**Report of the Barrack and Hospital Improvement Commission on ventilation of cavalry stables.**

# REPORT

OF THE

# BARRACK AND HOSPITAL IMPROVEMENT COMMISSION

ON

# VENTILATION OF CAVALRY STABLES.

LONDON:
PRINTED BY GEORGE EDWARD EYRE AND WILLIAM SPOTTISWOODE,
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.
FOR HER MAJESTY'S STATIONERY OFFICE.

1864.

# REPORT

OF THE

# BARRACK AND HOSPITAL IMPROVEMENT COMMISSION

ON

# VENTILATION OF CAVALRY STABLES.




LONDON:
PRINTED BY GEORGE EDWARD EYRE AND WILLIAM SPOTTISWOODE,
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.
FOR HER MAJESTY'S STATIONERY OFFICE.

1864.

7665.

[3728.—200.—12/63.]

# REPORT

OF THE

# BARRACK AND HOSPITAL IMPROVEMENT COMMISSION ON VENTILATION OF CAVALRY STABLES.

To the Right Honourable The Earl de Grey and Ripon, Secretary of State for War, &c. &c.

The Barrack and Hospital Improvement Commission having, in concert with Mr. Wilkinson, Principal Veterinary Surgeon, made inquiry into the various methods for improving the condition of air in Cavalry Stables, beg to submit the following report:

The inquiry included a special examination of examples of stables of various constructions, some of them of old form, and presenting the defects of the time, others somewhat better, and several examples of recent construction of a very superior character.

The stables examined were the following:

New Kensington Barracks, old model.
Hounslow, old and new stables.
Colchester, on a new model, not yet occupied.
Woolwich, Royal Artillery.
Aldershot:
1. Stables, recently built on an old model, with rooms over them.
2. Stable of recent construction, on a new model, with open roof.

York, three sets of stables:
1. On the old form.
2. Stables of recent construction, with men's rooms over them.
3. Open-roofed stables.

Examples of infirmary stables and loose boxes at two or three of the stations were also examined.

During these inspections we have had the advantage of frequent discussions on the principles of stable ventilation, under the various forms in which it presents itself in different kinds of construction.

As the inquiry proceeded the subject of it gained more and more in importance, and we have found it necessary to discuss the question of stable ventilation more fully, and to state the conclusions arrived at in a somewhat different form than was at first intended. This we now proceed to do under the following heads:

## 1. Relation of Plan, Construction, and general Sanitary Arrangements in existing Stables, to the State of their Ventilation.

In every instance the ventilation of occupied stables was found to be more or less insufficient. In some it was much better than in others, but in certain stables the air was so foul that it is matter of surprise how animals could breathe it, and retain any measure of health.

The practical point which first arrested attention was that the state of the air bore a certain relation to the structure and sanitary arrangements of the buildings, quite apart from the means of ventilation which had been adopted.

This element in the question has been so little considered, and is really of so much importance, that in order to its illustration we have had plans and sections of the various classes of stables prepared, to which we proceed to refer. It is only by a careful comparison of these plans that the requisites for stable ventilation, and the relation in which it stands to the form of construction, can be understood.

Plan I. gives a plan and section of the old troop stables at Hounslow. Each stable is 27 feet 10 inches wide. It is 40 feet long and 11 feet high, and contains 16 horses arranged in two rows, with about 70 square feet and 770 cubic feet per horse. Over the horses there is a flat closed ceiling of about 1,100 square feet, with men's rooms over. The only means of ventilation are doors, windows, and openings in the walls opposite each other, at a distance of 40 feet.

The stalls are arranged with their heads to the walls dividing the stables from each other, leaving a central passage between the stalls. There are only four stalls, those at the corners, which afford anything like a supply of fresh air for the horses. Each successive horse from the corners to the centre is supplied with air fouled more and more by the other horses. The air in these stables, notwithstanding their open position in the country, was extremely offensive, and cannot be otherwise than injurious to the health and stamina of their occupants.

The causes of so impure a state of the air in this stable are evidently,—1. the general plan and arrangement of parts; 2. want of height to correspond with the distance between opposite doors and windows; 3. deficient cubic space and superficial area per horse; 4. impossibility of renewing the air, except at the ends of the stable; 5. bad paving, and defective surface drainage consequent on it.

Plan II. shows the old troop stables at York. The arrangement is the same as at Hounslow. Each stable is 40 feet long from door to door, 28 feet 4 inches wide, and 10 feet 6 inches high. The superficial area and cubic space per horse are also similar. The stables are lower in the ceilings, and the ceilings are closed by the men's rooms above.

These stables have been improved in their ventilation by shafts carried up from their ceilings above the roofs, but their construction is radically bad, and the air in them can never be sufficiently pure.

Another similar example is afforded by the Aldershott troop stables. Plan III.

These stables are better paved and drained than the others. There is also an air channel carried along each division wall to admit air to the stalls close to the floor. Each stable is 30 feet wide by 39 feet 8 inches long between the opposite doors and windows, and 12 feet high. It contains 14 horses, allowing 85 square feet and 1,020 cubic feet per horse.

The ceilings are all closed, and have men's rooms over them.

One of the stables we examined had been ventilated by shafts and inlets, on trial. The results were carefully noted, and found to be unsatisfactory. Additional shafts and inlets were then provided, but without producing the results anticipated. The only dependence for anything like efficient ventilation in this case is on keeping the doors and windows open, or on the introduction of a wire grating instead of glass in the windows.

Here then we have stables of the old construction with closed ceilings, situated in the open country, better paved and drained than usual, and affording considerable space for each horse, having besides two sets of ventilating shafts carried from their ceilings above the roof, and still the ventilation by no means sufficient.

Perhaps the worst examples of this class of stables are at Woolwich. Plan IV.

They are double, and have two floors of men's rooms over them. The distance between the opposite doors and windows is no less than 65 feet, and there is a division wall, with arches, carried across the stable midway between the ends. These stables have been provided with shafts and inlets, but the air was extremely foul when we were in them. None of the horses, except those in the corner stalls, have any chance of obtaining a supply of fresh air.

The only stables of the whole class in which the air was tolerably pure were those in the new Kensington Barrack. Plan V.

Each stable in this barrack is 30 feet wide by 34 feet long between the opposite doors and windows, and 15 feet high. It contains 12 stalls, affording 85 square feet and 1,275 cubic feet per horse. In this stable an air shaft with openings into each stall is constructed close to the floor in the wall between every two stables. Other two shafts carried under the floor supply air to the pillars between the stalls. These pillars are hollow, and have perforations for allowing the air to enter the stable 3 or 4 feet above the floor. Foul air shafts have been provided in the construction. They open on the flat of the ceiling, and are carried up in the walls to the parapet of the roof. The window space is larger in proportion to the number of horses than in any other similarly constructed stable.

The better condition of the air in this stable is due to better construction, shorter distance between the opposite doors and windows, the latter of which are of large dimensions, and were open when we inspected the stables, greater height, larger space per horse, and better paving and surface drainage. The stable was besides perfectly clean, and there was no litter in it.

In all stables of the class we have been describing the only reliable sources of pure air are the opposite doors and windows. The shorter the distance between the opposite doors and windows, and the smaller the number of horses placed between them, the fresher is the air.

There is at York a recently-built stable of a new class, in which, while the closed ceiling and men's rooms over are preserved, the stalls are arranged longitudinally instead of transversely, so that there are only two horses between the opposite doors and windows, instead of six, eight, or more, as in the examples we have already given.

A plan and section of this stable are shown in Plan VI.

The structure is supported on arches, and is open from end to end. It is in truth one single stable, 334 feet 6 inches long and 35 feet wide between opposite doors and windows. Its height is 12 feet, and it contains 102 horses, half on each side of a long central arched division wall. The superficial area per horse is upwards of 100 feet and the cubic space above 1,200 feet.

The ceilings are closed and fire proof, and ventilating shafts are carried up in each division wall; these, with opposite doors and windows, are the means of ventilation. The paving and surface drainage are on the most recent improved plan, but there are cesspits within the stable. We could hardly judge of the ventilation of this stable, as it was only half occupied, but the advantages likely to arise from having only two horses between the opposite windows are obvious enough; the disadvantage, when the experience of the other stables is taken into account, is the closed ceiling with men's rooms over.

This stable was darker than the open roofed stables, partly from a projecting terrace over the windows along one side, used as means of access to the men's rooms above.

On plan V. there is a plan and elevation of a similar stable for 56 horses proposed to be erected at Colchester.

We have had an opportunity of examining another class of stables constructed upon a totally different principle from those we have described.

Examples of these exist at Hounslow, Aldershott, Colchester, and York.

The characteristic distinction in those stables, in which they differ essentially from all the others, is in their being constructed with open roofs with light and ventilation along the ridge, besides having opposite doors and windows. They differ somewhat in points of detail, but they all have ridge ventilation.

We have selected two examples as illustrations of these stables:—the open roof stable at York, Plan IV., and the open roof stable at Colchester, Plan VII. Both are lighted and ventilated from the roof, but they differ in the arrangement of the stalls.

In the York example, Plan IV., the stalls are arranged with the heads to the outer walls, and one central passage between them.

In the Colchester example the stalls have the heads towards a central division wall on which the roof is partially supported, and there are two passages, one on each side between the back of the stalls and the outer wall.

The York stable is 173 feet long by 29 feet wide. It contains 60 stalls. The height to the spring of the roof is 10 feet 6 inches. The superficial area is about 83 square feet, and the space, including the roof, upwards of 1,200 cubic feet per horse.

There is a swing window for every two stalls on opposite sides, one door on each opposite side, and one door and two windows at each of the opposite ends. The ridge is raised all the way along for ventilation, and a strip of the roof extending from end to end is of glass.

The central passage between the opposite stalls is 10 feet wide, which is not sufficient. The paving of this stable is not so good as could be desired, but the chief defect is in the use of cesspits placed at the heads of the underground drains within the stable. Making allowance for the defects in paving and drainage, the York stable, although full of horses, was well ventilated, light and cheerful; every horse and man in it could be seen at once, and the horses looked in remarkably good condition.

The Colchester stable, Plan VII., was unfinished. It is intended for 56 horses, 28 on each side the central division wall, with a passage 7 feet wide between the back of the stalls and the outer wall. It is 177 feet long, 34 feet 2 inches wide, 10 feet 6 inches high to the spring of the roof, which is open. Each horse in this stable has 108 superficial feet and 1,674 cubic feet. It has ridge ventilation, ridge lighting, and side windows, one for every two stalls.

