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1933

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CHAPTER I

CATTLE, SHEEP AND FRESH MEAT

1. *Classification of British breeds of cattle and sheep*

1. It is difficult to classify the breeds of cattle exactly, as different strains vary greatly: but the following is usually accepted :—

Beef cattle.—Some strains of shorthorns; Hereford, Aberdeen-Angus, Devon, Sussex, West Highland and Galloway.

Dual purpose cattle.—Some strains of shorthorns; Lincolnshire red shorthorn, red poll, South Devon, Welsh black, longhorn and dexter.

Dairy cattle.—Dairy shorthorns, Ayrshire, Jersey, Guernsey, British Friesian and Kerry.

2. The British breeds of sheep are classified in various ways; the most common plan is to divide them into longwoolled, down and mountain breeds.

Longwoolled breeds.—The chief are the Leicester, Border Leicester, Lincoln, Romney Marsh, Cotswold, Wensleydale, South Devon, Devon Longwool and Rosscommon.

Down breeds.—The chief are South Down, Shropshire, Suffolk, Hampshire, Oxford and Dorset Downs.

With the down breeds may be included the Dorset Horn, Ryeland Western and Kerry Hill.

Mountain breeds.—The chief are the Scotch blackface, with the allied Lonk, Derbyshire gritstone, Rough Fell, Swaledale, Limestone and Penistone, Cheviot, Welsh mountain, Radnor, Herdwick, Exmoor horn and Dartmoor.

3. Full details of the above-mentioned breeds of cattle and sheep are given in British Breeds of Live Stock, issued by the Ministry of Agriculture and Fisheries.

4. Details of the national mark scheme for grading home-killed beef are also issued by that Ministry.

2. *Inspection of live animals*

1. The conditions of contract for cattle and sheep require the inspecting officer, before accepting animals for slaughter, to satisfy himself as to their health, age, sex and quality. These points will be considered in detail.

Indications of Health and Disease

2. A healthy animal will have a bright, clear and full eye. It will be alert and brisk in its movements, and move away when approached.

Its coat should be glossy, the skin loose, soft and " mellow," moving freely on the underlying structures. The hair should be smooth and lie close to the skin, with no tendency to stand up on end, and no bare patches should be seen. The muzzle should be cool and moist. The hoofs, horn and ears should feel cool to the touch. There should be no unpleasant smelling discharge from the nostrils. The breathing should be regular and easy. The animal should, when quiet, be constantly " chewing the cud " ; if lying down, it should, when quietly raised, stretch itself. The dung should be normal, neither watery nor hard, unmixed with blood, and with no objectionable smeil. The urine should be of a clear yellow colour.

3. The normal temperature of cattle is 101·5° to 102° F. ; of sheep 102·5° to 104° F. A rise of 3° to 5° F. indicates a feverish condition.

4. The following points indicate ill-health :—

i. Eye dull or hollow.
ii. Movements dull and sluggish. A sick animal generally stands with lowered head and looks tired ; it frequently lies down and rises unwillingly.
iii. Coat staring, with hair standing on end and skin tight. This condition is known as " hidebound."
iv. In fevered animals the ears, hoofs and horn will feel warm. Heat will first be felt at the base of the horns, spreading to the tips as the fever becomes more acute.
v. Rapid breathing, accompanied by dilation of the nostrils and abnormal movement of the abdominal walls.
vi. Muzzle dry, hot and rough.
vii. Coughing.
viii. Dung thin, watery and bad smelling.
ix. Urine thick and cloudy.
x. Udder swollen, tender to the touch and hot.

xi. In sheep, wool loose, fatty secretion in the skin absent, drooping of the ears, arching of the back, and drawing of the legs together under the body.

Should an animal not stretch itself on being quietly raised or not chew the cud for any length of time, or should it stand apart from its fellows, or cower behind a bush or wall, it should be looked upon with suspicion.

5. The above are general indications of health or ill-health in live animals: more detailed symptoms of disease are given in the paragraphs dealing with diseases.

6. It is for the veterinary surgeon to say from what disease the animal is suffering, and whether it is in consequence unfit for human food; it is sufficient for the R.A.S.C. officer to recognize that the animal is in ill-health and to reject it in consequence.

Sex of Cattle

7. The conditions of contract require that slaughter cattle shall be oxen, heifers or young cows, within the prescribed limits of age. Bulls and stags are excluded.

8. The names applied to cattle of different ages of each sex vary in different places; the following are those most commonly used :—

i. *Entire males.*—

At birth	Bull calf up to one year old.
At one year	Yearling bull.
Thereafter	Two, three, four and five year old bull until six, when he is aged.

ii. *Castrated males.*—

At birth	Steer calf.
From first to second birthday	Yearling steer.
Thereafter	Two or three-year-old steer.
After four years of age	Ox or bullock.

The "Stag" is the male castrated late in life.

In Scotland the name "Stot" is sometimes used in the place of "Steer."

iii. *Females.*—

At birth	Heifer calf, cow calf or quey calf.
At the first year ..	Heifer or year-old quey.
In the second year ..	Heifer or two-year-old quey.
In the third year ..	Heifer or three-year-old quey.

The term "Heifer," or "Maiden heifer" is given to females that have not had a calf or been in calf; in some places, however, the term "Heifer" is applied to an animal that has had one or even two calves.

The cow is the female after she has had a calf.

"Stirk" is the name applied to weaned calves, both male and female. From a "Stirk" at twelve months it becomes a "Yearling" up to fifteen months and is known as "Baby Beef," followed by early maturity "Steers" and "Heifers."

Sex of Sheep

9. The conditions of contract exclude the ram, but allow wethers, gimmers and ewes, subject to the restrictions of the age clause.

10. There is considerable variation in the names applied to sheep; the following are those most commonly used :—

i. *Entire males.*—

From time of weaning to first shearing ..	Ram lambs, hoggets, hogs or hoggenets.
After first shearing ..	Shearing tups or rams.
Thereafter	Two, three or four shear rams according to number of times they have been shorn.

ii. *Castrated males.*—

From weaning to first shearing	Wether tegs, or shear hogs.
From first to second shearing	Shear hogs, wether hogs or shearing wethers.
From second to third shearing	Two shear wethers.

iii. *Females.*—

At birth	Ewe lambs or gimmer lambs.
Later up to first shearing	Gimmer hogs, ewe hogs or ewe tegs.
From first to second shearing	Shearing ewes, shearing gimmers, theaves or gimmers.

The "Ewe" is the female which has had one or more lambs.

Age of Cattle

11. Under the conditions of contract, oxen must not be under two or more than five years old; heifers and cows not under two or more than four years (48 months). Age is estimated by the teeth, and up to five years old a fairly accurate opinion can be formed. The adult animal has eight incisor teeth in the front of the lower jaw, but none in the upper jaw, which is provided with a dense fibrous pad. Molars or grinding teeth are present in both jaws, six on each side top and bottom, twenty-four in all.

12. At birth, the calf has usually the full complement of temporary incisors (milk teeth) distinctly visible under the gum, with the edges of some of them pricking through. For convenience of description the eight incisors are divided into four pairs, which are called, according to their position in the mouth, centrals, middles, laterals and corners.

At about one month old, the eight milk incisors are well up. There is never the least difficulty in distinguishing between a mouth which shows a full complement of milk teeth and one which has eight permanent incisors, since the latter are much larger and broader, and the size of the jaw bone clearly indicates whether it is that of an adult or of a calf.

As age advances, the milk incisors, beginning with the centrals, give place in pairs to permanent or broad teeth; but it is necessary to observe that the changes are by no means as regular as they are in the horse, there being a possible error of as much as six months in every diagnosis. It is necessary, however, to fix upon certain periods which can be taken as approximately correct, but the liability to variation should always be borne in mind.

It is generally accepted that the central broad teeth appear between eighteen and twenty-two months, and that at two years old they are well up.

The middles appear at about two years and three months, and by two and a half years they are well up.

The third pair, the laterals, come very irregularly, and may appear at any time between two and a half years and three years old.

The fourth pair, or corners, are usually fully up at three and a half years old, when the animal has what is called a full mouth, and at the same time reaches adult age.

After the completion of the full set of permanent incisors, an estimation of the animal's age can only be based on the amount of wear indicated by the appearance of the cutting edges of the teeth. Such evidence is frequently difficult to

interpret, but, speaking in general terms, the teeth become shorter, smaller and wider apart as age advances, while at the same time the gums recede.

13. Horned cattle are sometimes judged by the number of the annual rings upon the horns. The first ring is not formed until the animal is two years old, so that the age must always be estimated at one year more than the number of rings. This method is, however, a very rough and unreliable one, since it is often very difficult to decide how many rings are present. These rings must not be confounded with other small rings sometimes found at the root of the horn, which are often an indication of bad feeding during growth.

Age of Sheep

14. Under the conditions of contract sheep, wethers or ewes must be not more than five years old.

15. The arrangement and shape of the teeth of sheep are similar to those of cattle, but the changes take place about six months earlier.

