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CONSTRUCTION OF FIELD ARTILLERY CARRIAGES.

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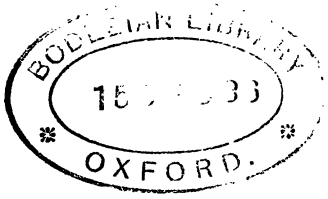
OXFORD

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CONSTRUCTION OF FIELD ARTILLERY CARRIAGES.

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In considering the construction of field artillery carriages, it will be well first to review those principles which, more or less, must be carried out in the building of all in common, and then to make a few remarks upon the particular requirements which govern the details of construction of the various descriptions of carriages.

Essential Qualities.

The following qualities may be looked upon as the *desiderata* in a field artillery carriage—viz., "mobility," that the carriage may be brought rapidly, and without difficulty, into any required position, or change of position; "stability," that in any movement the carriage may be required to make, even if the ground is tolerably uneven, it may not overturn; "strength," "durability," and "simplicity" are essential qualities, which require no comment; and lastly, "convenience of transport" must of necessity be desirable in a country like Great Britain, with numerous large and distant colonies.

The first and chief point, then, to be kept in view in the construction of all field artillery carriages, is "mobility;" for without possessing this quality in a very high degree, they would be comparatively worthless.

In the following remarks, the question of the advisability of employing a two or four-wheeled carriage will not be entered into, it being assumed that the nature and purpose of the load compel the latter; which is, further, the best for draught, though the less advantageous for wheeling. Also, in all cases, the mode of draught will be taken as shaft draught, being that adopted in the service, as placing the carriage more under control in manœuvring than pole draught, and as being more advantageous for the wheel horses.

1. *Mobility.*—The "mobility" of a carriage is influenced by several things—viz., by the "traction" (commonly termed the "draught"), or amount of power requisite to put it in motion, and keep it in motion;

by its capability of reversing; and by its power of passing obstacles. To render, therefore, a carriage mobile, "the draught must be as light as possible." This necessitates, in the first place, the load being a minimum—that is, the weight of the gun, or ammunition, &c., to be carried being given, the weight of the carriage a minimum—and in the second place, that the load be properly distributed over the axles.

Before passing on to the other points which affect the draught, it is to be noticed that the distribution of the load depends upon the relative diameters of the fore and hind wheels, and upon the fact that the traction of the fore carriage, taken by itself, is usually more difficult than that of the hind; because the fore wheels make, as it were, the tracks, and in so doing reduce the height of any obstacles for the hind. These considerations point to the reduction of the load upon the fore axle as compared with that on the hind; but, on the other hand, the fact must not be lost sight of, that if too much weight be thrown on the hind axle relatively to the fore, it will cause the hind wheels to sink too much in yielding ground, and thereby (though the decrease of weight on the fore axle tends, as before, to lighten it) to increase the draught on the whole.

Again, for lightness of draught, the axles must be of such length as to give the same track to both fore and hind wheels; in order that, as above, the fore may, in doing their own work, also assist the hind. The diameter of the wheels must also be a maximum, and that of the axletree a minimum. With regard to the former, the diameter of 5 ft. has been fixed upon as that most suitable for the field wheel.

Lastly, that the draught may be light, the point of the attachment of the traces must be the most favourable—that is, as regards height from the ground; it must be such as to give the most advantageous inclination to the traces. The point of attachment to the horse—viz., the collar—being fixed, experience has shown that this inclination should be about $6\frac{1}{2}^{\circ}$.

The carriage, to be mobile, must, in addition to being light in draught, be "capable of wheeling, or reversing, very short;" that is, not only must the carriage be of a minimum length, but the angle through which the fore carriage can sweep must be as large as possible – which latter mainly depends upon the diameter of the fore wheels, and details of construction of the body of the carriage.

The mobility of the carriage is influenced by what may be called its "power of passing obstacles," which point, so far as the wheels and inclination of the traces are concerned, may be considered as included under "lightness of draught;" but beyond this, is influenced by the mode of connection of the fore and hind carriage, which should be such as to admit of vertical motion of the fore carriage about the point of connection, so that the fore carriage may move in that direction independent, to some extent, of the hind carriage. The distance between the axles also slightly affects the power of the carriage to pass obstacles, but need hardly be taken into account, as the length between the axles best suited for passing certain obstacles will not be the best for passing others. And here it may be as well to remark, with regard to the distance between the axles, that it does not in

ordinary cases affect the traction, providing that the relative position of the centre of gravity of the load as to the axles remains unaltered.