The stable of corresponding construction which we had an opportunity of examining at Aldershott was occupied, and the ventilation and lighting were both good, and afforded a marked contrast to the condition of the other troop stables we examined at Aldershott.

These plans, if carefully studied, will readily account for the comparative state of the air in each class of stables, and they will enable the relation which exists between stable construction and ventilation to be easily understood.

No one with a knowledge of the laws of health could have made such an examination as that in which we have been engaged without being strongly impressed with the necessity of a more extensive knowledge of these laws being rendered available for the public service. The older class of cavalry stables, although quite as good or perhaps better than many private stables of the same date, can be described only as contrivances for subjecting horses to the necessity of breathing air contaminated with their own excretions.

Many animals would inevitably perish under such treatment, but for two things, their daily exercise in the open air, and a certain habit which their constitutions acquire of resisting air-poisons by continued exposure to their action. This resisting power of habit, in its nature conservative of animal life, can only be trusted to temporarily, because it inevitably leads to loss of health and life in the end.

The proof of its importance is the well-known fact that horses will bear sudden removal from a close hot stable to a cold pasture or hill side without danger; but after they have been accustomed to fresh air, they cannot be suddenly brought back to an unwholesome stable without immediate danger. At this time of change, colds, inflammations, and glanders are very apt to show themselves, and great losses have occurred in consequence.

In a well-ventilated stable such things should not happen. It is true that the air of a stable can never be made as fresh as the open air; but it is quite within the limits of possibility to adapt the principles of healthy construction to all new stables, so as to supply the horses with what is practically a wholesome atmosphere both by day and night.

The older stables we have examined can be more or less improved in their ventilation, although it is to be feared that some will always be of an inferior description, whatever is done with them.

In following up this part of the subject our enquiry has enabled us to arrive at certain principles, which, in our opinion, ought to be applied in the ventilation of all cavalry stables.

These principles we shall next proceed to discuss under separate heads:—1st. as they are applicable to the construction of new stables; 2d. as they ought to be applied to the ventilation of existing stables.

It has not yet been ascertained how much fresh air a horse requires to keep him in health. Such an inquiry, although of great value when warmth has to be combined with ventilation, is of little comparative importance as applied to stables, because the horse is not an exotic animal requiring artificial warmth. He is taken from a perfectly open-air life, with its vicissitudes of weather and temperature, to be confined, more or less, in a stable for purposes quite apart from his health. The real question at issue is, indeed, how to subject the horse to the captivity he has to undergo in serving man, without injuring him in his health and strength.

It is only by keeping this object steadily in view that we can arrive at a thorough understanding of the conditions required in stable ventilation. Although all animals have a certain power of adapting themselves to the conditions in which they happen to be placed, it must be evident that the example of nature should be followed as far as possible, and that the natural conditions she has provided should be taken as the model to be aimed at in the change.

Animal life is most perfectly developed and its functions are most perfectly performed, under the conditions of free diffusion of the atmosphere, including absence of stagnation, abundance of light, good drainage, absence of nuisance, and sufficient space to live in.

These are the conditions (besides of course food and drink) which nature has bestowed on the horse.

Good stable ventilation includes these conditions, because if the stable is filthy or ill-drained, or the ground saturated with putrid urine, it must be obvious that no amount of fresh air passing through the stable will keep it sweet or wholesome. Any amount of fresh air coming in will immediately be tainted by filth which ought not to be there.

Again, if a stable be ever so clean or well drained it will never be well ventilated without perfect freedom of movement of air through every part of it, together with free ingress and egress of air so provided as to prevent hurtful blasts falling on the horses.

In applying these principles we find,—

1. A fundamental improvement required in all stables we have visited is improved paving of such a character as to wear well, not to become slippery, to be water-tight, and to be easily cleansed. We were glad to learn that there is a committee appointed to inquire into this very important subject.

2. Another fundamental improvement required is good stable drainage. We object altogether to cesspits being placed either within or immediately outside the stable doorss Those which we have seen are receptacles of the foulest description, producing the most pestilential state of the air. Our objection to these cesspits extends to all sewers or covered drains within stables, which are merely cesspits of another form.

Surface drainage is the only kind of drainage applicable to the interior of stables.

The drains, like the stable floors, should be impervious to moisture. Cobble stones and paving stones should never be used for forming stable gutters. These should always be made of smooth material, with as few joints as possible:—carefully laid, having a shallow saucer-shaped section, and with as rapid an incline as it is possible to obtain. They should pass behind the line of stalls, as at present, and be conducted in as straight a line and by as short a course as possible to the outside of the stable, where they should be discharged into an underground drain (which should be a drain pipe), at a distance of at least 12 feet from the stable wall.

As the surface drains always receive a considerable quantity of dung besides urine and water, it would be advantageous to provide a trap at the openings of the underground drain to prevent effluvia returning, and to avoid stoppages.

3. The most scrupulous cleanliness of the surface of the stable should be enforced.

These measures for improving the paving, draining, and cleansing of stables would remove, as far as practicable, those surface impurities which interfere so greatly with the present ventilation. As already stated they are more or less required in all existing stables, and they should be provided for in all to be hereafter constructed.

Suppose these measures attended to, we should be in a position to deal satisfactorily with the provision of fresh air, at least in new stables; but unfortunately in all the older class of stables this can only be done in a very imperfect manner.

## 2. Plan and Construction of Stables best suited for ensuring good Ventilation.

In constructing new stables the great principle which ought to be kept in view is to have the air moving freely through every part of them, above and around the horses when they are standing, and in all the angles between the floor and walls when the horses are lying down, and every horse should have sufficient ventilation for himself without being obliged to breathe the foul air of his neighbours. These conditions would be most completely obtained in an open shed, such as is used for stabling horses in warm climates, and the nearer we can approach to this construction, keeping in view the necessity for protecting horses in this climate, while at rest, from extreme cold and cold blasts of wind, the healthier will be the stable.

There are certain forms of construction which are precluded by this principle, and which ought not to be repeated in future stables.

The worst of these is the old construction we have described, of placing the men's rooms over the stable space, and dividing the space transversely by walls into a number of separate stables having each two rows of horses with their heads to the division walls, and the windows and doors at the ends.

The most cursory examination of such a stable is sufficient to show that only the four horses in the corners can be supplied with fresh air under the conditions we have pointed out. All the others have very foul air to breathe.

We beg to recommend that this method of construction be in future abandoned, as inconsistent with ventilation and health. All existing stables of this class can be some what improved in the manner we shall recommend, but the construction is so opposed to sound principle that it ought not to be repeated.

One of the most important points in our inquiry has been into the effect on its ventilation of placing anything except the roof over the stable. We are aware that there are differences of opinion on this point, but, after careful consideration of the examples of various classes of construction, we have arrived at the conclusion that there is a considerable difference among them in degree of efficiency in the ventilating arrangements, and also in the possibilities of ventilation, and that beyond a doubt that form of construction which affords the maximum of facility for obtaining a free moving atmosphere throughout the body of the stable is the open roof with ridge ventilation carried all the way along.

Where the roof of the stable is not open, but flat and impervious, the distance between the effective ventilating openings, whether windows or other apertures, corresponds of course to the breadth of the stable. But with an open roof and ridge ventilation the distance is reduced to one half, while the difference of height above the ground between the ridge opening and the side windows ensures, according to a well-known

law in pneumatics, a far more certain and continuous movement of the air than could by possibility take place with side windows above, unless a high wind were blowing.

For the same reason that the best ventilated and most healthy barrack-room is a hut ventilated along the ridge, a stable with ridge ventilation is the most healthy stable.

A flat impervious roof, a hay loft, or a barrack-room over a stable increases the difficulties of ventilation. Our object being to obtain the best possible ventilation for stables at the least cost, we cannot do otherwise than object to any of these constructions. As already stated, where such exist, the ventilation can be improved by methods we shall afterwards suggest, but in future the structure should be avoided.

In so far then as concerns the general movement and renewal of the mass of air in a stable, the form of construction which effects this most easily and efficiently is an open-roofed stable, with ventilation along the ridge, swing windows along the sides, and a continuous inlet for fresh air under the eaves made of perforated brick, so arranged as to throw the entering currents up towards the roof.

A great incidental advantage of the open roof should not be overlooked, and that is the facility with which it enables the stable to be thoroughly well lighted. Light is in its place as essential to health as air, and moreover, when introduced vertically from the roof, it enables the state of cleanliness of the stable to be seen at once, while the conduct of every man in the stable can be seen from a considerable distance.

These advantages struck us forcibly in comparing the different classes of stables.

Stables without open roofs have no natural means of renewing the mass of air in the stable, except by opposite windows or doors, or by apertures made in the walls. When these are properly used, and when a wind is at the same time blowing more or less directly against the side wall of the stable, the air within can no doubt be kept in a certain state of wholesomeness. But if there be no such wind there will be always more or less stagnation, on account of the distance between the opposite windows and doors. The simplest and least expensive way of diminishing this risk is by carrying foul-air shafts from the ceiling of the stable up through the apartments above, and so to the roof. When these shafts are properly made, the action of the law of difference of temperature occasions a more or less constant movement upwards, to compensate which fresh air enters the stable, and so the amount of stagnant air is diminished.

We have examined a number of stables in which these shafts have been introduced. The state of the air we found to be better in some than in others, and much better no doubt in all than it would have been in the absence of the shafts; but the results generally show that it is a mistake to construct stables on a plan which renders such shafts necessary. There is no doubt an additional movement of the air effected by them, but it is questionable whether any practicable size of shaft would ventilate such stables sufficiently. The results rather tend to show the bad character of the construction of the stables.

As regards light hardly any of the close-roofed stables are sufficiently lighted. Some are better than others, and the best lighted are those which contain the smallest number of horses, and have the greatest height on account of the windows permitting the light to fall at a higher angle. But they are all very much inferior in this respect to open-roofed stables partially glazed.

Besides providing for free movement of the mass of air within the stable, it is necessary in all stables, but in some much more than in others, to supply fresh air near the ground level at the head of each stall, so that the horse may have fresh air to breathe when he is lying down.

The reason of this necessity is that in all stables the stratum of air next the floor level is the most impure, and will always be the most impure under any improved conditions of drainage and paving. Besides this, the horse, in lying down, places his head close to the angle between the floor and the wall where the air is stagnant.

The necessity of providing a slight air current at this angle has been recognized in recent stables, otherwise of a defective structure. It is done by a shaft in the wall carried from end to end of the stable, and communicating at both ends with the outer air. There is an air brick with a sliding cover communicating with this shaft for each stall, at 6 or 8 inches from the ground, through which the air is admitted.

