To a certain extent this division must necessarily prevail, but if we are to look for much improvement in our present process, or much advance in our actual knowledge, the two branches must also be in a great measure com' ined. Theory and practice, as I have said before, mutually aid each other, and the mechanic cannot hope to attain much eminence without some theoretical knowledge, whilst the theorist must not disdain the aid of practical experience. The working mechanic, it is true, can but rarely become an accomplished philosopher, but he can, at any rate, become familiar with the principles of those sciences more immediately connected with his pursuits; and such is the mutual dependence of all the sciences, that he should at least have some idea of the general bearing and extent of our whole physical knowledge. A mere acquaintance with rules is not enough; for a man can never thoroughly understand, or even remember a rule, unless he knows something of the reason of it, and if he comes to apply it under slightly altered circumstances, he can never be certain that it continues to hold good for the case he has in hand. How many persons have wasted great mechanical ingenuity in attempting perpetual motion, which a slight acquaintance with first principles would have shown to be impossible! How many thousands have been thrown away in sinking shafts for coal, in strata which any geologist knew beforehand could contain none, or in working imaginary gold mines for what a mineralogist would, at a glance, have pronounced to be only mica! Again: if the object sought is possible, science will guide you in ascertaining whether the means used are sufficient for the purpose, or are the easiest, and most direct and economical, which can be employed. But more than all, theory will often suggest, and invite to a new track, which never would have occurred to a person unacquainted with science. In a word, if you are content to go on doing what preceding generations have done, you may perhaps trust to experience and rules alone; but if you wish to attempt anything new, where you can have no guidance from experience or rule, you must recur to first principles, which it is the province of science to teach.

Human nature is so prone to cavil, and it is so true a saying, that a prophet has no honor in his own country, that I can imagine some of my hearers may say (or if they do not like to say it openly, may secretly think) that this would be all very well, if any of us were likely to make new discoveries, or hit upon great inventions, but that it is so improbable that the mechanics of a small village like Peterborough should be going so to distinguish themselves, that it is hardly worth while to make preparation for it. Perhaps we may have no undiscovered geniuses amongst us; but (not to mention that already one of our fellow-townsmen has produced an invention, not yet thoroughly tested, but which is now engaging the attention of persons in England, able and willing to give it a fair trial) we never can know whether we have them or not till it is proved by the event. Hundreds of inventions have been made by simple mechanics, having no greater advantages than many of you, whose achievements would tempt me to lay before you some examples, were we not promised a lecture upon this subject by my friend, Mr. Gemley. But not to mention names of such world-wide reputation as Franklin, Watt, Arkwright, Godfrey, Dolland, Stephenson, consider the numbers who, as improvers rather than inventors, are daily benefiting mankind, and laying the foundation of their own fortunes, without their names ever becoming known to fame. If there is only one of you, or one of your children, who has within him the hitherto undiscovered talent to contribute something new to science or to art, we should be sufficiently rewarded for all our exertions to enable him to acquire that knowledge, without which no opportunity, no ingenuity, no natural talent can be of any avail.

But if no practical mechanic can take full advantage of all the circumstances in which he is placed unless he have also some theoretical knowledge, neither can a mere theorist ever effect much who has not sufficient practical experience to know in what direction there is the greatest room for improvement, and what are the existing means for carrying it into effect. Almost all great discoveries and inventions have been made by men who united theoretical to practical knowledge.