2. *Stability.*—"Mobility" in a field artillery carriage would not, so to speak, be perfect, unless accompanied by "stability," which point has, therefore, next to be considered. Stability is influenced by the number of points on which the carriage rests, and by the vertical and horizontal position of the centre of gravity with regard to those points. The carriage being supposed on the level, the first mentioned distance should be as small as possible, and the second as great as possible (which latter, with convenience of width, governs the track), to yield maximum stability. This will be readily understood by supposing a carriage placed upon the level, and a vertical drawn through the centre of gravity, then the carriage tilted over through a certain angle; when it will be seen that the higher the position of the centre of gravity, the greater the distance through which it has moved, and therefore the more nearly will the vertical then drawn through it be to falling outside the bearings on the ground. Again, with regard to the horizontal position of the centre of gravity from the bearing points, it is evident that the further it is from them, the greater moment the weight, acting at that centre, has to resist any force tending to overturn the carriage.

Stability in wheeling or reversing, will further be influenced (setting aside the weight of the carriage, already fixed at a minimum by the consideration of mobility) by the height and mode of connection of the fore and hind carriages, as well as by the height of the attachment of the traces to the fore carriage.

That the carriage may be stable in any position of rest or of motion to the front, it is simply necessary that the vertical through the centre of gravity should fall within the figure formed by joining with straight lines the points upon which it rests. In field artillery carriages, the stability is considered sufficient when the upsetting angle for the carriage, packed, is about 35°; that is to say, the vertical falls outside the points on which the wheels rest, and the carriage overturns, when it stands upon a side incline exceeding 35°.

3. *Strength and Durability.*—The next points to be taken into consideration in the building of the carriage, are "strength" and "durability." The material used should be the strongest consistent with lightness; the scantling of each particular part being, in the same view, at a minimum consistent with the stress which the part may be called upon to bear. The material should also be such as will stand well the effect of shot striking it, the action of climate, &c., and should not be liable to deteriorate when kept in store.

Of late years, wrought-iron has very much superseded wood as a material for carriages, being much more durable. For instance, a shot striking a bracket of an iron gun-carriage will make a clean hole through it, without splintering and damaging the adjacent parts; whereas a shot striking the bracket or trail of a wooden gun-carriage will splinter it, more or less. Notwithstanding, comparing iron with English oak, it is but slightly heavier for the same strength; because, from its nature, its mass can be better disposed to withstand any given

stress. Wrought-iron, however, is not so elastic as wood, and therefore will not absorb so much of any stress as the latter; and, again, has the defect of readily suffering deformation, and thus loss of strength through loss of form. This latter defect sometimes necessitates the scantling of the iron being made of greater dimensions than mere strength to resist a particular stress would require.

4. *Simplicity.*—"Simplicity" of construction in the carriage is the next quality to be kept in view; that is to say, as far as possible, there should be nothing complicated nor likely to get out of order; neither should any part be such that, if damaged, it could not readily be repaired. Again, looking at the carriages in the aggregate, the parts and fittings should, as far as possible, be interchangeable.

5. *Transport.*—"Convenience of transport" is a point which must not be lost sight of in building the carriage; in view of which, it should admit of being readily taken to pieces and conveniently stowed on board ship.

6. *Length.*—Lastly, the total length of the carriage should be at a minimum; not only, as mentioned before, for mobility, but that in column of route it may cover as little ground as possible.

A few further remarks may now be made upon the particular requirements of the gun-carriage, &c.

The Gun-Carriage, with Limber.

The present form of gun-carriage has been arrived at, as fulfilling the foregoing conditions, and also as convenient for bringing the gun into, and serving it when in, action; as furnishing a stable carriage for the gun in action; as allowing of a supply of ammunition and stores being carried with the gun, readily accessible for use; and as admitting of a proportion of men being carried upon the carriage in addition to its proper load.