Usually the permanent centrals are well up at one year and three months, the middles at two years, the laterals at two and a half years and the corners at three years, but it frequently happens that the corners have not even appeared at this age, and that they are not fully up until four years.

At four years the centrals and middles are heavily worn.

Quality of Cattle

16. The most suitable oxen for military purposes are those which are moderately fat. Very fat animals, whose carcases waste much in cooking, are as much to be avoided as those which are thin and underfed. Marked absence of fat indicates bad feeding or disease, and the muscular tissue will be proportionately wanting in nutritive properties and unpleasant to the taste.

A good ox should have a level, straight back, and its bones should be well covered with flesh.

The head should be short, the forehead broad and full, especially between the eyes.

The neck should be short or medium in length, fine near the head, but full at the "neck-vein" or "shoulder-vein," where it merges with the shoulder, the blade of which should fit snugly to the body with sufficient slope to give the animal an easy carriage; the upper line from the top of the shoulder to the poll should be almost straight, except when it rises in the crest of the bull.

The body should be moderately long, deep, rounded and barrel like, equally balanced, and evenly covered with firm flesh, especially at the best cuts; it should be free from roughness at the shoulder points and hip-bones, and not patchy at the pin-bones or other parts.

The trunk from any point of view should closely resemble a rectangle; the upper and under lines should be straight; the brisket projecting well forward and low and wide, making the fore-legs stand well apart.

The skin should be of medium thickness, soft, mellow and elastic to the touch.

Fat represents primarily a reserve of food material, and a protection against minor external injuries; and being a bad conductor of heat it prevents the body from losing its warmth too rapidly.

Long established custom in the cattle trade has directed special attention to the following, which are known as the "Quality points" and "Handling points."

Quality Points

17. The following quality points of the ox are illustrated in Plate I (page 8).

Reference No. on Plate 1.

1. *Natches, or pin-bones.*—Should be well covered, and not too prominent. They should be fairly wide apart, though different breeds vary a little in this respect.
2. *Tail.*—Should be broad and fat, hang perpendicularly, and fill up the space between the natches.
3. *Hips.*—Should be smoothly covered, wide apart and level. If a stick be laid from hip to natch, there should not be much daylight.
4. *Loin.*—Should be wide, flat and well furnished.
5. *Space.*—Should not be hollow.
6. *Ribs.*—Should be long, well covered, and arched out from the back, so that the animal's form is cylindrical.
7. *Crop.*—Should be broad and flat on the top, and well filled up on each side; the width of back and roundness of rib should be maintained forward, so as to leave no hollow behind the shoulders.
8. *Shoulder.*—Should have a roll of fat from the upper to the lower part. It should be covered with flesh, compact on top and smooth.
9. *Neck vein.*—Should form a collar of fat connecting the fat of the shoulder with the fat of the breast.
10. *Jowl.*—Should be filled up with a pad of fat, not hollow, as in the horse.

