PRACTICAL MECHANISM.

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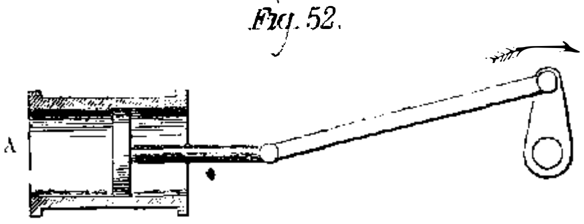
MOVEMENTS OF PISTON AND CRANK.

The variation in the supply of steam, when considered in proportion to the amount of piston movement, to which reference has already been made, arises from the irregularity of speed in feet per minute at which the piston travels at different parts of the stroke: which irregularity is due to the varying angles of the connecting and slide valve rods during the stroke, but mainly to those of the connecting rod. The amount of this irregularity will vary with the length of the connecting rod; the longer the connecting rod is, the less will be its variation.

The fly wheel, acting as an equalizer of the power of the engine throughout the stroke, travels at a comparatively uniform speed: and nearly the whole of the variation of speed (caused by the unequal admission of steam during one stroke, as compared to the other stroke, necessary to complete a revolution of the engine) falls upon the piston. In an engine of 12 nches stroke, the connecting rod being, say, 23 inches from center to center of its journals, the piston will have moved 6¾ inches of its stroke when the crank has performed the first quarter of its revolution, and stands at or near its point of full power, as shown in Fig. 52, which

Fig. 52.



represents a cylinder, piston, piston rod, connecting rod, and crank in the positions referred to, the piston having moved from the end, A, of the cylinder. While the crank is moving the next quarter of its revolution, the piston will move 5¼ inches only, thus completing its stroke of 12 inches. Moving the crank the third quarter of its revolution, we find the piston to have moved back 5¼ inches, standing in the same position as it did at the end of its first movement of a quarter revolution. During the last quarter revolution of the crank, the piston moves 6¾ inches, both piston and crank returning to the respective positions from which they started.

STEAM SUPPLY.

The inequality of the comparative piston and crank movements here disclosed causes the supply, expansion, and exhaust of the steam (in common or simple slide valve engines) to be irregular and unequal at one end of the cylinder as compared to the other, as shown by the following example, taken from a working engine of 12 inches stroke, the eccentric and connecting rods being each 23⅜ inches long, the steam ports ⅞ inch wide, the width between the steam ports being 3 inches and the valve having ⅜ steam lap, with neither lap nor clearance on the exhaust side. The stroke of the valve was 2¼ inches, or just sufficient to permit the steam ports to open to their full extent. Commencing, then, when the piston is at the front end of the cylinder, that is to say, at the end farthest from the crank, we find the following respective movements:

TABLE 1.—FRONT STROKE.

Piston moved Inches	Port open inch
1	$\frac{9}{16}$
2	$\frac{3}{4}$ barely
3	$\frac{13}{16}$
4	$\frac{7}{8}$
5	$\frac{7}{8}$
6	$\frac{7}{8}$ barely
7	$\frac{3}{4}$
8	$\frac{11}{16}$
9	$\frac{9}{16}$
10	$\frac{3}{8}$
11	$\frac{1}{6}$
11⅛	closed, and expansion begins.
11¾	" " " ends.
12	exhaust open ⅜ inch

TABLE 2.—THE RETURN OR BACK STROKE

Piston moved inches	Port open inch
1	$\frac{11}{16}$ full
2	$\frac{7}{8}$
3	$\frac{7}{8}$
4	$\frac{7}{8}$
5	$\frac{7}{8}$
6	$\frac{13}{16}$ full
7	$\frac{3}{4}$
8	$\frac{5}{8}$
9	$\frac{7}{16}$
10	$\frac{3}{16}$ full
10⅝	closed, and expansion begins.
11¾	" " " ends.
12	exhaust open ⅜ inch.

It will be at once observed that the supply of steam to the piston is much greater, from the very first inch of piston movement, in the back stroke as compared with that of the front stroke; but this inequality is somewhat compensated for by the fact that the cubic contents of the steam space in the cylinder is greater in the case of the stroke tabulated in No. 1 than it is in No. 2, because of the space occupied during the latter by the piston rod.