With regard to the mobility of the gun-carriage, it is to be remarked that it has an advantage not possessed by ordinary carriages—viz., of having fore wheels of equal diameter to the hind, yet locking through a considerable angle. Further, the connection of the fore and hind carriage may be said to be perfect, as regards passing obstacles; for the vertical as well as the horizontal motion of the former is very independent of the latter.

In point of strength and durability, not only has the gun-carriage to be able to withstand the strains to which it may be exposed as a travelling carriage, but it also must have sufficient strength to withstand the action of the gun when fired at the most hurtful elevation.

In investigating the effect of the discharge of the gun upon the carriage, we may consider that discharge as simply producing a force or blow applied at the bottom of the bore, and acting in the line of the axis of the gun—though it is questionable whether the action is actually so simple. The gun—that is, its weight, charge, &c.—are supposed in the following remarks to be given and constant; and, unless the contrary

is specified, the carriage standing on the level, and the gun laid at any angle of elevation or depression. From the symmetry of the gun and carriage with regard to the vertical plane through their longitudinal axes,* we can further take the whole of the forces to be spoken of as acting in that plane. Taking, then, the single force applied at the bottom of the bore, we may conceive it resolved into two components—one horizontal, the other vertical. Now, a proportion only of this single force, or its components, is transmitted from the gun to the carriage; part—depending in amount upon the weight and thickness of metal of the gun—being expended upon the former.

Again, of the proportion transmitted to the carriage, the whole is not expended upon the carriage, but a small part transmitted to, and expended upon, the ground—the amount depending upon the nature of the latter. Now, the gun is supported upon, or attached to, the carriage at two points—viz., the trunnion holes, and the bearing of the elevating screw on the trail; but the attachment is not rigid, for the gun is moveable about the axis of its trunnions, and is hinged to the elevating screw, the latter being also moveable in a vertical plane round its bearing on the trail.

Taking, therefore, a certain horizontal and vertical force as transmitted from the gun to the carriage, we see, from the nature of the connection between the two latter, that the horizontal component will be applied at the trunnion holes, and the vertical component partly at the trunnion holes and partly at the bearing of the elevating screw—mainly, however, at the latter. The horizontal component decreases as the angle of elevation or depression with the horizontal at which the gun is fired increases. It exerts itself upon the carriage in two ways—viz., in giving it a motion of translation to the rear, and a twist or tendency to constrained motion about the point of the trail, as that point may be regarded for the instant as fixed. Hence, to render the effect of this component as little hurtful to the carriage as may be, the latter should in itself oppose the motion of translation as little as possible; which amounts to saying that its inertia, and consequently its weight, should be a minimum (the latter we have already seen mobility also demands); while to reduce the twisting strain to a minimum, the trunnion holes should be as low as other considerations will admit. The vertical component will act in an upward or downward direction, according as the gun is fired at an angle of depression or elevation with the horizontal, and will increase with the angle. If upward, it will tend to tear the carriage asunder; if downward, to crush it—the latter being that which tells most upon the carriage, on account of the resistance of the ground upon which the carriage bears. The body of the carriage is supported upon the ground at two points—viz., the axletree arms and the point of the trail; when, therefore, the blow of discharge is transmitted to the carriage, if the vertical component act downward, we shall have at these points certain resistances called into play, that at the arms being

* It is not only convenient, but necessary that these axes should lie in the same vertical plane, to prevent the carriage receiving a twist horizontally.

much greater than at the point of the trail; because the axis of the trunnion holes lies vertically to the front of the axis of the axletree, and also the bearing of the elevating screw is nearer the axletree than to the point of the trail—in fact, because the vertical component, part of which acts at the trunnion holes and part at the bearing of the elevating screw, acts as a whole at some point intermediate between the two.

