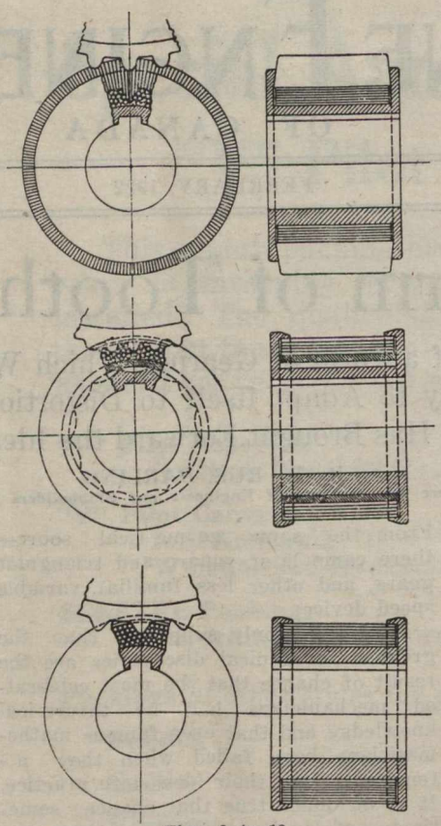
fighting these evils but some of the less familiar propositions may be of interest. From Holland comes the proposal to subject the pinion blank to the torsion at which it is expected to work when in service, and to retain it in that condition while the teeth are being cut. A special machine has been devised for this purpose, and while the idea seems practicable, it appears, at the best, to provide only for mean conditions. In the United States of America it was discovered that pinions which had lain in the store for some months before being fitted into place had become so much distorted that they had to be removed, and the teeth recut, after a brief and noisy trial run. This led to the suggestion that certain parts of machinery should be laid aside in a rough state for some time before machining, so as to get rid of internal stresses. A very sensible practice adopted in machine-tool works in Germany reminds one that more thought should be given to the prevention of gear troubles rather than to their cure. This practice is to balance all rotating parts, and, according to report, it materially reduces the noise and vibration usually ascribed to other causes.

If inaccuracies, either in the form of teeth, alignment, or balancing of parts, were the sole cause of power transmission troubles, there would be no excuse for their continued existence, but there are, and always will be, certain varying conditions on land and sea which must be conquered. To overcome these varying conditions, it may be necessary to revise some of the basic theories. a to steer clear entirely of makeshifts and half-measures. A theory is nothing else but a regular union, or methodical and connected arrangement, of all the facts relative to a certain natural or artificial effect; facts which are obtained by true experience. If a theory is perfect, and the product perfect, the resultant effect should be perfect. The tangible elements, being subject to the five senses, may be easily dealt with and eliminated, and with imperfect results before us the theory must bear the blame.

I have endeavored to outline the combination of sciences from which were evolved the modern wheel and pinion, but the new gear which I now propose to introduce comprises an element which, to the best of my knowledge, has never before been applied to practical mechanics. Before embarking upon any radical change in a time-honored theory or practice, it is well to investigate their origin and development, and determine whether the justification is to be found in an inherent or an incidental deficiency.

Figs. 8 to 19 show how the new Autopitch Gear developed in the mind of the inventor, the first form consisting of a wheel body with loose pieces of thin plate fitted close together round the rim, forming, as it were, a regularly laminated ring in the position usually occupied by teeth and their corresponding spaces. It may be interesting to note how this idea originated. Having arrived at the conclusion that the old theories were unlikely ever to produce a gear which would in its own composition, cope with the varying conditions of wear, torque, alignment, expansion, etc., and that some of these conditions were natural and therefore permanent, the following list was made out to indicate requirements of a perfect gear:—



Figs. 8 to 13.

Strength, sufficient to ensure safety.

Durability, unlimited.

Adaptability, to all possible variation of conditions.

Elasticity, sufficient to absorb unavoidable vibrations of other parts.

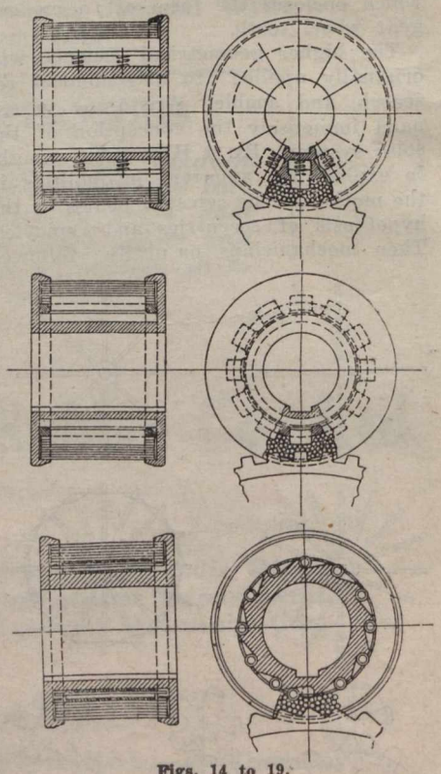
Noiselessness, approaching to silence.

Economy, both in cost of production and in power.

The first requirement, strength, seemed to be a matter of design plus material, the second, durability, of material plus design; the third, adaptability, seemed to lend itself less to ordinary methods of solution, and was set aside for a deeper analysis; the fourth, elasticity, seemed to depend on material plus design plus mounting; the fifth, noiselessness, would appear to be covered by the fourth plus workmanship; and the sixth, economy, may be accepted as secured by the realization of the other five.

On looking over this list it was apparent that the third requirement would be most difficult to fulfil, all the others being within the scope of modern knowledge and practice. With the time-honoured principle of the wheel and pinion still guiding the mind, a careful review of the reasons why this principle had failed to produce the desired adaptability, led to a concentration of thought on the pinion. Any trouble with the larger wheel of a pair was traced to the pinions which drive them, and it was then concluded that the solution of the problem might be found in a pinion which would have no pitch or form of teeth except that imparted to it by the engaging wheel. In other words, every driven wheel should be its own odontagraph. Simple minds mould their ideas from simple patterns, and, in this instance, having come to the conclusion above stated, the next step was to find some simple basic element or principle in nature, which, when viewed in the light of centuries of thought, experience and application, might point some untrodden way to the desired end.

The old mill wheel, with its continuous stream of water "gearing" into it, suggested possibilities. The mill stream adapts itself to almost any conceivable variation of a nature corresponding with those to be met with in mechanical gears. If the mill stream could be rolled up in a circle of suitable diameter, and provided with a shaft and bearings, it would form a pinion of the required adaptability. The absurdity is, of course, apparent, but in search for a new theory, apparent absurdities must be fully considered. And this same apparent absurdity is one of the most familiar features of nature; the feature which makes it necessary to build ships instead of railways. By the same method of reasoning the earth is revealed as a pinion, in constant motion, which, given the outside connection, might drive the universe. In the earth as a whole there is the embodiment of the idea of a mill stream revolving continuously round an axis. But in building



Figs. 14 to 19.