RECIPROCATING vs. ROTARY ENGINES.

By F. A. Wiswell.

Beebe Plain.

Very many mechanics labour under the erroneous impression that a reciprocating steam engine does not furnish as much power as would a rotary engine, both using the same amount and pressure of steam. Many inventors have spent years of time and study on this very point, supposing, when perfected, they would have a machine of great power with comparatively small expenditure of steam. Unfortunately but too many such are unacquainted with the details of mechanics, and it is only after much hard study that they gradually become aware that there are principles involved that, at first, they were totally ignorant of. Then, when they "read up" on the subject, they discover that so much is required in a rotary engine to successfully compete with the improved styles of reciprocating engines that they usually become discouraged and abandon the project; thus losing much time spent in misdirected study. It is not only of rotary engines that this is the case, but of many other machines; notably, perpetual motion; when had they but known this truism: "*Power cannot be gained except at the expense of time,*" would have prevented useless study in this direction. A short time since, a gentleman came to me, and, in very enthusiastic terms, explained a road metor to be propelled by springs, and on which he desired me to secure Letters Patent for him at once. I asked how long it would take to wind up the springs for an hours journey. "I haven't made any calculations as to that," he replied. When I explained that with a carriage of such weight that it would require his whole strength to move it three miles in one hour, it would also require the same exertion for an hour to wind up a spring that would drive the carriage the same distance in the same time, I am happy to say he abandoned the idea altogether.

A properly constructed reciprocating engine, with appliances for expanding the steam to the most economical point, will develope as much power as is possible to obtain in a rotary, both being of that type called high pressure. That is to say, without taking advantage of atmospheric pressure in either. At first thought, this might seem to those for whom this paper is written, to be incorrect; but I will endeavour to show that my assertion is based on a thorough understanding of the subject.

First, then, it is supposed that a large per-centage of power is lost by the intervention of the crank,—that when at or near the inside and outside centers the pressure of the steam does not exert the maximum of power. To clear up this point, it must be borne in mind that near these points the motion of the piston is slow, while the force of the steam is more sustained than at any other part of the stroke. In other words the quantity of steam used exactly corresponds to the amount of power developed. This is also true of every part of the stroke, for it is evident that when the stroke is half performed the speed of piston is greater than at any other portion, consequently a greater quantity of steam is being used at that portion, while a greater amount of power is being developed. If, however, steam is used expansively— divided from the generator at a certain portion of the stroke, the sum becomes changed somewhat, but not to a disadvantage unless carried to extreme. For instance, suppose the steam to be "cut off" at $\frac{1}{10}$ of the stroke at a pressure of 115 lbs. per square inch (the 15 lbs. bring the atmospheric pressure), it will be understood that when the piston has travelled $\frac{2}{10}$ of the stroke, the steam having expanded to twice its original bulk, the pressure will be reduced one half. To make this easy of comprehension the following table of approximate figures has been prepared:

Point of cut off.	Pressure of steam.	Pressure of air.	Total.	Temperature.
$\frac{1}{10}$	100	15	115	330°
$\frac{2}{10}$	50	$7\frac{1}{2}$	$57\frac{1}{2}$	280°
$\frac{4}{10}$	25	$3\frac{3}{4}$	$28\frac{3}{4}$	220°
$\frac{8}{10}$	$12\frac{1}{2}$	$1\frac{7}{8}$	$14\frac{3}{8}$	210°
$\frac{10}{10}$	10	$1\frac{1}{2}$	$11\frac{1}{2}$	200°