Again, this being the position of the point of application, as it were, of the total vertical component, it is evident that the trail and brackets (as part of the trail) have to support the whole brunt of it, while the axletree has only to bear a part of that whole. If the vertical component act upwards, the resistances of the ground will not then be called into play, but the weight of the carriage acting downward at its centre of gravity will offer the resistance; the tendency being, as before said, to tear the carriage asunder. When the vertical component acts downwards, and the resistances of the ground are called into play, they will in general be less in total amount than the component itself, the excess of the latter being expended upon the ground. This excess will vary with the hardness of the ground, and the carriage will be saved according as the latter is more or less yielding. Just in the same manner, the ground, by its nature, will influence the recoil, and, as before mentioned, in so doing influence the amount of the horizontal component spent upon the carriage, and the portion transmitted to and expended upon the ground.

In a similar manner, the slope of the ground to the front or rear, by influencing the recoil, affects the destructive effect upon the carriage.

It only remains to be noticed, with regard to the force transmitted from the gun to the carriage, that in guns having the axis of the trunnions below the axis of the piece, other things equal, the blow upon the trail at the bearing of the elevating screw is more severe than in guns in which the axes intersect; because the impulse on the bottom of the bore, acting in the line of the axis, has a moment or twist round the axis of the trunnions.

Carriages having a detached elevating screw are liable to a second and destructive blow upon the trail, from the breech of the gun and the screw falling back to their place, after the rebound of the trail from the ground has thrown them up.

As regards serving the gun in action, it is to be observed that the carriage is admirably adapted for laying the gun; admitting of ready motion being given to the latter in a plane perpendicular to the axis of the trunnions and to the carriage itself, and therefore to the gun in a plane at right angles to the former.

As to furnishing a stable carriage for the gun in action, the form adopted gives three points of support, the vertical through the centre of gravity falling between them, and hence a stable carriage. Not only so, but a carriage that is stable when the gun is fired; as the axis of the gun lies in the vertical plane (the wheels being on the level) containing the centre of gravity of the system, while the rear point of support of the carriage is in the same plane, and at a sufficient distance from the centre of gravity.

It now remains to make a few remarks upon the parts of the gun-carriage in detail.

The wheels and axletree are of sufficient importance to be treated of by themselves, and it need only here be mentioned, with regard to the destructive action of the gun upon the carriage, and axletree in particular, that, looking at their inertia, the weight of the wheels should be a minimum (as well as for mobility).

The scantling of the parts has been arrived at from experience and experiment, as well as from scientific considerations; being always kept at a minimum consistent with proper strength, for the sake of mobility, which consideration in the following remarks is understood to be kept in view.

The wooden axletree bed, hitherto used, served as a convenient means of securing the axletree to the carriage body, more particularly in wooden gun-carriages; it also distributed the load in travelling, and the strain in firing, more uniformly over the axletree, serving by this means, and by its own additional strength, to admit of the axletree being made lighter than it otherwise could be.

In iron carriages, however, it gives no additional facility of construction, and though it has the advantage of assisting the axletree to some extent, it is a questionable advantage; so that in this case it would appear to be a superfluous, and it may even be said to be a faulty form of construction—a compound axletree, as it were, being made of two substances differing so much in elasticity as wood and iron, and further, the material having the greatest elasticity placed to receive the pressure or blow; in fact, the iron may be broken before the full strength of the wood has been called into play. For this reason, it is probable that in iron carriages of the future it will be dispensed with, and the axletree modified.

In form, the bed is of the same section throughout, but not rectangular; because while the upper surface is parallel to, and the sides perpendicular to, the under surfaces of the brackets into which it is housed, its under surface must be such as to be parallel to the ground when the trail is upon the limber-hook, in order that the lower surface of the axletree may be parallel to the same—that being the position of the axletree for which the lead and hollow are calculated.

The dimensions of the bed depend entirely upon the axletree; its length—in which direction the fibre should run—being the same as that of the body of the axletree; its depth being regulated by the height considered necessary to be given to the axis of the gun (which is governed by the general rule that the gun should be able to fire over a parapet 3 ft. 6 ins. high at 5° depression); and its width such that it may be able to retain a good hold upon the axletree without giving way itself.

The height of the brackets must be at a minimum consistent with the maximum elevation and depression necessary for the gun—viz., about 15° elevation, or 10° depression, being given when required—and also to give (in wooden gun-carriages) room for sufficient depth of housing over the axletree bed.

The depth must be kept, as stated, at a minimum, because the deeper the brackets, the stronger, and therefore heavier, they must be