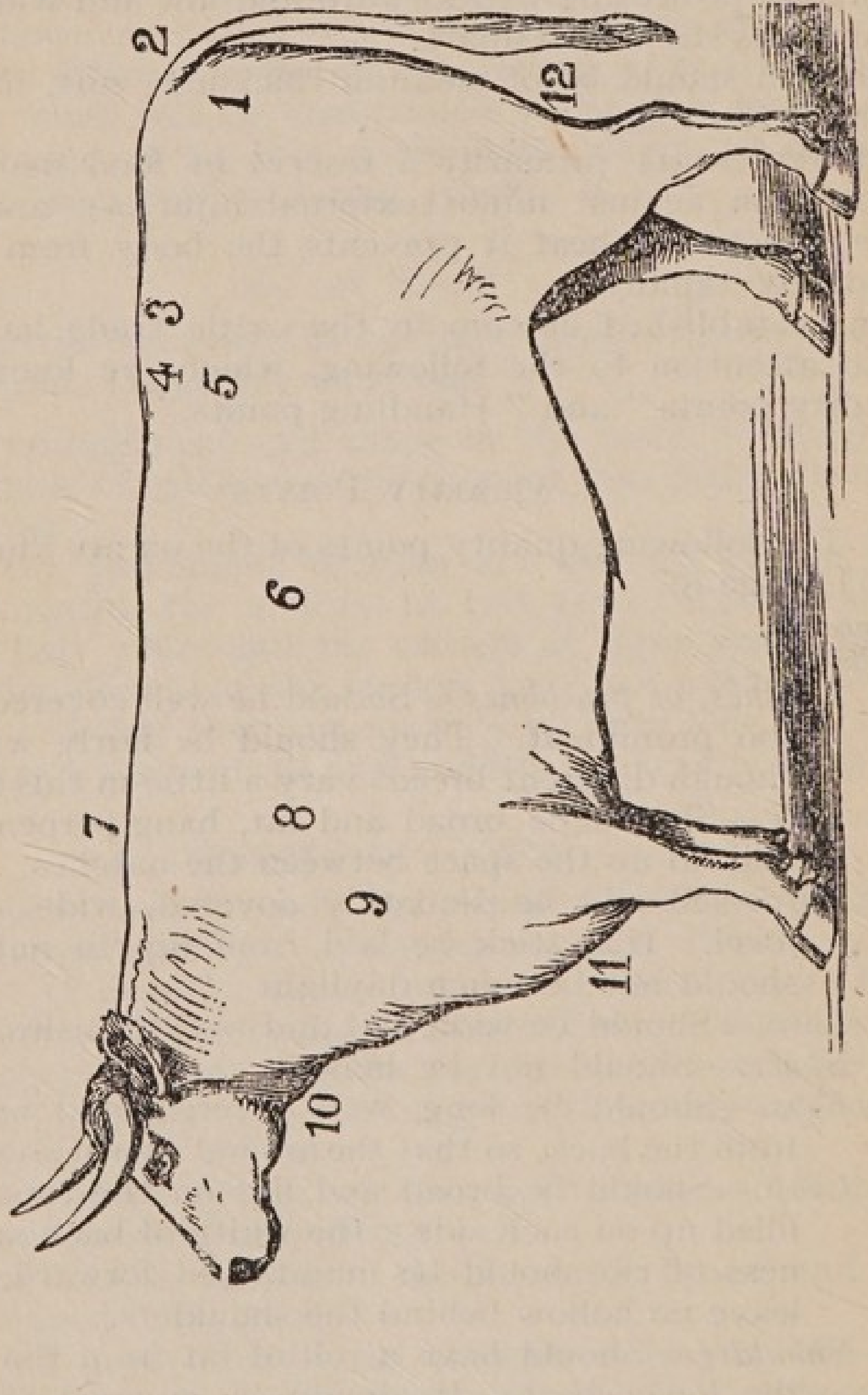


PLATE 1.—QUALITY POINTS OF THE OX

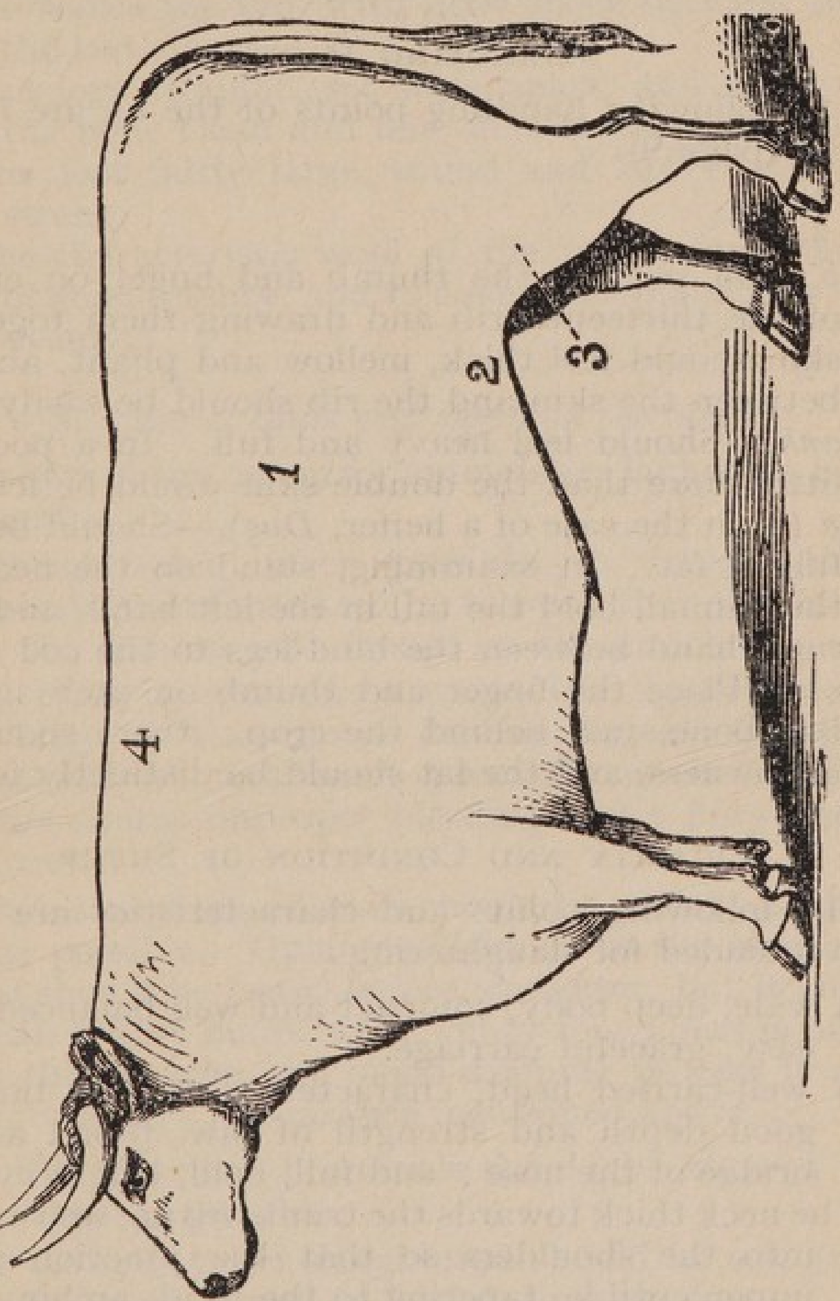


PLATE 2.—HANDLING POINTS OF THE OX

11. *Breast*.—Should be full, wide and deep. It should come out prominently between the fore-legs, and the dewlap should hang to within two or three inches of the knee-joint.
12. *Buttock*.—Should have great fullness inside and out, so as to give a good "twist." The flesh should be solid, but mellow.

Handling Points

18. The following handling points of the ox are illustrated in Plate 2 (page 9).

Reference No. on Plate 2.

1. *Rib*.—On putting the thumb and finger on either side of the thirteenth rib and drawing them together, the skin should feel thick, mellow and pliant, and the fat between the skin and the rib should be easily felt.
2. *Flank*.—Should feel heavy and full. In a poor animal little more than the double skin would be felt.
3. *Cod* (or in the case of a heifer, *Dug*).—Should be soft and full of fat. In examining, stand on the near side of the animal, hold the tail in the left hand, and pass the right hand between the hind-legs to the cod or dug.
4. *Crop*.—Place the finger and thumb on each side of the backbone, just behind the crop; there should be no hollowness, and the fat should be distinctly felt.

Quality and Condition of Sheep

19. The following points and characteristics are desirable in sheep intended for slaughtering :—

i. A wide, deep body, compact and well balanced, with an easy, graceful carriage.
ii. A well-carried head, characteristic of the breed, with good depth and strength of jaw, broad across the bridge of the nose; and full, bold, bright eyes.
iii. The neck thick towards the trunk, fitting well and evenly into the shoulders so that the junction is almost imperceptible, tapering to the head, arching slightly, medium in length and free from "throatiness" at the junction with the head.
iv. The chest broad, deep and projecting well in front of the fore-legs.
v. The back level and broad throughout its length (though some of the mountain breeds have sharp shoulder-tops or withers), with an even covering of firm and muscular flesh; under and upper-lines straight.

vi. The ribs well sprung and deep.

vii. The shoulders well laid and covered with firm flesh. The regions immediately behind the shoulders level and free from hollows.

viii. The thighs, arms and fore flanks thick and fleshed well down.

ix. The quarters long, deep and wide, not drooping much towards the tail, with little space between them and the last ribs.

x. The legs straight, set wide apart, and not too long; the bone clean and fine, neither coarse nor deficient.

xi. The feet fairly large, sound and hard; the pasterns strong.

xii. The characteristic wool of the particular breed to be of good quality, and to cover the whole body well and evenly.

3. *Care of cattle and sheep on the march*

(Particulars of the ration for animals are laid down in Animal Management.)

1. It is advisable, when possible, to drive cattle along different roads from those used by troops; they should never be driven in the column with troops on the march.

2. Any form of excitement raises the temperature of the animal's body, so that gentle driving, careful handling and quiet methods of treatment generally must be practised. Excitement causes improper bleeding and a fiery appearance of the carcase.

3. Before slaughter, animals should be rested and fasted for as long as possible. Opinions differ as to the length of time an animal should be fasted before slaughter, but it should not be less than twelve hours, and twenty-four hours is preferable. Unless this is done, the blood-draining process is retarded, producing the fiery appearance mentioned above.

4. On the other hand, animals should be allowed to drink as much water as possible.

5. The animals to be slaughtered should be selected in the morning, and not allowed to feed during the day.

6. The remainder should be fed and watered early, again in the middle of the day, and again on reaching camp.

7. Cattle should be allowed to graze when on the march and while stationary. When halted for any length of time they may be tied, with head ropes round the horns, to trees or wagon wheels, if no lairage is available on the spot. When the numbers are large, cattle guards, preferably mounted, must be

employed. Polled cattle not accustomed to being tied will become agitated and should be settled before slaughter.

8. Sheep-pens can be made by enclosing a space of the size required with hemp or wire sheep netting stretched on stakes, with stakes placed within a few inches of each other and interlaced with brushwood, with " bavins " placed on end in a trench (the earth being well rammed down to keep them firm), or with two strands of barbed wire strained to trees or stakes. Netting is the most effective. In either case a space must be left for a door, which can be closed with boards, etc.

4. *The conformation of oxen*

Skeleton

1. Before discussing the quality of meat, it is necessary for the meat inspector to have a thorough knowledge of the skeleton of the ox or cow, as the appearance and position of the various bones is of great importance to enable him to determine questions of age and sex, and also to recognize small portions of a carcase. (*See* Plate 3.)

2. *The bones of the spinal column.*—The bones of the back or spinal column are divided as follows, beginning from the head :—

Reference No. on Plate 3.		
1.	Cervical vertebræ	7 joints.
2.	Dorsal or thoracic vertebræ ..	13 ,,
3.	Lumbar vertebræ	6 ,,
4.	Sacrum	5 ,,
5.	Coccygeal or tail vertebræ	18 to 20 joints.

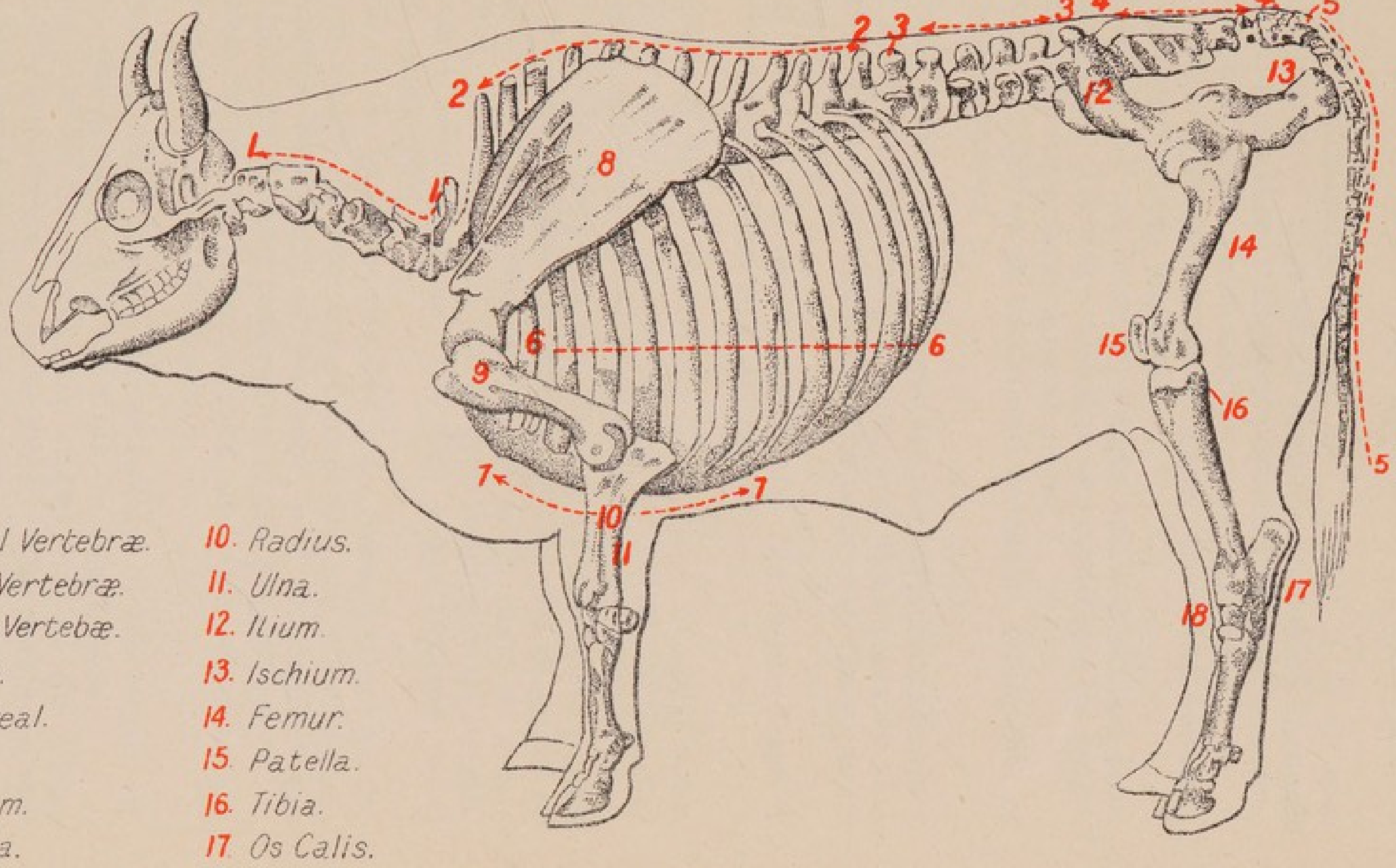
These bones form a chain, closely connected and placed one behind the other, capable of considerable vertical and lateral movement.