We propose to extend this improvement to existing stables by having a shaft carried from outer air to outer air under the cribs. In all stables where the horses heads are not placed against the outer walls, these shafts should have at least double the section per horse of those at present in use for transverse stables.

In stables where the horses' heads are placed against the outer wall these horizontal air shafts would not be necessary; simple openings, and air bricks in the outer walls, would be sufficient.

Perhaps the best place for these openings would be between the stalls, where they would be less likely to occasion draughts on the horse during high winds. They should consist of small perforated bricks, or of bricks so made as to throw the air current downwards to the floor. Two or three such bricks in line would be sufficient for each stall, and they should be placed about 6 inches from the floor.

In stables with the horses' heads to the outer walls one such brick per stall would be sufficient. It is an incidental advantage of this method of arranging the stalls that it admits of greater facility of this under-ventilation than any other form of stable.

It follows from what has been said that the easiest and most efficiently ventilated stable is the open roof partially glazed, with ridge ventilation all along, ventilation at the eaves, a swing window per stall, and the horses' heads turned outwards, with a proper air brick in the outer wall introduced 6 inches from the ground between every two stalls. We were very glad to find that stables with open roofs are coming more into use. As already stated we found them in use at Aldershot, Colchester, Hounslow, and York for officers' stables, troop stables, and infirmary stables. The examples at the different stations vary in details, and in adaptation for their object. But taken altogether we believe that it is impossible to deny the great superiority they possess as healthy stable-construction over any form of the old close roof with barrack or other accommodation over the horses.

So far as concerns health, Mr. Wilkinson informs us that these open-roofed stables are free from sickness, while the old form of stable yields the usual amount of disease among the horses.

Believing that this point of construction must be considered as settled, we are very desirous that the improved principle should be thoroughly carried out, and we shall next state our impressions of the different applications of the principle we have seen. As already stated, two arrangements of stalls exist in the troop stables having open roofs. We have carefully examined these, with the view of estimating their relative advantages. In all these open-roofed stables, except in one at York, a partial wall is carried along the stable exactly under the ridge, and the heads of the stalls are placed against this middle wall, leaving the hind quarters of the horses towards the outer walls of the stable, with a passage about 7 feet broad between the stalls and the wall.

It was stated to us that this arrangement had been adopted for greater safety from injury, which is presumed to be less with one row of horses than with two. It occurred to us, however, that if the horses heads had been turned to the outer walls the same breadth of stable would have enabled a passage 14 feet wide to have been obtained between the opposite stalls ; an arrangement which would apparently have ensured greater safety than the other.

We propose that 14 feet be allowed as the breadth of one central passage, not only because of its greater safety, but because of the larger superficial area per horse, and the greater facility for stable work which it affords.

The central wall also interferes to some extent with the free ventilation of the stable, by obstructing more or less the movement of the air across it, while it makes no provision for introducing fresh air near the floor for the use of the horse when he is lying down. It would be more difficult and costly to introduce such a fresh air supply in stables of this construction, because the central division wall has a passage between it and the outer end walls of the stable, and the only way to meet the difficulty would be to carry an air shaft under the end passages to the wall, and then along the wall. The usual openings for each stall would have to be made from the air-shaft. If this class of stable is to be extended this point would have to be looked to in new plans, and it would be very desirable to carry a course of perforated bricks all round the outer wall a few inches above the ground, and a similar course all round under the eaves.

It struck us that stables with these division walls were not so light as the open-roofed stable at York, having the central passage. There is a great difference also in the facility of supervision afforded by the two classes of construction. The open-roofed stable, with its light central passage, enables every horse and man to be seen at a glance, which is certainly not the case with the other form.

Both stables are good, and either of them is a great advance on any other existing form of construction, so far as concerns their ventilation ; but that form of construction which appears to us to combine the greatest facilities for effective ventilation, with light, facility of supervision, and economy, for troop stables, is the open-roofed stable with the central passage.

We beg to conclude this part of our report on the form of future construction of troop stables best adapted for preserving the health of horses with the following recommendations:

1. That the old transverse arrangement of stable be discontinued.
2. That in future all troop stables be built with open roofs and ridge ventilation from end to end.
3. That the roofs be partially and sufficiently glazed to afford plenty of light.
4. That in so far as concerns facility of ventilation and supervision, the open-roofed stable, having a central passage 14 feet in width between the stalls, is preferable to the open-roofed stable with a centre division wall and two passages, each of half that width.
5. That besides ridge ventilation and light, each stall should be provided with a swing window over the horse, and a row of perforated bricks should be carried round the stable under the eaves.
6. That each stall should have a supply of fresh air introduced in the space between the stalls, about 6 inches from the ground through perforated bricks.
7. That improved impervious paving be introduced.
8. That all drainage within the stable be carried away in shallow impervious open drains by a rapid slope to the outside of the stable. Covered drains and cesspits within stables or near the stable walls to be discontinued.

### 3. Model Plan of a Stable.

In order that these principles of construction may be better understood, we have had a model plan (Plan VIII.) prepared embodying them, to accompany this report.

The plan is that of a stable for 48 horses under a single roof. The interior length of the building is 143 feet 8 inches and the breadth 33 feet. The height of the side walls to the spring of the roof is 12 feet, and the total height is 20 feet 6 inches. Each horse will thus have 1,605 cubic feet and about 100 superficial feet of space. There is a door opening in halves and two windows at each opposite end, and a door opening in halves on each opposite side.

The stalls are of the usual width of 5 feet 6 inches, and there is a central passage 14 feet wide between the opposite stalls.

This stable is ventilated by a louvre 16 inches wide carried from end to end of the roof, affording about 4 square feet of ventilating outlet for each horse.

To ensure a continuous movement of the air in the stable at all times, a course of air-bricks is carried round at the eaves;—the whole affording a fresh air inlet of one square foot per horse, and an open space is left under all the doors for the same object. When a larger amount of ventilation is required, it can be afforded by opening a sufficient number of swing windows, of which one is provided for each stall. These windows are 3 feet 3 inches high by 2 feet 6 inches wide. To ensure a movement of the air near the horse's head when he is lying down, an air-brick is introduced between every two stalls.

These points, together with continuous roof lighting, improved paving, and carefully laid surface drains, will, if attended to, enable healthy stables to be built.

### 4. Ventilation of existing Stables.

The principles on which ventilating arrangements should be applied to existing stables are the same as those already discussed. We shall merely give a summary of them separately, for the sake of greater distinctness. It is essential to the possibility of ventilation in existing stables that the paving, draining, and cleansing should be good. There are many stables at present which cannot be supplied with pure air by any contrivance on account of the foulness of the surface, and until thorough cleanliness is rendered possible by good paving and drainage, these stables will never be wholesome.

The drains behind the stalls in this class of stables should always be carried out in a straight line, and not curved to one side.

All cesspits within existing stables, or immediately outside the stable doors, should be abolished, and the drainage improved.

Suppose these improvements to be carried out, we would propose to ventilate the stables in the following manner:—

1. For troop stables of the old transverse construction, represented on Plans I., II., III., we recommend that shafts for removing the foul air be carried up from the ceiling of each stable to above the roof. These shafts would be most conveniently introduced

at each corner of the stable, but where practicable the most efficient place for them would be towards the middle of the length of the stable. Their conjoint area should be equal to 18 square inches per horse at the least. We have limited the area of the shafts on account of practical difficulties in their construction.

We propose that sufficient fresh air to supply the shafts be introduced by openings close to the ceiling, two at each end of the stable. Each shaft and inlet should be provided with a louvre or spreader within the stable, to prevent occasional down draughts on the horses. There should be as many air-bricks introduced at the ends, close to the ceiling, as can be done. An improved air-brick with a louvre to throw the air upwards is a desideratum in stable ventilation. Either a portion, or the whole of the glass should be removed from the window frames (according as the stable is more or less exposed to winds) and wire grating introduced instead.

A general want in the worst class of stables of this kind is more window space. This should be given as far as practicable. In these stables also the door should not fit close below. A space of two or three inches should be left between the bottom of the door and the sill, to increase the movement of the air.

To supply air to the horse in stables of this plan while lying down, it will be necessary to carry a shaft all the way across the stable, under the cribs, from outer air to outer air. Perhaps the easiest method of effecting this in stables where such shafts do not already exist, would be to have an iron shaft to fit into the angle between the transverse wall and the floor. There should be a number of holes in the shaft to admit fresh air at the angle between the floor and wall of each stall. The area of the holes should equal that of two or three ordinary air bricks. The holes should be placed from 6 inches above the floor and upwards.

2. In stables with a central division wall on Plans VI. and VII., where the horses' heads are turned towards the division wall, the ventilating shaft for supplying air when the horse is lying down should be carried from the outer air under the end passage, and then brought up, and carried all the way along under the cribs, to deliver fresh air between every two stalls, in the manner described above.

It would improve the ventilation in all existing stables of this class to introduce as many air bricks as could conveniently be done in the outer wall, behind the horses, at a short distance above the floor. But, as already stated, in new stables of the same class, it would be better to carry a course of air bricks all the way along the outer walls, a few inches above the floor.

Additional air bricks should likewise be introduced at the top of the wall, close to the eaves or ceiling.

3. In stables with open roofs, having the horses' heads turned to the outer walls, an opening should be made for introducing fresh air between every two stalls, to supply the horse when lying down, in the manner shown in the model plan. It would further improve the ventilation in stables of this class to leave an open space for air below each door.

### 5. Infirmary Stables and Loose Boxes.

We have inspected several of these stables at the stations we have visited. They are all on the same general plan. They consist of a number of separate stalls under a common roof, arranged in line, with the horses' heads to one of the outer walls, leaving a passage of greater or less width between the back of the stall and the opposite wall of the stable.

The usual arrangement is shown in Plan IX.

They are generally more roomy and constructed on better principles than the older stables. The paving, drainage, and ventilation are all better, and there is a more liberal allowance of space per horse.

In some points of detail they are still defective, and might be advantageously improved.

Infirmary stables should always have open roofs, with ridge ventilation carried the whole way along. They also require opposite windows. They should have a row of ventilating bricks carried along the wall behind the horse, a short distance above the ground. Each stall requires a single air brick, placed at the line of division between two adjacent stalls, to supply fresh air when the horse is lying down, and a course of ventilating bricks should be carried entirely round the stable at the eaves.

A continuous skylight should also be carried along the roof, as in other open-roofed stables.

The largest superficial area and cubic space per horse is given at Colchester, on which the model plan (Plan X.) of an infirmary stable accompanying this report is based.