The expansion commences earlier in the stroke, and ends earlier; and the distance moved by the piston under expansive steam is ⅛ inch more in the back than in the front stroke. The effect of the irregularity will, however, be more correctly understood by comparing the movements, as shown in the following table

TABLE 3.

Movement of crank	Movement of piston	Average Port opening
1st quarter	6¾ inches	$\frac{126}{160}$
2d. "	5¼ "	$\frac{96}{160}$
3d. "	5¼ "	$\frac{134}{160}$
4th. "	6¾ "	$\frac{64}{160}$

A comparison of the first and third quarter revolutions of the crank: during each of which it moved from a dead center into about full power, and during each of which the piston moved from one end towards the middle of the cylinder: shows that, while the piston moved the greatest distance in the first, it received the least amount of average port opening, and hence the least supply of steam. A comparison of the second and fourth quarter revolutions of the crank, during each of which the piston moved from near the middle of the cylinder towards one end, discloses that, while the piston traveled the least distance in the second, it received the most steam during the fourth quarter revolution. Now let us compare the second and third quarter movements of the crank with the piston movement and steam supply. During each of these movements, the piston traveled an equal distance; but we find the average opening of port for the admission of steam to be $\frac{3}{16}$ of an (inch nearly one third) greater in one case than in the other. So likewise a comparison of the first and fourth quarter revolutions of the crank shows that, while the piston and crank moved an equal distance in both cases (namely, the crank a quarter revolution and the piston 6¾ inches of the stroke), the average port opening for the supply of steam was very nearly double in the first quarter of what it was in the fourth. So far, then as we have considered these movements, the steam supply has been (in consequence of the area of the port opening) in each case the least, in proportion to the distance moved by the piston, where it should have been the most, and *vice versa*.

The first quarter movement, considered in relation to the second, shows the steam supply to be the greatest when the piston movement is the greatest; but the third quarter movement, as compared with the fourth, discloses the greatest discrepancy of all, since not only was the port opening more than double in one case of what it was in the other, but the greatest amount of port opening was given to the least amount of piston movement.

Considering the port opening with reference to the crank movement only, it would seem to be desirable to have an equal average of opening for each quarter movement; but when considered with reference to the piston movement (that is, with reference to the amount of steam which is required to pass through the port in a given time), it becomes self-evident that the area of the port should be greater when the piston is traveling fast than when it is traveling slowly.

We must, however, consider that, during the second and fourth quarter revolutions, the piston is at that end of its stroke where the exhaust takes place; so that the piston is not under steam (during each respective quarter movement) for the whole of the movement. Hence the smallness of the opening of steam port is not so disproportionate (considering each quarter movement of itself, and not comparatively with another) as it would at first sight appear to be.

It must also be remembered that, since the ports are of rather larger area than they would be if employed as steam ports only, instead of as steam and exhaust ports alternately, the inequality of port area during the movement, shown in the above tables, is not experienced to so serious an extent as it otherwise would be. It is, however, felt by the engine to a sufficient extent to render it of great advantage to give to the valve (when it has not more steam lap than one half the width of the steam port) more travel than is absolutely necessary to open the ports to their full width; because not only does a small amount of increased valve travel more nearly equalize the average steam port area, but it gives to the engine a much better and quicker supply of steam. It may thus be accepted as a positive rule that such a valve should always have this increase of travel, as will be hereafter shown, there being advantages due to this increase on the exhaust as well as on the steam side of the piston.

Testing and Mounting of Lenses.