Vertebræ which are not fused together are called true vertebræ, and those which become joined as the animal advances in age, as in the sacrum, are called false vertebræ.

All joints of the spinal column, except the cervical and tail vertebræ, have what are called spinal processes (vertical) ; these vary considerably in length, attaining the greatest height at the crop. Attached by cartilage to the thirteen dorsal vertebræ are the thirteen ribs, and the lumbar vertebræ and sacrum are provided with transverse (horizontal) processes.

3. *The bones of the chest.*—These are the transverse processes of the dorsal vertebræ, *i.e.* the ribs, thirteen on each side, and the sternum (breast or brisket bone). The latter in very young animals consists of seven joints, but in old animals of only two, the other joints having become fused together.

PLATE 3.- CONFORMATION. OF THE OX.



1. Cervical Vertebræ.	10. Radius.
2. Dorsal Vertebræ.	11. Ulna.
3. Lumbar Vertebæ.	12. Ilium.
4. Sacrum.	13. Ischium.
5. Coceygeal.	14. Femur.
6. Ribs.	15. Patella.
7. Sternum.	16. Tibia.
8. Scapula.	17. Os Calis.
9. Humerus	18. Astragalus.

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Malby & Sons, Lith.

Of the thirteen ribs, eight are called " true " ribs, and are directly attached to the sternum by cartilage ; the five remaining, the " false " ribs, are loosely attached by cartilage to each other.

" Cartilage " (familiarly known as " gristle ") is of two kinds ; " permanent," that which remains unossified through life and is found in a large variety of parts of the adult skeleton, and " temporary," that which ossifies as age advances.

The horse has eighteen ribs on each side, the sheep thirteen, the goat thirteen, the pig fourteen.

The ribs of the ox are broader, longer and less arched than those of the horse. They are united to the cartilages by joints, while those of the horse have a fixed union.

The sternum of the ox is broad and flattened, while that of the horse is keel-shaped.

4. *The bones of the fore-leg.*—These are the scapula or shoulder blade, the humerus or shoulder bone, and the radius or shin bone, which has the ulna attached to the back of it, the superior end forming the elbow.

The ulna bone of the ox is larger, and the radius bone is shorter and straighter than that of the horse.

5. *The bones of the pelvic cavity.*—The pelvis, or aitch bone, and the sacrum form the framework of the pelvic cavity, and the point of attachment of the hind limbs to the body.

The pelvis, in a young animal, consists of two parts joined by a layer or pad of cartilage, which divides the os pubis or pelvic bone (the central portion of the aitch bone or cross-piece of the H) into two equal parts along the line of its length. As the animal becomes older, the two parts become fused together by ossification.

Each side of the pelvis is divided into three distinct parts, viz. the ilium, which includes the point of the hip, the ischium, which comprises the natch or pin-bone, and one-half of the os pubis, which is generally referred to as the pelvic bone.

The sacrum of the ox is less arched, and the pelvis longer and narrower than that of the horse.

6. *The bones of the hind-leg.*—These consist of the femur, or thigh bone ; the patella ; and the tibia, or shank bone.

The lower end of the femur, the upper end of the tibia, and the patella constitute the stifle joint. The patella of the ox is much smaller than that of the horse.

The lower end of the tibia, with the os calcis (the point of the hock), the astragalus and cushion bones form the hock joint.

The grooved surfaces of the astragalus and tibia are straight in the ox, but oblique in the horse.

The Internal Organs

7. The inside of the carcase is divided into two parts by the diaphragm ; these are :

1. The cavity of the chest, or thorax.
2. The cavity of the abdomen.

8. The diaphragm, more commonly called the skirt, is a muscular tissue.

9. The organs of respiration are the right and left lungs and the heart, which is embedded in the lungs, and almost touches the front part of the brisket bone.

10. The organs of digestion comprise the liver and gall bladder, situated just behind the diaphragm on the right side ; the spleen in a similar position on the left side ; the kidneys close under the lumbar vertebræ, one on either side ; the four compartments of the stomach, and the large and small intestines.

11. The four compartments of the stomach are called respectively the rumen, the reticulum, the omasum and the abomasum.

The function of the first three compartments of the stomach is mainly that of trituration and maceration, digestion proper taking place in the abomasum or rennet bag.

Food is taken quickly into the rumen without mastication. Later the animal regurgitates small portions of it, and masticates each ball thoroughly for about five minutes, i.e. chews the cud. The masticated food may pass back into the rumen when re-swallowed, or, if satisfactory, may go straight into the omasum. Conditions vary, and a second or even third return to the rumen may possibly occur.

From the omasum it passes into the abomasum and thence into the intestine.

12. The stomachs of the sheep and goat (which like the ox are ruminants) are similar to, but smaller than, the stomach of the ox.

13. The omentum, which is part of the serous membrane containing the various organs, covers a good part of the intestines, and is attached to the liver and colon in addition. Its fold contains a good deal of fat in a good specimen.

14. The mesentery is a similarly fatty membrane which attaches the intestines to the peritoneum and prevents the coils from becoming entangled.

15. The pleura is the fibrous membrane which lines the pectoral cavity, and the peritoneum that which lines the abdominal cavity.

Comparison between the Organs, etc., of Various Animals

16. A knowledge of the differences between the organs of various animals, some of which resemble one another generally, is necessary to the meat inspector.

17. The tongue of the horse is smooth, long, and narrow and less firm than that of the ox, whilst the free part is shaped like a spatula, being narrow a little way back from the tip.

The tongue of the ox tapers to a point and is rough, whilst its breadth is very marked; it has a marked ridge or mound on the upper surface, which also bears spiny, filiform papillæ. It has a series of circumvallate papillæ on each side, compared with two in the horse.

The tongue of the sheep is rough, hollowed out in the middle line, and is rounded at the tip. The filiform papillæ are blunt.

The pig has a smooth tongue with no dorsal ridge and two circumvallate papillæ, one on either side of the middle line. The papillæ are small and soft.

18. The lungs of a horse are hard and firm, and very large; those of the ox are soft and flabby.

19. The heart of the ox weighs about 5½ lb. It has three furrows or grooves; it also contains two ossified segments in the ring of gristle which surrounds the aorta, which are not found in that of the horse.

20. The liver of the ox weighs about 13–14 lb. and has one large lobe and a small thumb-piece, and is roughly bean-shaped in outline. It is concave on the side which fits the diaphragm. It is thick in the centre, and thin at the edges. It has a gall-bladder attached to it.

The liver of the horse has no gall-bladder and weighs 10–12 lb.

The liver of the sheep varies greatly in size and is made up of three lobes, two large and one small, with a gall-bladder attached.

A pig's liver has four distinct lobes which are long and thin at the ends, and one small lobe; it has a gall-bladder, and the surface has a net-like appearance sometimes called "nut-meg."

21. The kidneys of the ox weigh about 1½ to 2 lb. each, and are divided into a number of distinct lobes; or, in other words, they are made up of a number of simple kidneys aggregated together.

The right kidney is attached to the abdominal wall close up to the spine, the left is free or "floating."

The kidneys of the horse are smooth and non-lobulated. The left is bean-shaped, and the right is supposed to resemble a cocked hat. They weigh about 1 lb. each.

The kidneys of the sheep, goat and pig are smooth, non-lobulated, and are bean-shaped. Pigs' kidneys are flatter and sometimes paler in colour than other kidneys. They are about 4 inches long and weigh about 4 oz. each.

22. The ox spleen or " milt " lies on the left side of the rumen and is attached to it. It is thin, long and narrow and varies in colour, sometimes being reddish-brown, sometimes greyish-blue or even dark red. It is rounded at the ends and is soft and elastic.

The spleen of the horse is sickle-shaped, pointed at one end, and is generally of a blue-white or violet colour.

The spleen of the sheep is flatly compressed and shaped like a blue-point oyster.

The spleen of the pig is long and tongue-shaped and reddish in colour.

23. The tongue, heart and liver of the horse are the organs which are most likely to be used fraudulently to represent the corresponding organs of the ox.

5. *The joints in beef and the bones they contain*

1. The slaughtered ox, when dressed, is spoken of as a carcase. The process of chopping down divides the carcase into two sides. Each side is subsequently divided into two quarters, the division taking place between the twelfth and thirteenth ribs, so that twelve ribs go with the fore-quarter and one with the hind-quarter (Army method).