The model plan (No. X.) shows an infirmary stable for 18 sick horses. The stable is 118 feet long, 21 feet wide, 11 feet high to the spring of the roof; the total height,

including the roof, being 17 feet. The superficial area per horse is about 137 square feet, and the cubic space about 1,900 feet. Each stall is 6 feet 6 inches wide. (The regulation width of stalls with partial divisions, viz. 6 feet is too narrow for any divided stalls). The stalls are 9 feet 6 inches long, and the passage behind them is 11 feet 6 inches wide. Ventilation is provided for by a louvre carried along the ridge; by a continuous course of ventilating air brick carried all round the stable at the eaves; by a course of air brick along the foot of the wall opposite the stalls, and by an air brick between the heads of every two stalls. For lighting and additional ventilation, when necessary, each stall has a swing window 2 feet 3 inches high by 2 feet 6 inches wide. There is also a row of windows in the opposite wall, and a continuous skylight along the roof. The paving and drainage are of the same kind as already proposed for the model stable.

For loose boxes the construction shown in the plan (No. X.) includes every requisite.

Each box is 17 feet by 12, and allows 204 square feet for the horse. The wall is 11 feet 6 inches high, and with the slope of the roof the cubic contents are about 2,700 feet. The partitions between the loose boxes should always be carried up to the roof.

Each box requires a louvre in the ridge, a ventilating course of brick under the eaves, an air brick close to the ground on the two opposite sides, and also opposite swing windows.

These requirements for ventilation have been the result of our examination of the loose boxes at different stations. In none of those we found occupied is the provision of fresh air sufficient.

### 6. Model Forge and Shoeing Shed.

We beg to call special attention to the excellent new forge and shoeing shed at York, of which we have given a plan and section (Plan X.) It is a model of its kind. The only improvement we have introduced in the plan consists of skylights and a low wall for shelter in front of the shed. With these alterations we beg to recommend that similar forges and sheds be introduced at other stations.

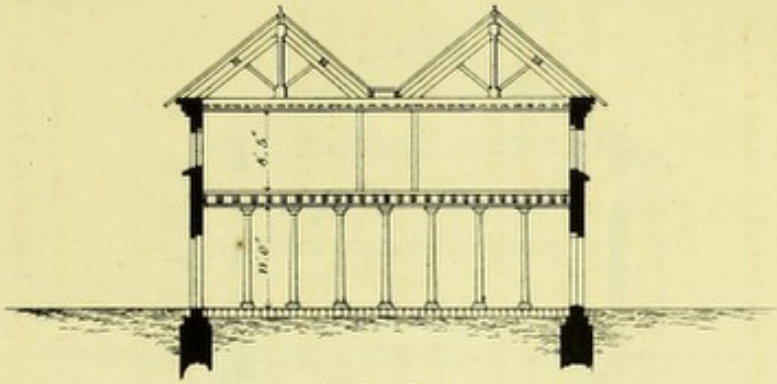
We desire to conclude this report with our acknowledgments to commanding and other officers for the facilities afforded us in our inquiries, and also to the Principal Veterinary Surgeon, for useful information and assistance. We are glad to say that he concurs with us in the views expressed in this report; and we are all of opinion that stables constructed on the principles we have laid down will improve the health and stamina of their occupants, and will be economical to the public service.

(Signed) Richard Airey, Q. M. Gen., President.
Douglas Galton.
John Sutherland.
T. G. Logan, Insp. Gen. of Hospitals.
Edward Belfield, Dep. Dir. Works.

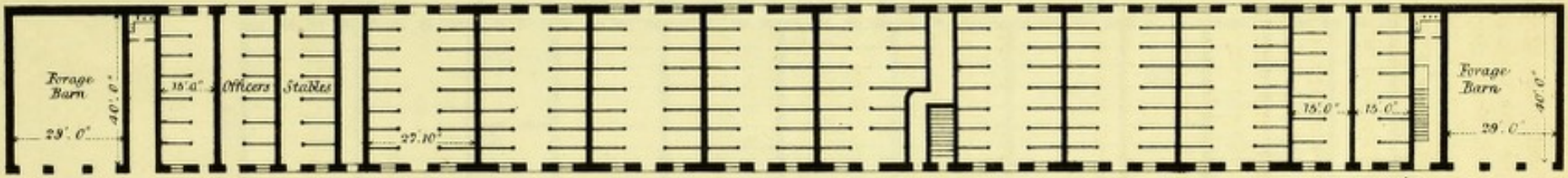
J. J. Frederick, Secretary,
War Office, 31st October 1863.

# HOUNSLOW BARRACKS

## TROOP STABLES




SECTION.



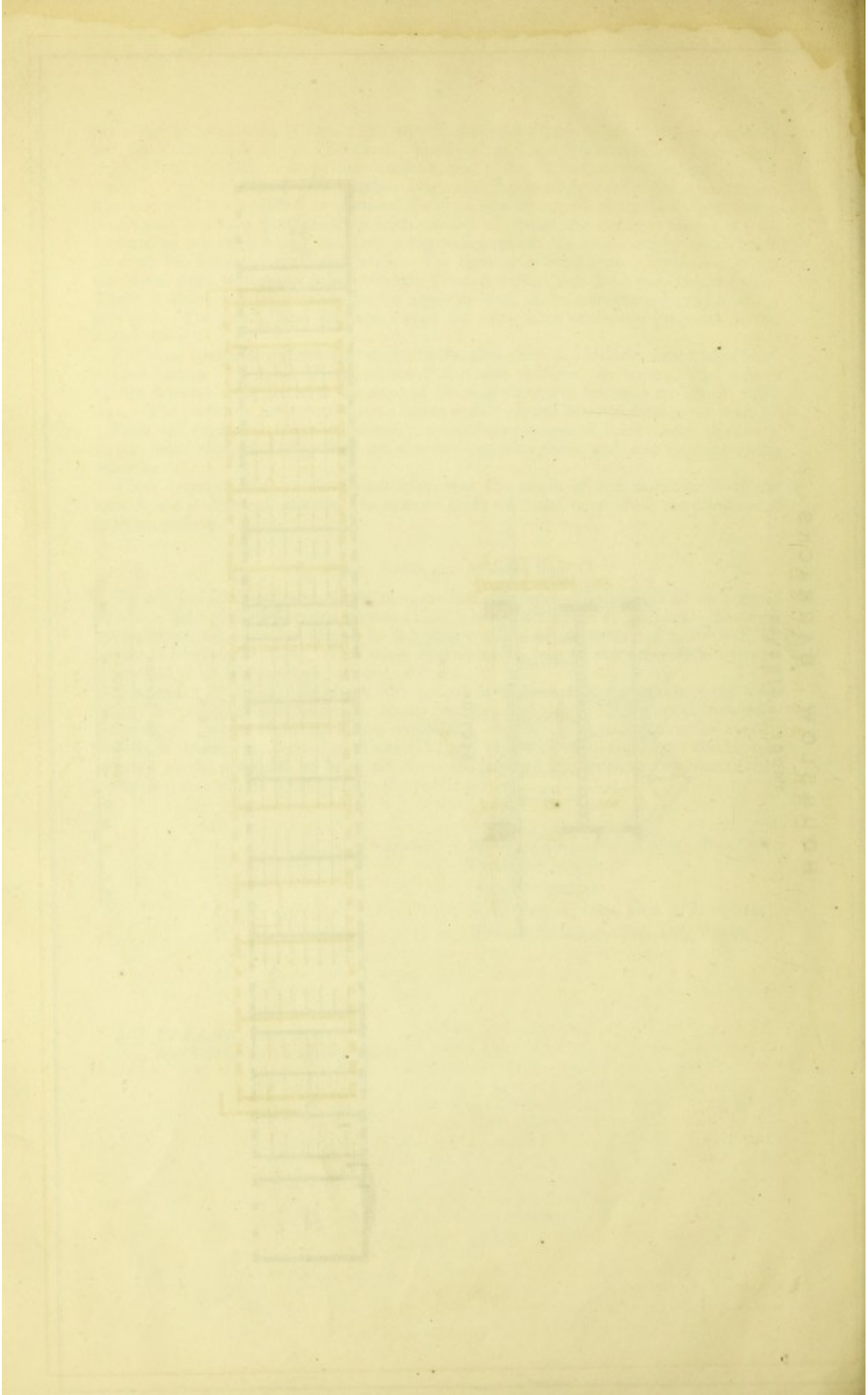

PLAN

SCALE TO SECTION.

0 5 0 10 20 30 40 50 FEET

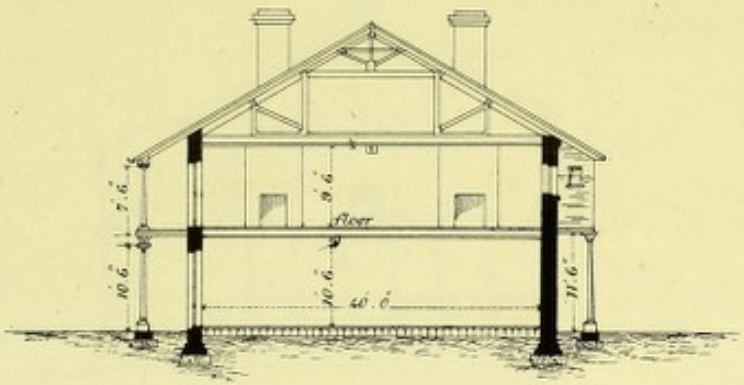
SCALE TO PLAN

10 5 0 10 20 30 40 50 60 70 80 90 100 110

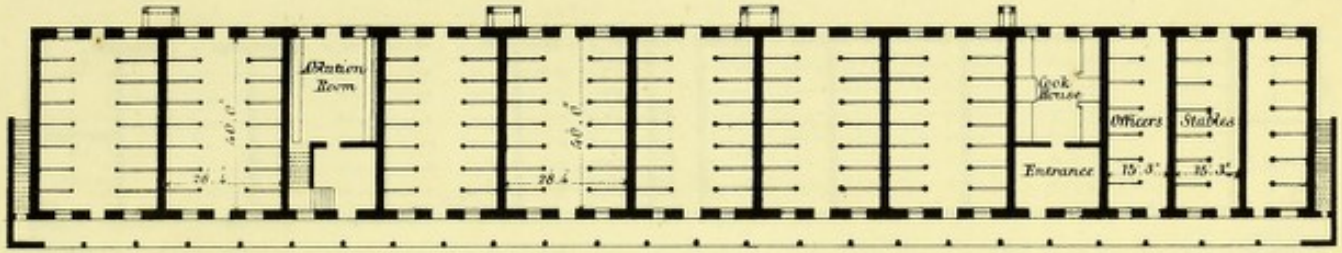


# YORK BARRACKS.

## OLD TROOP STABLES




SECTION




PLAN

SCALE TO SECTION.