Mr. E. L. Wilson, describing a visit to the establishment of Ross & Co., London, says, in the Philadelphia *Photographer*: "The number of tools or curves in this establishment is very great, consisting of upwards of two thousand, all of them being ground with such accuracy that the curvature of each is known to the fourth place of decimals, their respective radii extending from 30 feet down to 0·1 inch (a hundredth of an inch). The curvature to which any particular lens is to be ground is calculated mathematically to suit the refractive and dispersive ratios of the glass of which it is to be formed; and after the lens is finished, if, on examination, it fails to come up to the standard of sharpness, the particular surface which exercises control over the shortcoming is reground in a tool one degree deeper or shallower in curvature, to suit the requirements of the case. The most intense sharpness is insisted upon as a *sine qua non* in this establishment, no portrait lens being allowed to pass into stock unless it can produce a picture with open aperture sufficiently sharp to bear a large degree of magnifying. Such an idea as diffusion of focus is not recognized, the reason assigned being that, if once a lens is made that will produce absolute sharpness, perfection of definition can at will be destroyed in any special case by the mere interposition of a transparent pellicle, or even a sheet of homogeneous paper, between the negative and the print, the latter of which will thus possess that quality known as diffusion, although from the very same negative may be obtained an enlargement of the greatest sharpness and perfection. One large shop in this factory is devoted to brass turning and fitting, and numerous workmen are here engaged in making the new small symmetrical lenses. In this kind of lens the Messrs. Ross have effected a reformation that has, for a long time, been much desired by photographers, namely, the reduction of the diameter of the lenses to the smallest possible size, and the causing of the whole series of twelve to screw into one flange, one cap also fitting all of them. This series of lenses consists of twelve separate combinations, all, as I have said, of the same diameter in mount, which, by the way, is very small, owing to every superfluous portion of glass being removed from the lenses, which are thus reduced to scarcely more than the size of the stop. Their foci range from 3 inches to 21 inches, a lens of the latter focus covering a plate 21 x 25 inches. So small and light are they that a photographer may without any inconvenience carry several of them in his pocket, and screw into his camera any one of them which, from its focus, is best adapted for the representation of any special view. It would be well if this system of having one standard flange for all lenses up to a certain size were more prevalent, for it would prove a boon of inestimable value to photographers. The system of universality of screw has for many years been in use in connection with the object glasses of microscopes; and no matter now in what countries either microscopes or objectives may have been made, all are fitted to one gage. The varying diameters of photographic objectives will ever, of course, prevent the adoption of one individual flange for all purposes; but what can and ought to be done is the adoption throughout the world of a series of flanges, as few as possible, of recognized and standard sizes. Notwithstanding the small dimensions of the symmetrical lenses, they work with greater rapidity than those of large size, when used under similar circumstances of lighting and aperture.

The racks used for portrait lenses are toothed in the solid, so to speak, and are sawn asunder afterwards, three dozen being made at a time.

The cutting of screws, in the tubes, cells, and flanges, is effected both by hand and by mechanism attached to the turning lathe, the special mode to be adopted in each case being determined by the size of the article. The screwing of the tube of a lens of ten or eleven inches in diameter would never be undertaken by hand alone, while on the other hand the services of the lathe screwing machine would never be had recourse to in the case of a small symmetrical lens.

When two achromatic lenses are to be mounted, they are first of all placed in a trial mount, so adapted as to permit of an approximation or separation of the lenses. The test object is a watch dial placed at the extreme end of the testing room, and the image of this dial is examined through a powerful eyepiece. Unless it can divide the closest lines upon this dial, the lens is rejected. In this trial both the central and oblique pencils are examined, and the exact amount of separation of the lenses from each other is now determined by experiment and marked upon each pair, as the instructions for the workman to whom is intrusted the duty of the final adjustment of the length of tube, an operation which influences materially the performance of the lens, when it is considered that so nicely poised are the qualities, in some of the combinations of more recent production, that a deviation of a fortieth part of an inch from the exact distance, required and determined in the way described, will affect its performance and be detected by the manager in course of the final trial, which is made after the lenses have been finished.

The consulting engineer of the firm of Ross & Co. is Mr. F. H. Wenham, who has apartments upon the premises. Most of the modern improvements in the microscope owe their existence to the genius and executive skill of this gentleman, who, by his invention of the binocular microscope, his simplification and improvements of the object glasses, which throughout the world are all now made upon his principle, his parabolic condenser, and other inventions, has acquired a name which will ever be associated with the highest department of optical science, both mathematical and applied.

Turkish Steam Engineering.

Some ironclad ships were recently built in England for the Turkish government, and sent out under the care of English engineers. On arriving at their destination these were discharged, and Turkish mechanics substituted. Like all other persons who undertake matters which they have no fitness for or knowledge of, these persons came to grief at once. Being required to start the engines of the Mahmouhdeh, much delay ensued; the engines did not start; they were pronounced "all wrong," and one officious party, growing impatient after having moved every movable lever, spied some cocks, which he thought must be the right thing to work, and went for them at once. He was scalded by receiving a jet of steam full in the face, which precipitated not only matters, but himself and several other Turkish gentlemen backward down a pair of iron stairs leading to the fire room.