2. The method of dividing a carcase differs considerably in different localities. The side is, however, universally the first division. The term " long side " is self-explanatory. The " short side " means a hind-quarter on which eleven or sometimes eight ribs are left. When the side is divided into quarters, the exact point of division varies in different markets, but it is more or less constant for the same market.

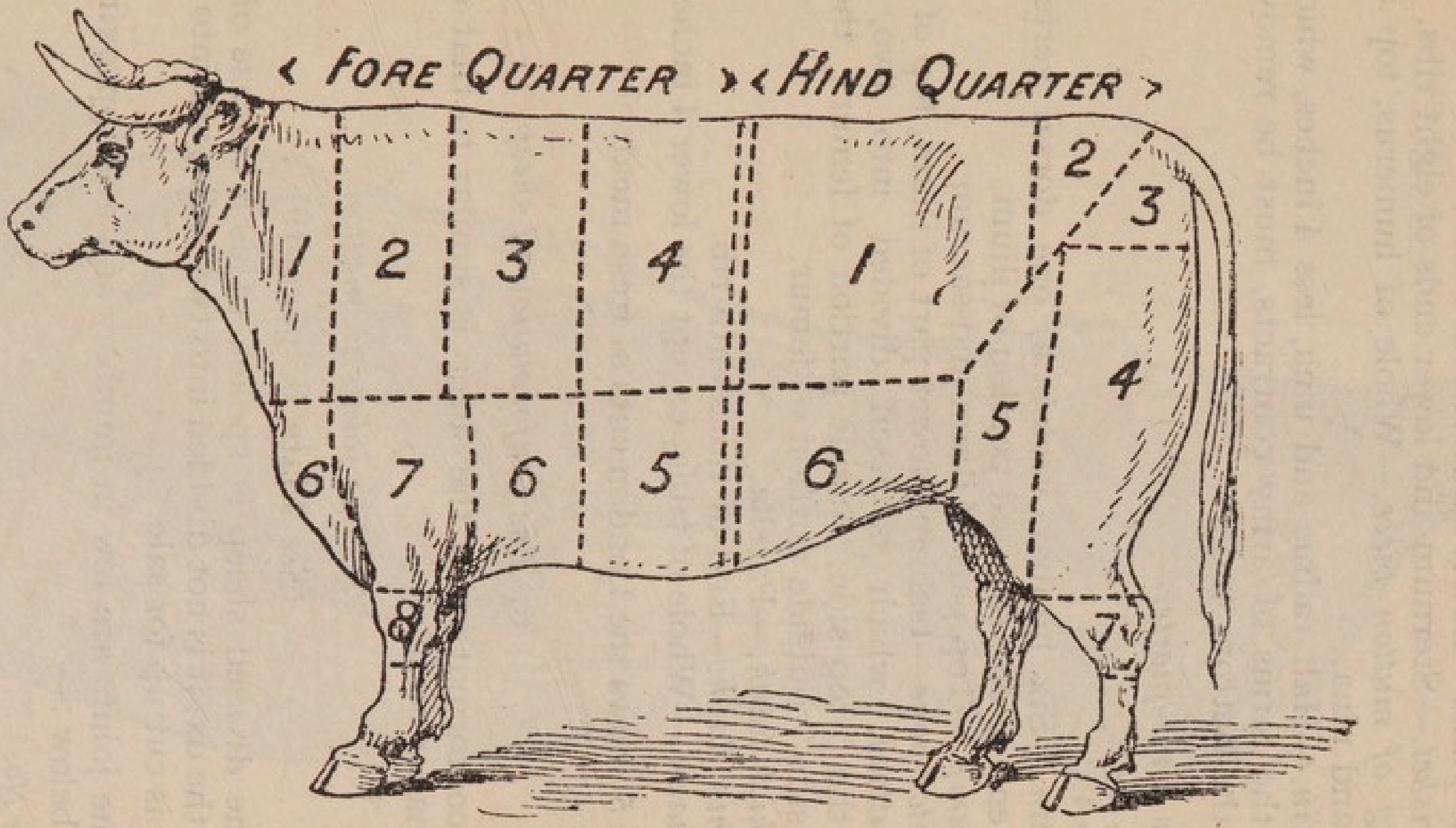
3. The usual custom in the Army is to recognize the joints enumerated as follows, and shown approximately on Plate 4, page 17.

In the fore-quarter—

Reference No. on Plate 4.

1. *Sticking piece.*—Five joints of cervical vertebræ.
2. *Chuck rib.*—Three dorsal vertebræ, top ends of three ribs, bottom end of scapula, two cervical vertebræ.

PLATE 4.—THE JOINTS IN BEEF



3. *Middle rib.*—Four dorsal vertebræ, top ends of four ribs, remainder of scapula.
4. *Fore rib.*—Five dorsal vertebræ, top ends of five ribs.
5. *The plate.*—Lower ends of four ribs.
6. *Brisket.*—Sternum and lower ends of eight ribs.
7. *Leg of mutton piece.*—Whole of humerus, top of radius and ulna.
8. *Shin.*—Half radius and ulna, less 4 inches, which, under the terms of army contracts, must be removed from the bottom end.

In the hind-quarter—

Reference No. on Plate 4.

1. *Loin.*—Six lumbar vertebræ, one dorsal vertebra, top end of one rib, and portion of ilium.
2. *Rump.*—Top part of ilium and sacrum.
3. *Aitch-bone*—Ischium, lower part of ilium, top of femur.
4. *Buttock,* which is itself divided into two, namely, the " top side," inside portion of femur; the " silver side," outside portion of femur.
5. *Thick flank.*—Patella.
6. *Thin flank.*—End of thirteenth rib.
7. *Shank.*—Whole of tibia, except the lower 4 inches.

Plate 5 shows the London cuts of fresh meat.

6. *The conformation of sheep*

The conformation of the sheep is similar to that of the ox on a smaller scale.

7. *The joints in mutton*

(*See* Plate 6, page 19).

1. The dressed sheep is spoken of as a carcase of mutton. Unlike the ox, it is not divided into two sides, nor into quarters, until it is cut up for sale.

2. The joints are few in number, and are approximately as shown below :—

Reference No. on Plate 6.

1. Neck, two scrag-ends.
2. Neck, two best ends.
3. Two shoulders.
4. Two breasts.
5. Two loins, equal one saddle.
6. Two legs.

PLATE 5.
LONDON CUTS OF FRESH MEAT.