10 5 0 10 20 30 40 50 FEET

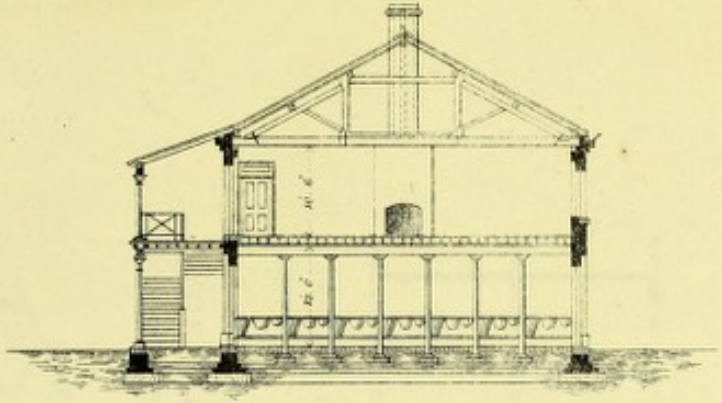
SCALE TO PLAN.

10 5 0 10 20 30 40 50 60 70 80 90 100 110 FEET

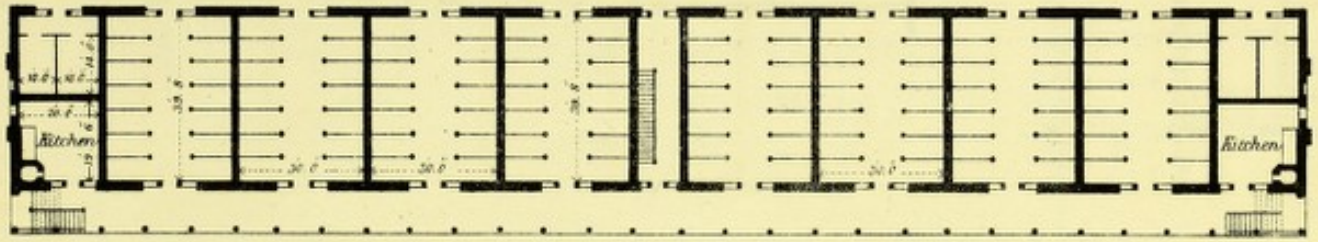
Day & Son Lith.rs to the Queen

# ALDERSHOT BARRACKS

## TROOP STABLES



SECTION




PLAN

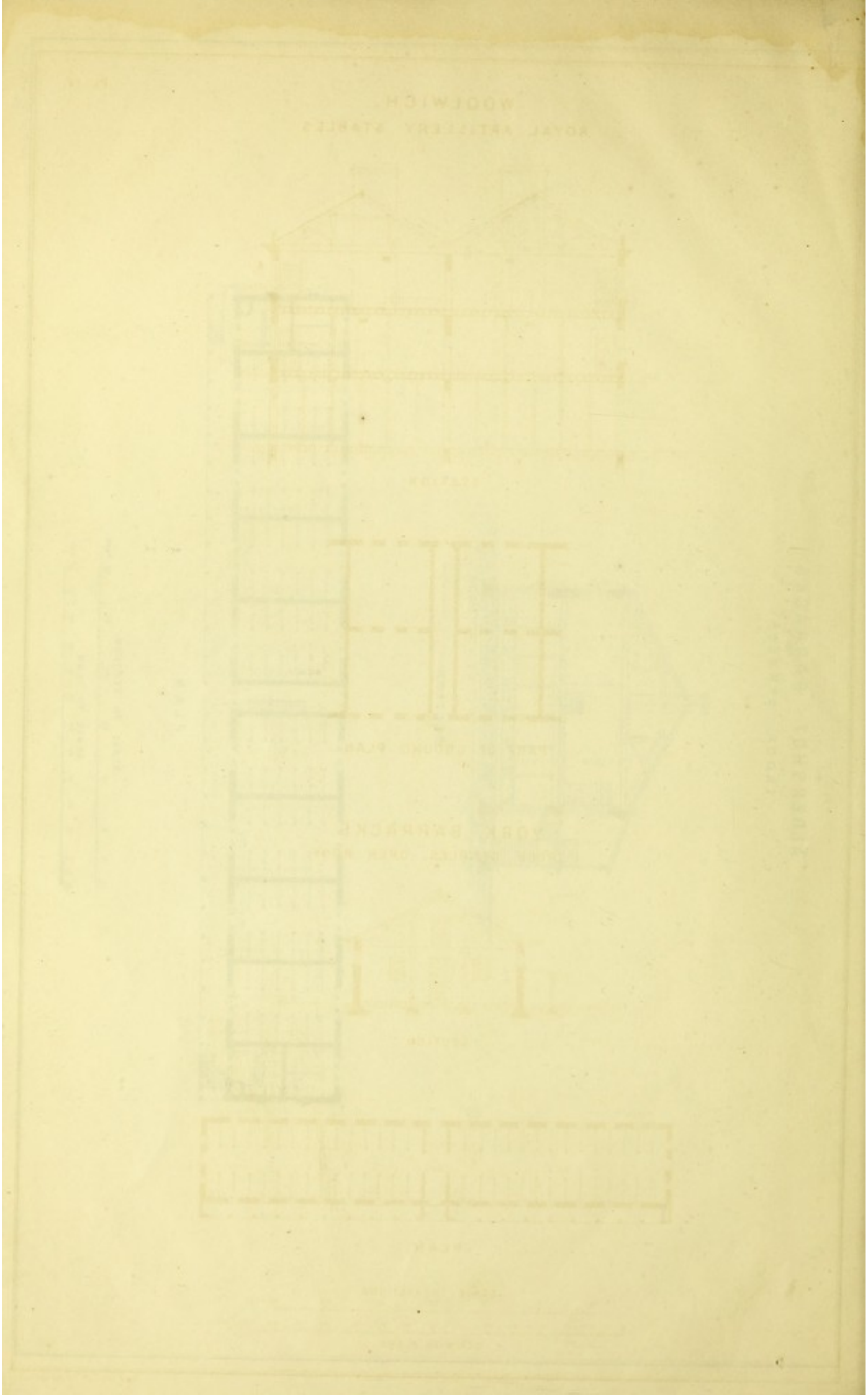
SCALE TO SECTION

10 5 0 10 20 30 40 50 FEET

SCALE TO PLAN

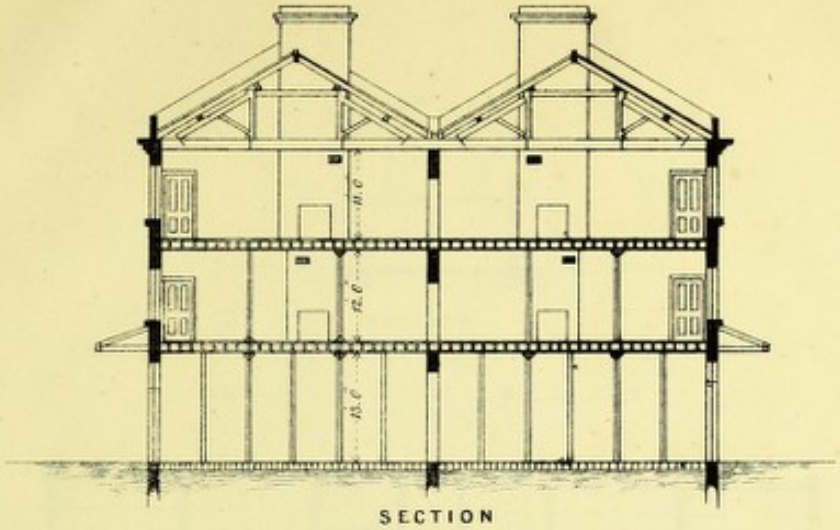
10 5 0 10 20 30 40 50 60 70 80 90 100 110 FEET

Day & Son Lith^rs to the Queen.