It will be seen from this table that the 10 lbs. pressure of steam is 5 lbs. below atmospheric pressure, while its temperature is several degrees below that necessary to maintain the vaporous state. (*) It is evident, therefore, that a vacuum would be formed on the steam side of the piston. Another disadvantage that arises from the extreme expansion of saturated steam *i e*—steam having a temperature that is simply due to its pressure—is, that when so expanded, and its temperature so much lower than that of the cylinder, heat is abstracted from the latter, which in turn, being cooler than the fresh, high pressure steam, cools it, so that a portion becomes condensed; thus destroying the effective force of that portion. And this is not obviated by jacketing, although the cooling of the cylinder from the outside is prevented in a measure. To prevent the loss of pressure by condensation, steam should be super-heated sufficiently to have a temperature at its greatest expansion nearly, if not quite, that due to its greatest pressure. These, of course, are evils that our indigenous to both types of engines, but such as are successfully overcome in the best reciprocating engines, and such as must be overcome by the rotaries before they can successfully compete with them.

The main object of the compound engines is to use steam expansively without the successive variations of the temperature of the cylinder incident to the expansion of steam in the one cylinder, by using steam direct from the generator the full length of the stroke then exhausting into a longer cylinder, usually about four times the size of the first. Of course there is back pressure in the first cylinder; but it is only one fourth that on the opposite side of the piston, while the greatly increased area of the auxiliary cylinder, it is claimed, gives, combined with the first, a larger amount of power with greater economy of steam than is possible to obtain in one cylinder.

With the successful working of the compound engine in view, it strikes me that it would be mechanically easier to construct the rotary so as to expand the steam in separate compartments, or, perhaps, segments of its circle, than to attempt to "cut off" at a certain, or even variable portion of the stroke as in the Corliss engines.

Having explained the principal difficulties to be overcome by the rotary to make it equal in power and economy to the reciprocating engine, and having shown, too, that it cannot hope to surpass the latter in these respects, the question may be asked: "What is the use, then, of attempting to invent a rotary?" The answer is: "Economy of space; its direct applicability to rotary saws, and such like machinery; cheapness of construction; simplicity; portability, and great speed without the intervention of pullies, belts or cog wheels." These are cogent reasons, I think, why a rotary engine, combining these features would be very desirable; but nothing less than this will satisfy the users of steam power of the present day.

(*) I am aware that John Bourne states in his Catechism of the Steam Engine that "if steam of 100 lbs be expanded down to steam of 15 lbs., it will have 35 degrees of heat over that which is required for the maintenance of the vaporous state, or in other words, it will be surcharged with heat." This is an error which I am confident that gentleman made unwittingly, for I cannot believe he was unaware of the fact that by the expansion of steam its heat was also expanded, and that if compressed again to its original volume, its corresponding temperature would be again assumed. F. A. W.

PREMIATED DESIGN FOR THE GERMAN PARLIAMENT HOUSE.

(See page 356)

Some time ago the German Government invited designs from architects of all countries for their Parliament House, proposed to be built at Berlin. From a large number sent in, five designs were selected, and received the premiums. One of these was the work of the distinguished architect Sir Gilbert, G. Scott, R. A. The style adopted is that of the thirteenth century, retaining in it those especially German characteristics which may be viewed as more properly belonging to the twelfth, though nevertheless extending themselves far into the thirteenth century, and thus raising and standing by the national banner against the advancing fashion of amalgamation which eventually effected their extinction.

It is reported that another competition, *confined to German Architects*, is to be invited.—*Builder.*

THE BELL-TOWER AT EVESHAM.

(Page 357.)

Our readers may remember that, at the last Congress of the British Archæological Association, held in Evesham, a discussion arose concerning the real date of the bell-tower there, always attributed to Abbot Lichfield, who received that office in the year 1513. The Rev. Mackenzie Walcott, in a paper then read, brought documentary evidence to show that, so far from this being the case, it was built about a century earlier, probably by Abbot Zetten, in which view he was supported by Mr. Parker. The question excited considerable interest, and the architectural members of the Association who happened to be present met on the spot the next morning, and agreed unanimously, on the evidence of the building itself that the ordinary belief was correct. In this we fully agree, and the tower being a noble one, and amongst the latest works in the Gothic style in England, we give