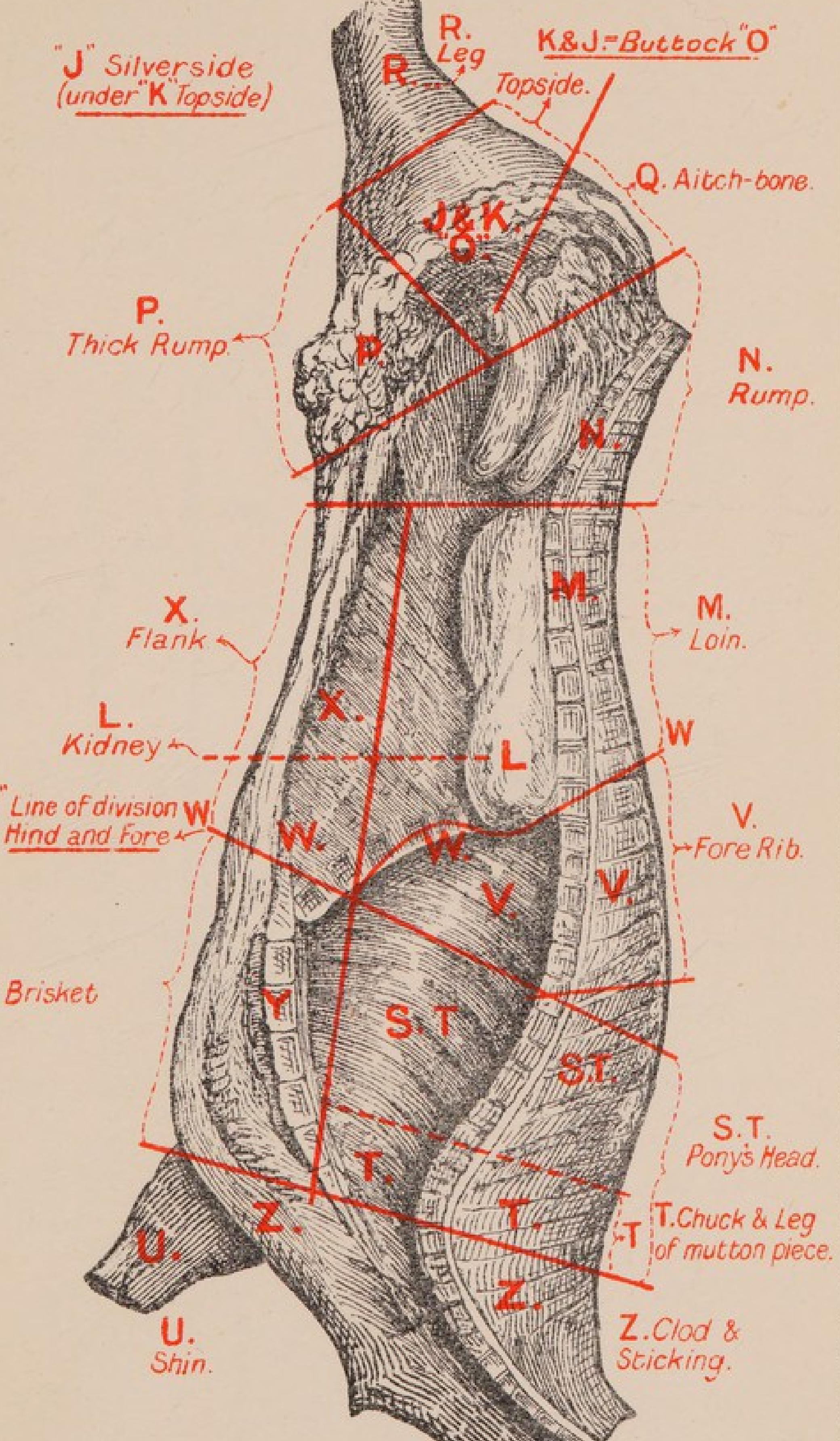


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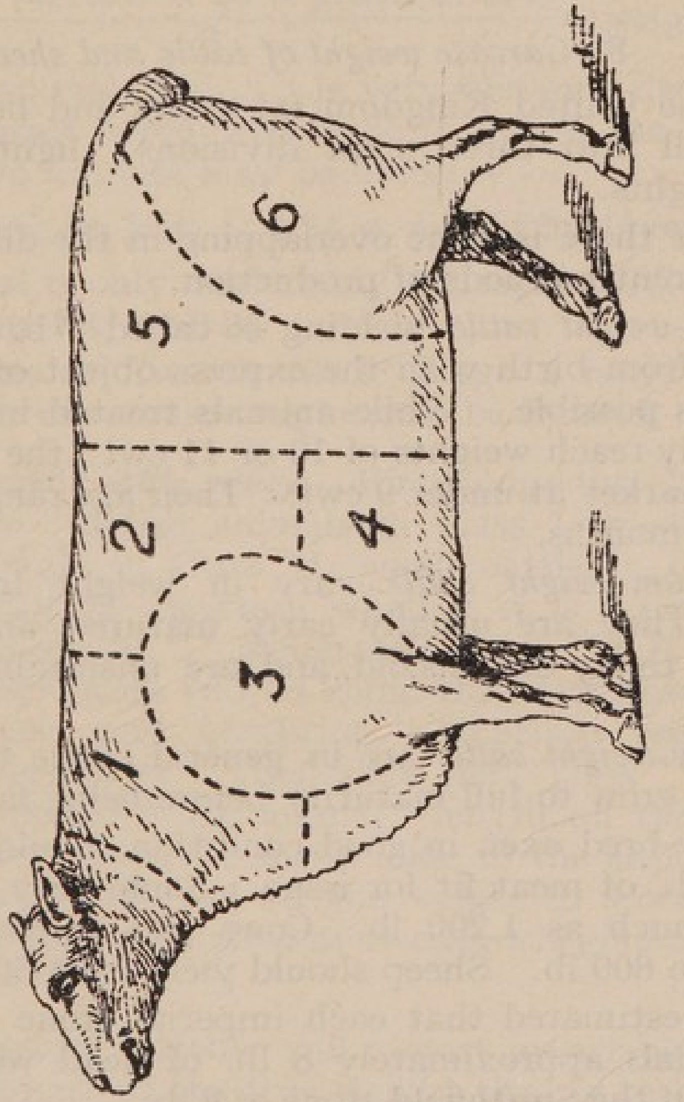
PLATE 6.—THE JOINTS IN MUTTON



3. The terms generally used in the trade to distinguish the joints of mutton are leg, loin, breast, shoulder, neck. The haunch consists of the leg, aitch bone and rump or hind-quarter, less loin and thin flank. The neck is often divided into the scrag-end, middle and best end.

The breast is divided into point end and best end.

The legs and shoulders are divided into knuckles and fillets; the loin into chump, middle and best end. A mutton cutlet is a chop (rib) from the best end of the neck.

8. *Carcase weight of cattle and sheep*

1. In the United Kingdom fat steers and heifers ready for market fall into three main divisions: light, medium and heavy weights.

2. While there is some overlapping in the division, it represents different methods of production.

3. *Light-weight cattle* yielding so-called "baby" beef have to be fed from birth with the express object of being finished as early as possible. While animals treated in this way may occasionally reach weights of 10 or 11 cwt., the great majority come to market at under 9 cwt. Their age ranges from fifteen to twenty months.

4. *Medium-weight cattle* vary in weight from 9 cwt. to 11 cwt. They are usually early matured animals of from twenty to thirty months old, and are unsuitable for first-class trade.

5. *Heavy-weight cattle* are in general cattle that have been allowed to grow to full maturity before being fattened.

6. Home-bred oxen in good condition should yield not less than 600 lb. of meat fit for issue. Some very fat beasts will yield as much as 1,200 lb. Cows and heifers should yield from 500 to 600 lb. Sheep should yield from 50 to 80 lb.

7. It is estimated that each imperial stone (14 lb.) of live weight equals approximately 8 lb. of dead weight. This is the origin of the Smithfield stone of 8 lb.

8. The following table gives fair average percentages for cattle of carcase to live weight and bone to carcase weight. (*See* Part I, Report of the Army Cattle Committee, 1918.)

Type of animal (1)	Percentage carcase to live weight (2)	Percentage bone to carcase weight (3)
Fat	55 to 63	14 to 15
Moderately fat ..	51 to 59	17 to 18
Lean	51 to 55	25 to 27

9. There are various ways of estimating the carcase weight of cattle—

i. Pass the animals over a weigh-bridge to ascertain the live weight, and allow 55 to 60 per cent. for meat.

ii. Ascertain the length of the animal from the hollow on the crop (usually well marked by a curl in the hair) to the natches, in feet and inches, also the girth close behind the shoulder in feet and inches;

$$\text{Then } \frac{\text{length (in feet)} \times 10 \times \text{girth (in feet)}}{3} = \text{weight in lb.}$$

In very fat animals add $\frac{1}{20}$; in very thin ones deduct $\frac{1}{20}$.

Or, if the result is required to be in stones, the following alternative formula may be used :—

$$\text{Girth}^2 \times \text{length (in feet)} \times 0{\cdot}24 = \text{weight in stones of 14 lb.}$$

If the animal is only moderately fat, replace 0·24 by 0·23, or, if prime fat, by 0·26.

iii. By means of Ewart's cattle gauge a fairly accurate estimate of carcase weight may be formed.

10. *Use of Ewart's cattle gauge.*—First judge the class of the animal, i.e. large English animals in Class I, medium-sized and foreign animals in Class II, small cattle in Class III. Handle the animal to ascertain whether it is "Extra fat," "Very fat," "Prime fat," "Moderately fat," "Half fat," etc. On the back of the gauge will be found the letter answering to the animal's class and condition. Ascertain length and girth as before described. Then slide the "class" letter on the small ivory scale to the animal's length on the wooden scale below. Next move the metal slide to the animals girth on the ivory scale, and read off the weight in scores on the top line. This weight multiplied by twenty will give the weight in pounds.

11. An experienced butcher will almost invariably make a much nearer estimate of the true weight than is to be got by any of these methods. He judges solely by the quality and handling points, and should not make an error greater than 5 per cent. either way.

12. In judging the weight of cattle, however, one of the most important factors is a knowledge of where and how they have been fed. A favourite trick played by dishonest dealers is to give animals salt water and thus cause excessive thirst which induces the animals to drink heavily shortly before being weighed. As much as 60 lb. increase in weight may be caused in this way.

13. To estimate the carcase weight of sheep, kill a few animals, and take the average weight of the carcases as the average weight of the whole. The estimate of an experienced butcher will, as in the case of oxen, also be found to be a reliable guide.

14. Weights of sheep vary largely according to the breed and thickness of wool.

15. The following table gives fair average percentages of carcase to live weight for sheep :—

Type of animal (1)	Percentage carcase to live weight (2)
Lean	42 to 47
Half fat	48 to 51
Very fat	53 to 62

9. *Slaughtering and dressing of cattle and sheep*

1. A squad of butchers consists of six men, viz. one Class I, three Class II butchers and two Class III butchers. For killing and dressing cattle, they are divided into two sub-divisions.

(*a*) Class I. / Class II. / Class III. (*b*) Class II. / Class II. / Class III.

The squad should kill and dress two bullocks in 45 minutes. For killing and dressing sheep they are divided as follows :—

(*a*) Class I. / Class III. (*b*) Class II. / Class III. (*c*) Class II. / Class II.

The squad should kill and dress three sheep in 12 minutes. Thus in a day of eight working hours a squad of butchers will kill and dress twenty bullocks or 120 sheep.