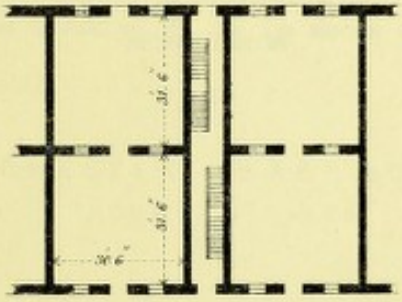


# WOOLWICH.

## ROYAL ARTILLERY STABLES.



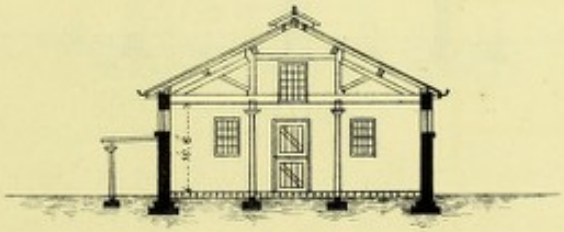
SECTION



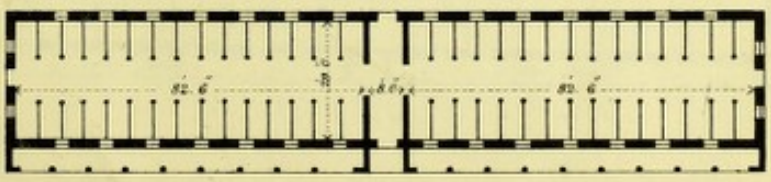
PART OF GROUND PLAN

## YORK BARRACKS.

### TROOP STABLES. OPEN ROOF.



SECTION



PLAN

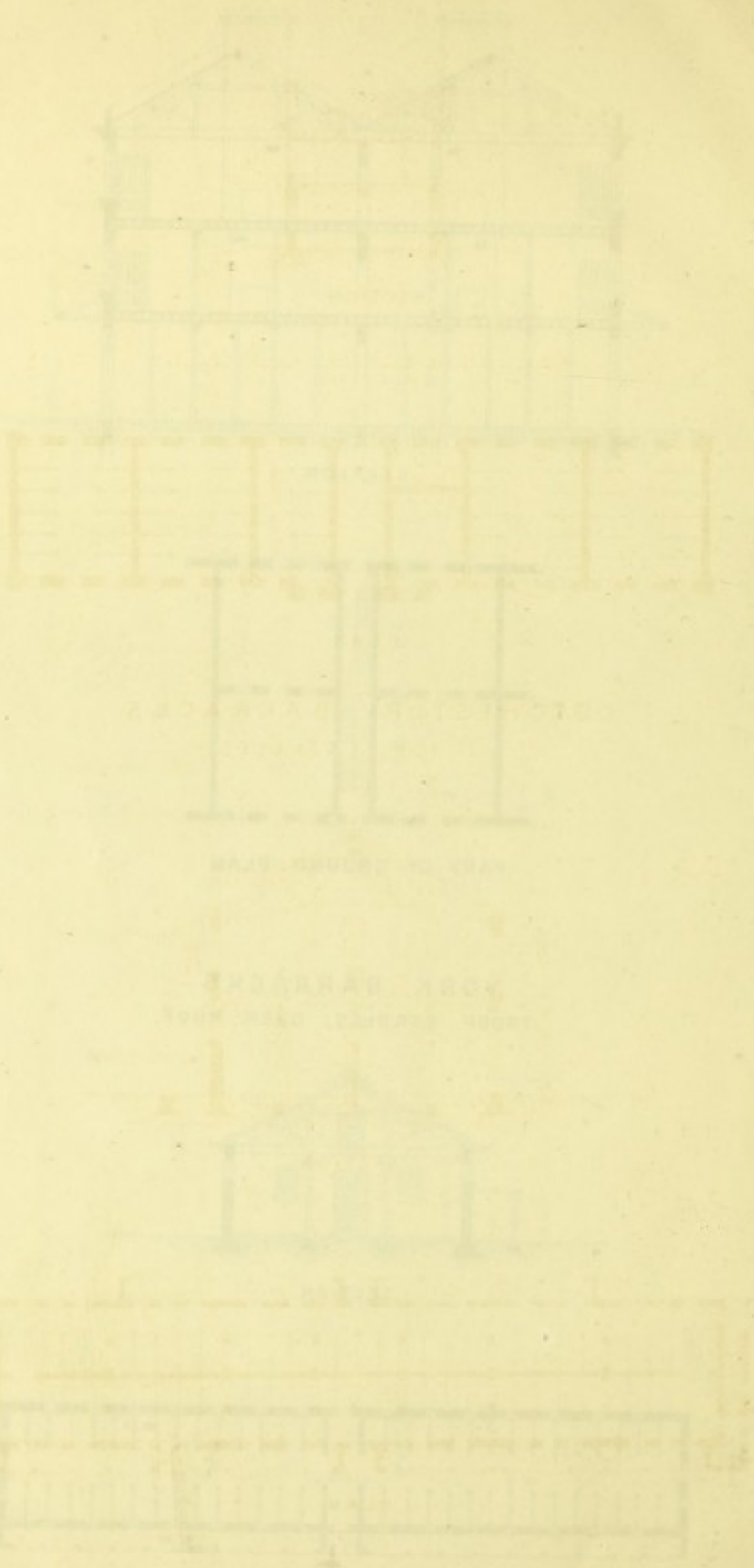
SCALE TO SECTIONS.

10 5 0 10 20 30 40 50 FEET

10 5 0 10 20 30 40 50 60 70 80 90 100 110 120 130 FEET

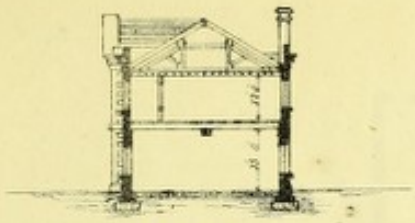
SCALE TO PLANS.

Day & Son Lith.rs to the Queen.

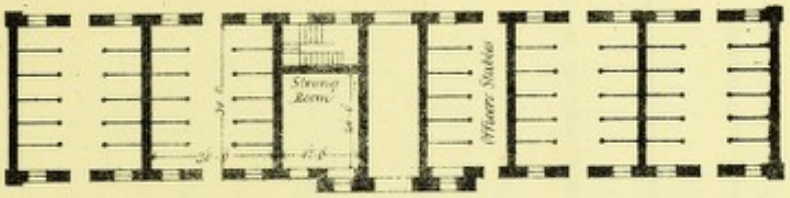


# KENSINGTON PALACE NEW BARRACKS.

## TROOP STABLES.



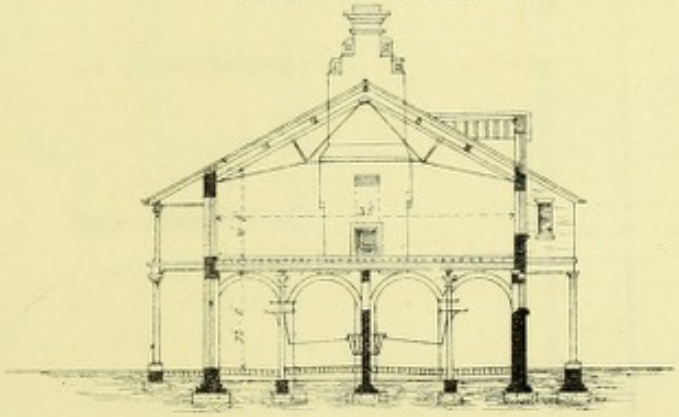
SECTION.

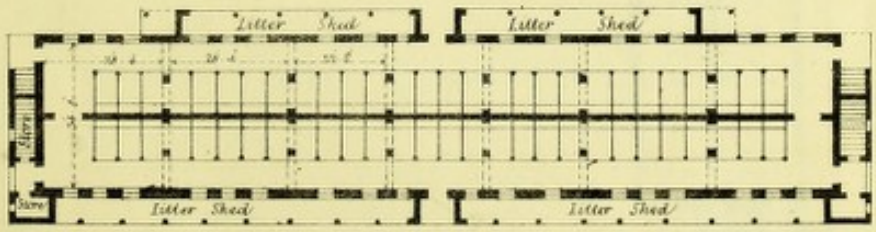

PLAN.

# COLCHESTER BARRACKS.

## TROOP STABLES.

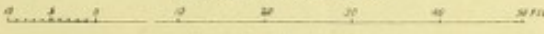


SECTION.

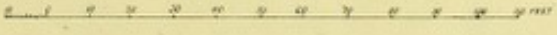



PLAN.

SCALE TO SECTION.



SCALE TO PLANS

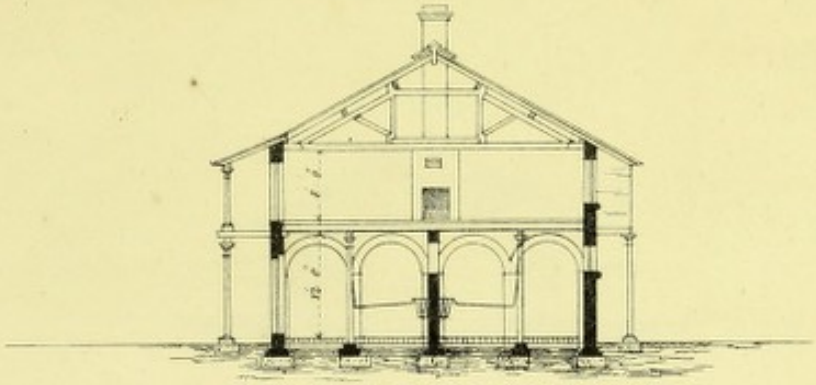


Day & Son, Lith. to the Queen.

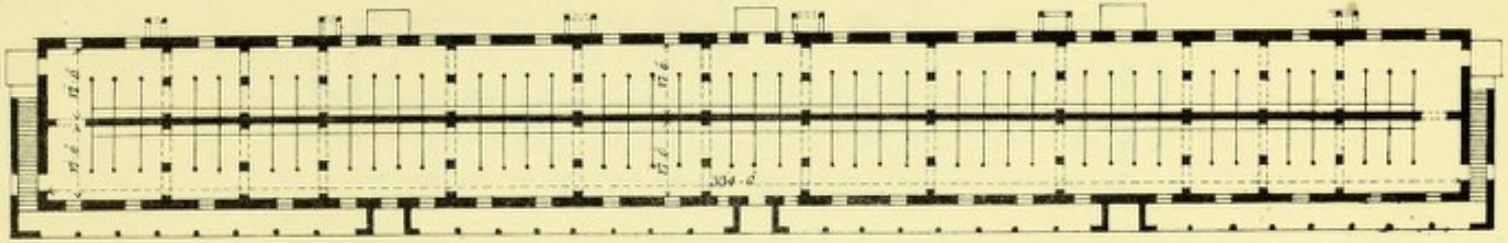
# YORK BARRACKS.

PL. VI.

## NEW TROOP STABLES.



SECTION.

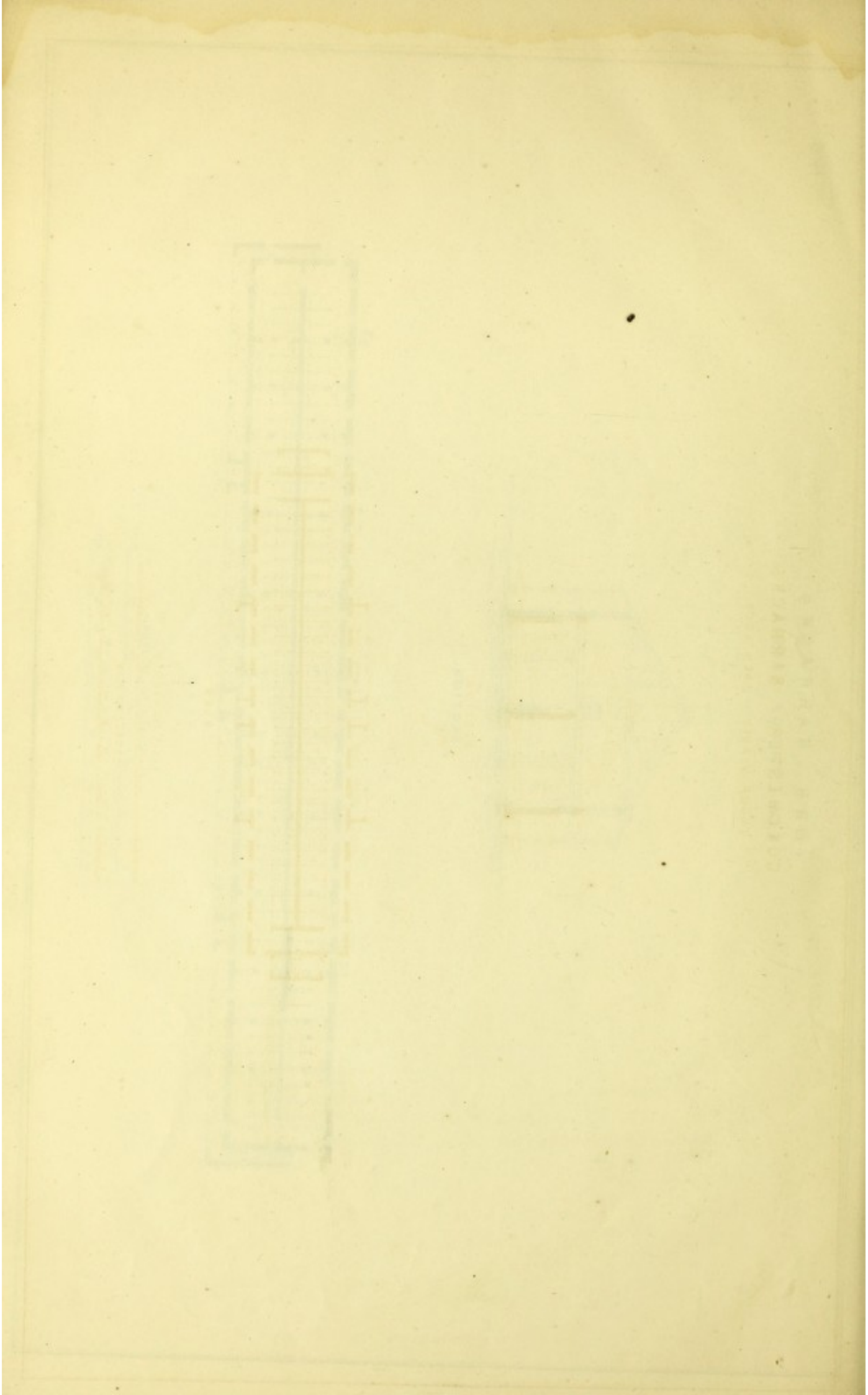


PLAN.

SCALE TO SECTION.

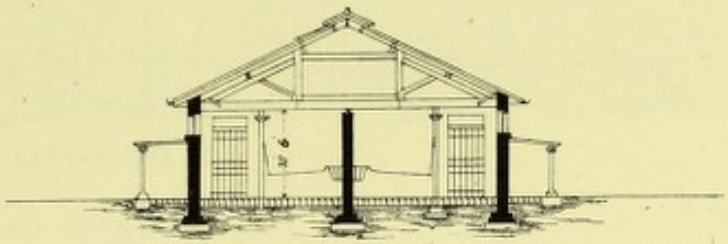
10 5 0 10 20 30 40 50 FEET.

SCALE TO PLAN.

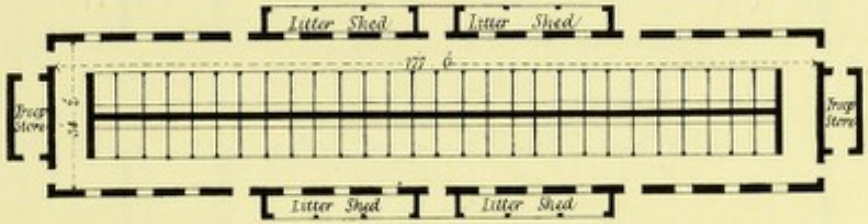


# COLCHESTER BARRACKS.

## TROOP STABLE OPEN ROOF.



SECTION.




PLAN.

SCALE TO SECTION.

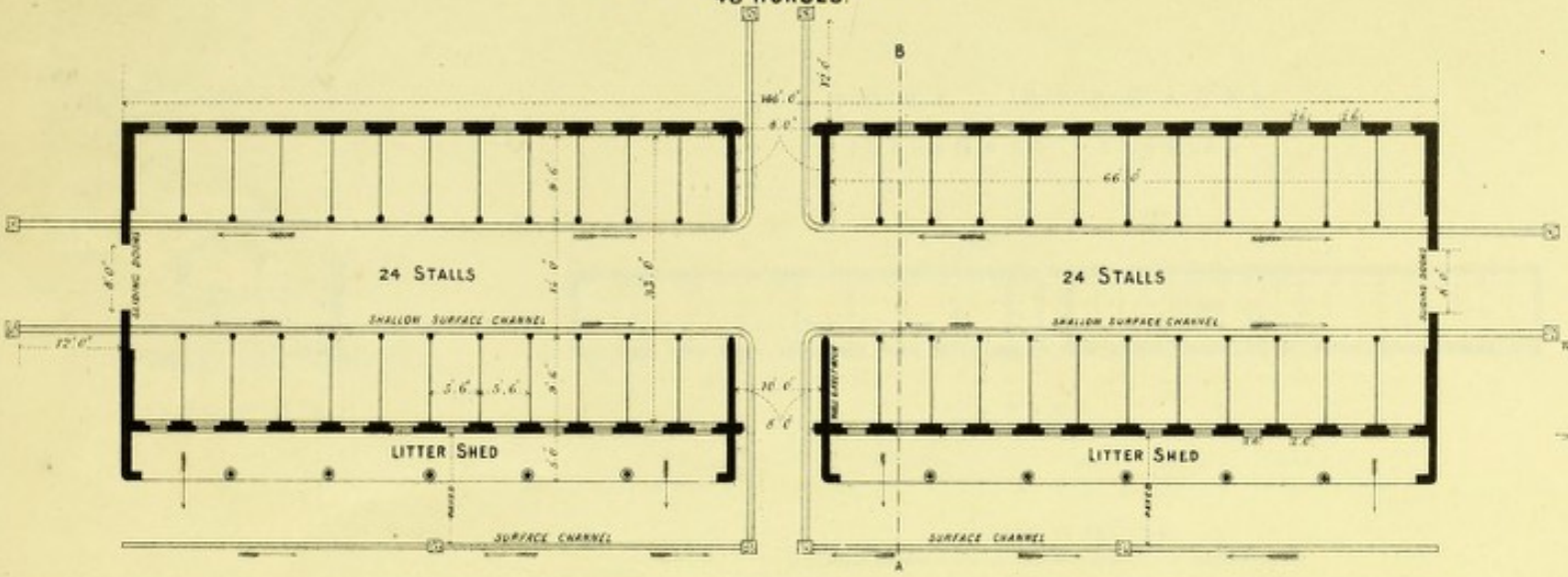
SCALE TO PLAN.

SIDE ELEVATION.

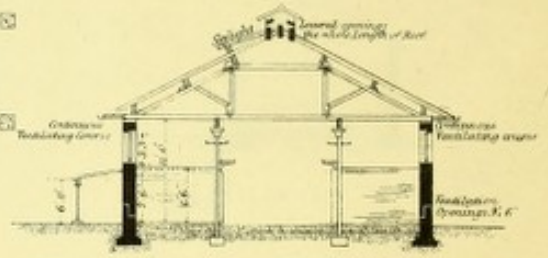
END ELEVATION.

# MODEL STABLE'S.

## 48 HORSES.

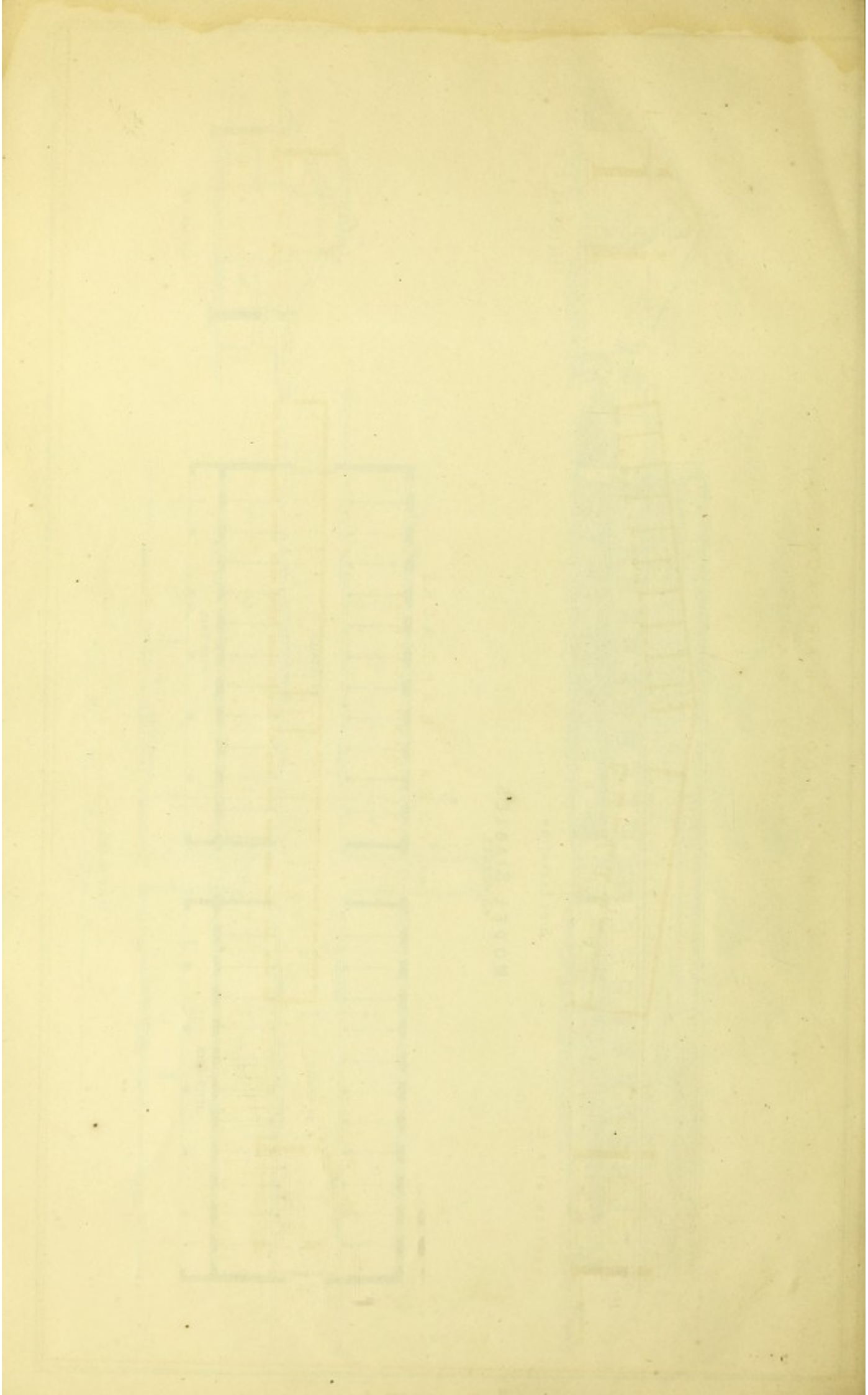



SCALE OF FEET



SECTION. A.B.