2. The classification of butchers is based on their qualifications as assessed by the standard trade tests which are laid down in Regulations governing the issue of Tradesmen's Rates of Pay.

3. The operations in slaughtering and dressing are as follows :—

CATTLE

Knocking down.—This is done with the Humane killer, or, in the field when cattle are wild, by shooting.

Pithing.—A cane is forced through the orifice made by the bullet from the Humane killer into the brain and down the

spinal cord, which runs through the centre of the dorsal vertebræ.

Bleeding.—The jugular veins are then cut through, and the animal is bled.

The bleeding should be done as thoroughly as possible. Blood decomposes rapidly, so that the greater the amount that can be drained from the carcase and its organs, the more thoroughly the carcase will set, the longer the meat will keep, and the better will be its appearance.

The average quantity of blood in an animal's body is approximately one-thirteenth of the body weight.

In properly bled carcases the quantity of blood should be so small that, upon cutting through the muscle fibres and pressing, only a few drops should exude from the smaller veins.

The greatest care must be taken to avoid " over sticking," which means that the animal bleeds internally. This causes staining of the pleura. (*See* Sec. **10**, 28, ii.)

Scalping.—The skin is removed from the head, and the horns are chopped off.

Skinning the brisket.—The beast is placed on its back and pritched up. The brisket is skinned and the legs jointed off at the knees and hocks.

Legging and siding up.—The skin is now removed from the hind-quarters, legs and sides.

Great care and skill are required in the process of removing the hide, i.e. " flaying." Some animals are more difficult to flay than others. For example, an animal in good condition is easier to flay than a poor conditioned one. Similarly, animals which have been overdriven before slaughter are more difficult to flay than those that have been given proper rest and treatment.

Careless flaying causes serious depreciation in the market value of the hides.

Removing caul and tail.—The urethra is removed as far as possible, the cod fat or dug evenly divided, the belly cut through till the aitch bone is reached. The caul is removed, the brisket sawn through, and the aitch bone divided, the " tree " is placed in the hamstrings, and the carcase is wound up the gallows. The tail is then removed.

Removing offal and hide.—The offal or intestines are next removed, the kidneys being left in, and the hide is taken off the back. The brisket is opened, and the gullet, windpipe, heart and lungs are removed.

Chopping down.—The sacrum is then sawn or chopped through, and the backbone chopped through, the spinal

processes being then cut out with a knife and left alternately on either side of the carcase. The veins of the shoulder are then trimmed out and the neck trimmed and wiped.

The carcase is then allowed to "set." "*Setting*" means that the carcase has passed into a condition of *rigor mortis*, due to the coagulation of myosin, or "muscle clot."

To facilitate this setting, the meat should be rapidly, skilfully and cleanly dressed without undue use of water.

It should be hung in a well-ventilated and dry-cooling chamber set apart specially for the purpose. A well-nourished carcase under favourable conditions should set well in about twelve hours, but much depends on the weather conditions and the quality of the meat. A very rich fat carcase, or a poor lean one, will not set so well or so quickly as a good medium carcase. A cold dry atmosphere facilitates setting, but a moist, foggy, or muggy atmosphere retards it.

The carcase is fit to issue in twenty-four hours.

If a carcase fails to set within a reasonable time, it is probably diseased.

Sheep

Sticking.—The sheep is thrown on its left side, and a knife is passed through the neck behind the windpipe; this severs the jugular veins. The neck is then broken by placing the right hand on the nape of the neck and giving the head a sharp jerk backwards with the left hand. The sheep is then left to bleed.

Legging.—The sheep is placed on its back, and the skin removed from the shoulders and hind-legs; the gullet is tied in a knot and the legs jointed off at the knees and hocks.

Dressing.—The "gamble" is placed in the hamstrings, the sheep hung up, the tail gut drawn, and the skin removed.

Removing offal and pluck.—The offal, or intestines, are removed, the breast sawn through, and the pluck (i.e. heart, lungs, liver and spleen) removed.

Wiping out.—The "bellyset" is then placed in position, the carcase wiped and the neck trimmed. A hot wiper, which has been wrung out as dry as possible, should be used.

In temperate climates the carcase is fit to issue after twenty-four hours.

4. Carcases of cattle and sheep should not be allowed to lie on the ground longer than necessary. The sooner they are hung up the better they will be drained.

5. *Abattoirs and lairages.*—The following are the chief points to which attention should be paid in the construction and lay-out of abattoirs and lairages.

The internal surfaces of buildings should be smooth, hard and impervious, corners should be avoided and angles rounded off to prevent accumulation of dust. Walls should be cemented to a height of 6 feet.

The floor of the slaughter-house should be of impervious material, such as concrete or paving (but not asphalt), and be properly drained to an outside gully.

Adequate lighting and ventilation are necessary.

An efficient hot and cold water supply is essential, and the construction of the buildings should be such that the interior can be thoroughly hosed out.

Lairages should be properly paved, drained and ventilated. The entrance from the lairages to the slaughter-house should be so constructed that the animals do not see the slaughtering in progress.

Dry, well-ventilated stores should be provided for hanging meat during setting.

Dressing rooms and lavatories for the butchers should be provided.

Separate accommodation is required for condemned meat.

6. A good gallows for dressing bullocks in the field may be made by placing a stout pole between two trees in the forks of the branches. If there are no trees, a single gyn can be made with three poles about 15 feet long lashed together at the top, or a double gyn may be made by placing a pole across the tops of the two small single gyns.

Offals and By-Products of Cattle and Sheep

7. *Cattle.*—Offals are usually divided into two main classes, edible and inedible. The former class includes the tongue, head, thick skirt, sweetbreads, kidney, heart, liver, tripes, tail and edible fats.

The chief inedible offals are the hide, hair, horns and melt (or spleen), bones and intestines (or guts), and inedible fats.

As a rule nothing is absolutely wasted except the manifold and part of the blood.

8. *Sheep.*—The edible offals include the head and tongue, the kidneys, the plucks (heart, liver, lungs, melt, skirt and trachea), the sweetbreads, the fries and the caul.

The inedible offals include the skin, horns (in horned breeds), intestines and the contents of the stomach and guts.

10. *Inspection of meat*

(*See* Memorandum No. 62/Foods, on meat inspection, issued by the Ministry of Health.)

1. The inspection of meat should be carried out with direct reference to the conditions of contract, and a copy of these conditions for the current period should always be hung up in every meat store, and wherever the daily ration board assembles.

2. In general terms, the inspection of meat involves questions of age, sex, quality, sweetness and dressing.

3. All meat contracts lay down clearly in the specification the requirements under these headings, also any special conditions which may be applicable at any particular command or station, e.g. in the fresh meat contract for home commands the following special condition clause is included :—

> "The description 'fresh beef and mutton' shall mean cattle and sheep slaughtered in the United Kingdom and afterwards neither frozen nor submitted to a longer chilling process than is usual in the trade."

4. Familiarity with the normal appearance of good beef and mutton of the quality demanded under the conditions of army contracts will, in ordinary circumstances, be a sufficient guide in forming an opinion as to the suitability of consignments submitted for inspection. A detailed knowledge of diseases, and their effects upon the carcase, is unnecessary, since any abnormal condition is sufficient to justify rejection.

Beef

Age—

5. The usual conditions of contract require that ox beef shall be not under two or more than five years old, and heifer or cow beef not under two or more than four years (48 months).

6. An estimate of the age of meat may be formed from certain external and internal appearances.

7. It is the object of an inspecting officer to decide whether the beef submitted for his inspection comes within certain well-defined limits, and to exclude everything which is outside them. The indication of age in carcases of animals slaughtered between two and five years old being very distinct, a satisfactory conclusion on this head can be arrived at with little difficulty.

8. Temporary cartilage will invariably be found to be present in the carcases of young animals at the points described below.

Since cartilagé disappears from these places at or about the age at which the animal becomes an adult, which coincides very nearly with the limits of age quoted above, inspection for age may be directed to this condition alone, whenever a complete quarter is the subject of examination.

9. Cattle reach adult age at or about three and a half years old, and cartilage disappears, through having become ossified, at about the same period. The process of ossification is, however, gradual, and the deposits of bone are at first markedly soft and porous, and blue or rosy in colour, becoming flinty, hard and bleached in appearance as age advances.

The presence of cartilage at the tips of the spinal processes is a sufficient guarantee that the fore-quarter is under the limits of age. The slow process of ossification which leaves the tips of these processes rosy in colour, soft and porous, and capped by a red line even after cartilage itself has disappeared, enables an inspecting officer to decide if the cartilage has but recently disappeared. The inspection for sex and quality will assist, should there be any doubt. For instance, in countries where oxen are not used for draught purposes, the five-year-old ox is practically unknown and, therefore, a fore-quarter obviously well over four years old is most unlikely to be ox beef, and is liable to rejection as cow beef, which must not be accepted over that age.

As regards the hind-quarter, in the young animal the pelvic bone is divided into two parts by a layer of cartilage, and can, up to adult age, be cut through with a knife, leaving the exposed section of the pelvic bone, or "os pubis," in each quarter covered with a layer of cartilage. The ossification of this cartilage follows the general rules already outlined.