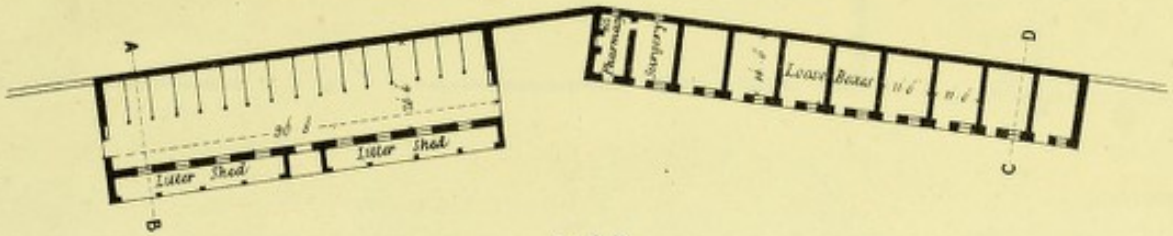
Day & Son. Lith.rs to the Queen.



# HOUNSLOW BARRACKS.

## INFIRMARY STABLES.

SECTION AT A. B.



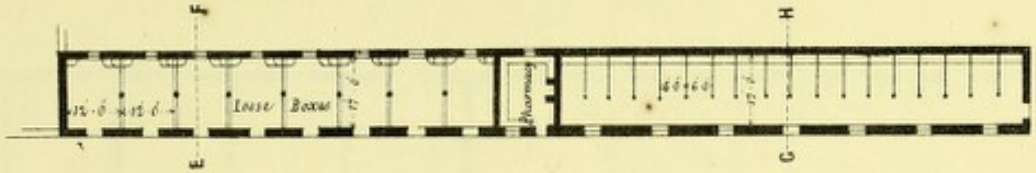

PLAN

SECTION AT C. D.

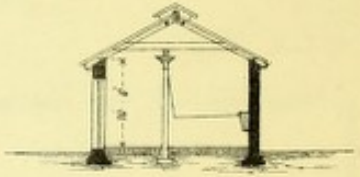
# YORK BARRACKS

## INFIRMARY STABLES

SECTION AT E. F.

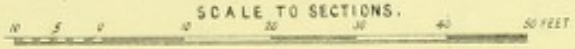



PLAN



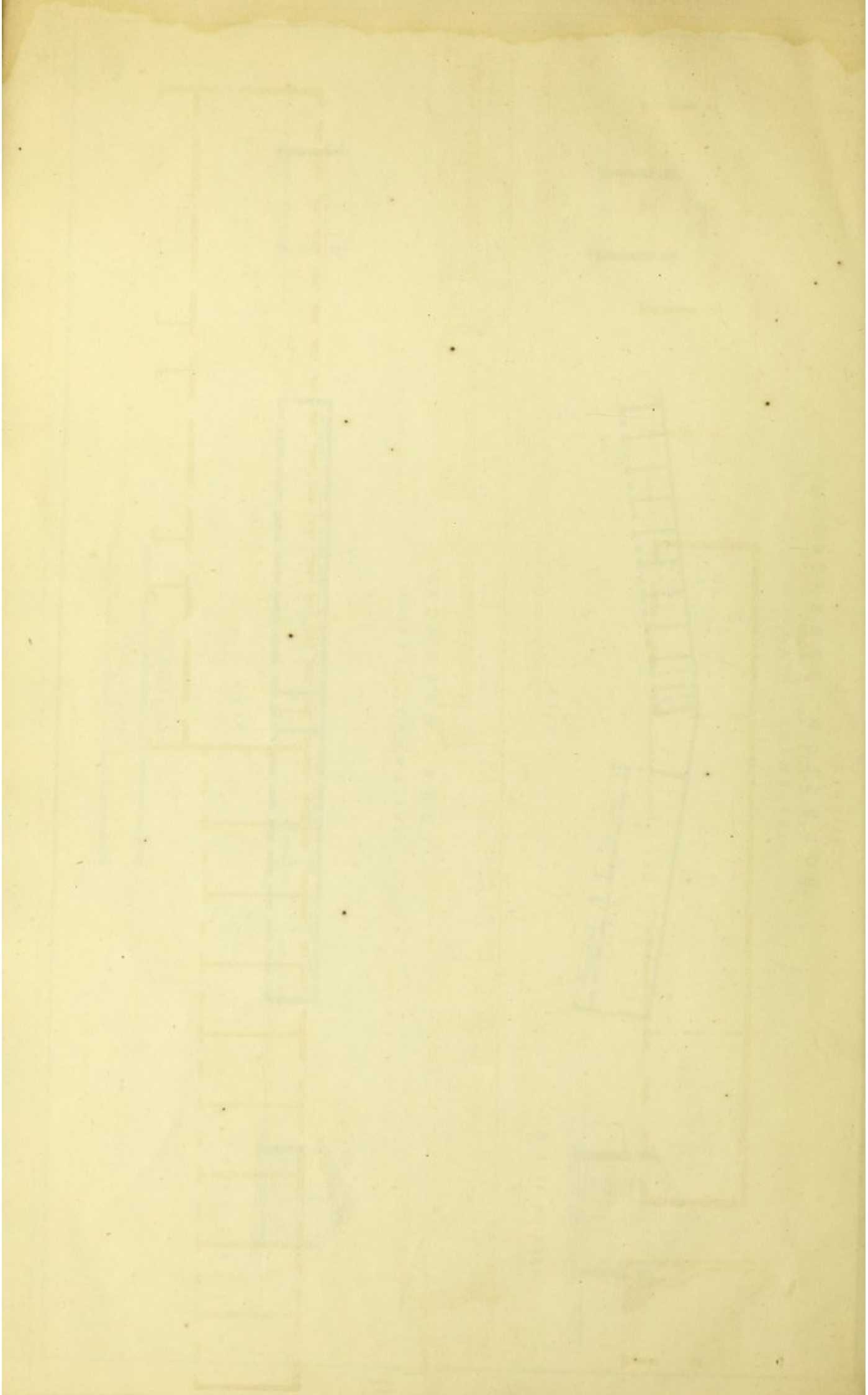
SECTION AT G. H.

SCALE TO SECTIONS.




SCALE TO PLANS

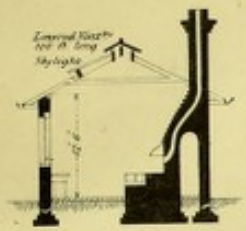

Day & Son lith.r to the Queen



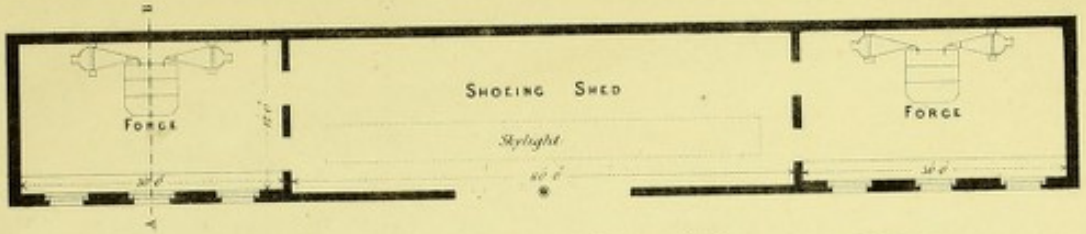
# INFIRMARY STABLES.



## FORGE, 18 STALLS AND 8 LOOSE BOXES.

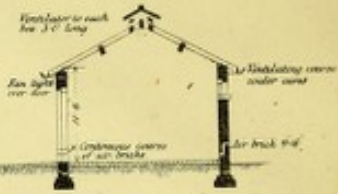


SECTION A B

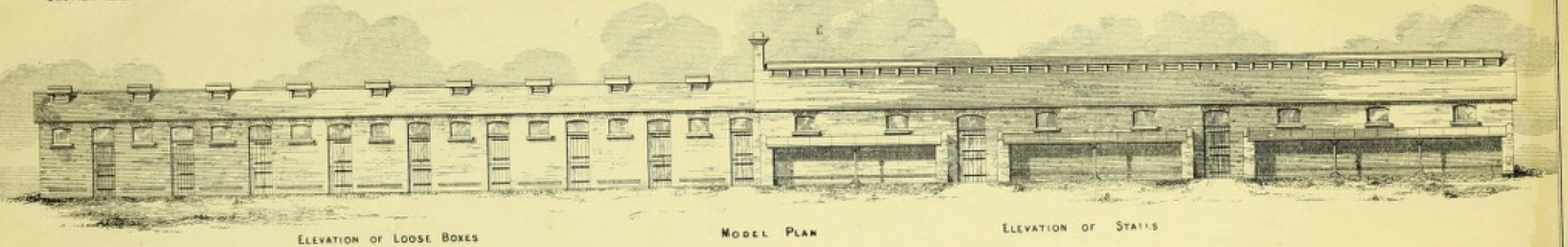



PLAN OF FORGE AND SHOEING SHED.

SECTION C D



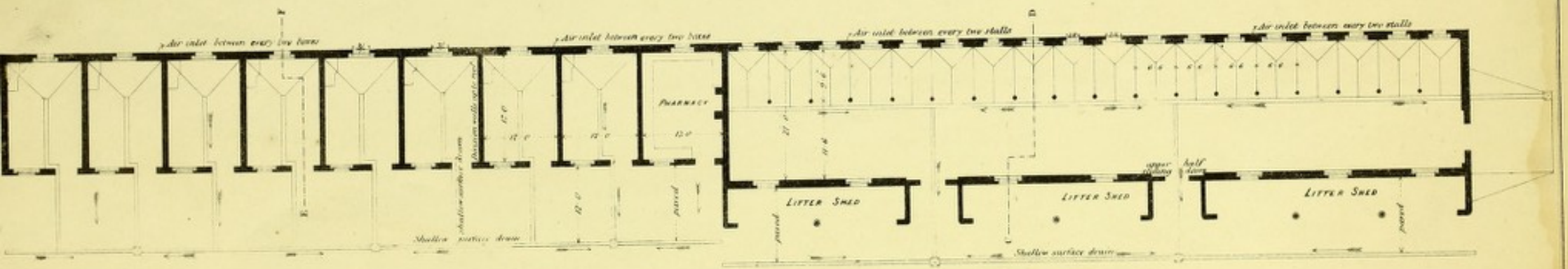
SECTION E F.



ELEVATION OF LOOSE BOXES

MODEL PLAN

ELEVATION OF STALLS




PLAN OF LOOSE BOXES.

PLAN OF STALLS

SCALE OF FEET

Day & Son, Lith.rs to the Queen