10. When only a portion of a quarter is presented for inspection, examination may have to be extended to other indications of age which do not need to be regarded when the whole quarter is present. Should any of the spinal processes or the "os pubis" be contained in the portion under inspection, the rules above hold good. In their absence, if the portion is acceptable under the terms of contract as regards quality, the age may be taken as sufficiently correct to warrant the waiving of an objection on that score. It may also be of use to remember that the bones of young animals are soft, smaller and more vascular than those of older animals.

11. The inner surface of the ribs in young animals is pink; in the case of old animals it is white and shiny, giving a characteristic bleached appearance. The sections of the vertebræ of the spine appear ruddy and porous, whereas the bone in an old animal is hard, flinty and white. The neck of

an old cow is long and lean, the shoulder is prominent, and the shin-bone fine and pointed. There is little need to look for carcases of animals *under* the stipulated age. At two years old, neither oxen nor heifers are developed sufficiently to be profitable as slaughter cattle, and this lack of development is manifest in the carcase.

12. The examination for age may be summed up as follows :—

i. A fore-quarter is acceptable in this respect if cartilage is still present on the tips of the spinal column, or if it has quite recently become ossified as shown by the condition of the bone at those points. A fore-quarter that does not display this condition should not as a rule be accepted at home stations, since the five-year-old ox is so rare, and, assuming that the quarter is, therefore, that of a cow, it would be over age, in this case four years. Both fore- and hind-quarters of bull or stag beef would be eliminated under the sex clause.

ii. A hind-quarter of ox beef is, at home stations, practically acceptable at sight, so far as age is concerned. In countries where oxen are used for draught purposes, the appearance of the bones of the " os pubis " and spinal processes will be sufficient indication of the age of the carcase.

iii. A hind-quarter of heifer or cow beef is acceptable only if cartilage is to be found on the " os pubis " or there are clear indications that ossification has only recently become complete.

iv. The " os pubis " pelvic or aitch bone has three prominences. In the young heifer or cow, it is very large and round at the front point ; with age it not only loses its cartilage, but narrows down to at least a third and broadens out extensively at the centre back points.

For illustrations as to age, *see* Plates 13 to 16, following in sequence after page 34.

Sex—

13. If examination is conducted in the order followed here, carcases of old cows will already have been rejected under the age clause, and examination for sex becomes merely a question of detecting bull and stag meat.

14. At the same time it may be useful to remember the characteristic conformation of the old cow as mentioned above. " Cow beef " from animals as much as eight or nine years old is frequently fat and answers to the description " well fed." The udder is generally large, pendulous and spongy.

15. There is no means of distinguishing the fore-quarter of a young well-fed ox from that of a young well-fed heifer, but there is no need to, since both are acceptable.

16. The fore-quarter of bull beef is most easily recognized by the thick, heavy, dark-looking "crest." There is a general massive appearance of the frame, showing more lean than fat.

17. In the hind-quarter sex is recognized as follows :—

The exposed muscle in the buttock above the pelvic bone is triangular in the male and kidney shaped in the female.

In the ox, the root of the pizzle is much smaller than in the bull, and the erector muscle is usually from a half to one inch wide. The cod fat, absent in the female, is ragged and plentiful.

In the bull, the root of the pizzle is thick and coarse, and the erector muscle may be as much as three inches wide. The cod fat will lack the ragged appearance, will not be so plentiful as in the case of the ox, and will be less pointed.

The aitch or pelvic bone of the bull is large and massive.

The flesh of the bull is coarse, dark in colour, dry and harsh to the touch and less juicy, and the marbling of fat is absent.

The fat of the bull is generally very white, and there is much less fat in proportion to muscle than in the ox.

The buttock of the bull shows far greater muscular development than that of the ox.

18. The characteristics of "stag" meat are similar to those of bull meat, but are less marked.

If the operation of castration was performed early in the animal's life, the general appearance will more nearly approach that of the ox than if castration was carried out at a later age.

The thickening of the muscles on the top of the neck is always a feature in a stag carcase no matter at what age the animals have been castrated.

The ability to recognize stag meat is important as contractors, particularly in the case of frozen beef, frequently try to pass off stag meat as ox beef.

19. The udder of a heifer is a smooth oval of solid fat. The greater part of the udder of a young cow is solid. The udder of an old cow is loose, brown, spongy and pendulous, in proportion to the age attained. (*See* Plate 13.)

20. Butchers often cut the udder partly or entirely out of an old cow, and fasten the skin neatly over the part with a wooden skewer, or sometimes by means of stitches. The use of a skewer, or the presence of stitches, should always arouse suspicion. (*See* Plate 14.)

21. The skin round the kidneys of poorly fed animals is frequently stuffed with caul fat. If the kidneys and surroundings are examined and the skewers pulled out, this will be easy to prove.

22. For illustrations as to sex, *see* Plate 7, *et seq.*, following page 34.

Quality—

23. The conditions of contract require that the meat shall be " well-fed, good, sound, sweet and wholesome."

24. Assuming that the animal is of the right age and sex, the quality of the meat will mainly depend on the way in which it has been fed, and on its freedom from disease.

A healthy carcase of well-fed beef has, externally, a rounded, well-filled appearance: the back will be covered with bright clean-looking fat which will be of light yellow colour and free from red patches, spots or other discoloration. The natches, hip-bones and shoulders will be well covered, with no hollowness behind the shoulder blade. The muscles on the outside of the carcase will be uniformly red and not bloodstained. The buttock will be full and round. Internally, the portion of the chest-cavity nearest the skirt will often be found to be well covered with waves of fat, but while their presence is indicative of good feeding, their absence is not necessarily due to poor feeding, since the condition is very largely due to peculiarity of breed. Many carcases of undeniable quality are entirely deficient of fat on the ribs.

The pelvic cavity will be well filled with firm healthy looking fat, and the kidneys well covered with fat. The total of fat in the carcase should be moderately abundant, the normal proportion being held to be about 33 per cent. of the total weight. The proper proportion of bone is from 15 to 20 per cent. The bones will show no discolorations, softness or enlargements.

The colour of the fat will vary from cream or pale straw to bright yellow. The latter shade may arise from peculiarities of breed or feeding. It should be well set, that is to say it should solidify within twelve hours of slaughter. It will be somewhat greasy to the touch, and free from watery or jelly-like fluids, and have no unpleasant smell.

The muscle, or flesh, should be soft and silky to the touch, full of juice and of a slaty blue colour, but a freshly cut section changes colour in a few minutes to a bright cherry red as the result of exposure to the atmosphere. The muscle should be well bled and free from bruises, elastic under slight finger pressure, and free from any tendency to " pit," moist without being wet, and well mottled or marbled with fat. The

graining of the muscles on transverse section should be fine. The connective tissue should glisten on exposure and should be moist, but no fluid should escape from it. In the old cow, there will generally be an absence of marbling. This is not always a dependable guide, because quickly fattened old cows show more marbling than any others; but in all cases the lean will be harsh and stringy to the touch, duller in appearance and deficient in juice, and there will generally be little fat.

25. In the old bull, the flesh is dark in colour, feels like indiarubber, and marbling is absent. There is a very much greater proportion of muscle than fat.

26. Abnormal conditions are generally due to disease.

27. A carcase will sometimes be found to have been stripped, that is to say the pleura (the lining membrane of the chest cavity), and sometimes the peritoneum (the lining membrane of the abdominal cavity) will have been removed.

To remove the lining of the pleura is an easy task if it is done when the carcase is still warm, and the fact that this has been done is generally not apparent to the casual glance.

Investigation, however, will almost always disclose the marks of the knife under the skirt, and, should any doubts still remain, an infallible test consists of trying to strip the quarter again. There is a second membrane immediately covering the ribs and under the pleura, but this will only tear off in little pieces instead of coming away whole, as does the tougher pleura.

To remove the peritoneum is a difficult operation if done in such a manner as not to cause mutilation of the carcase, and the result is always unsightly and obvious.

It is usual, when stripping is apparent, to suspect that it has been done to conceal some disease characterized by growths on the pleura or peritoneum, and stripped carcases should always be rejected. In the conditions of contract there is always a clause to the effect that the removal of any part of the pleura will be considered sufficient justification for rejection.

It is usual when stripping has taken place to smear the stripped carcase with fat.

28. There are, however, two perfectly legitimate reasons for stripping a fore-quarter :—

i. Calves are very subject to pleurisy and, although they become quite cured, the two parts of the pleura will often have become united, and after slaughter the removal of the viscera causes the pleura to tear and leave an unsightly appearance. The butcher, therefore, resorts to stripping to make his meat saleable.

ii. The result of "bodying" or "over sticking," caused by the knife used for bleeding being allowed to cut a passage into the thorax and so admit blood into the chest cavity from the severed jugular vein. This stains the pleura, and necessitates its removal before the carcase is saleable.

These two exceptions cannot, however, be allowed to interfere with the general rule that all stripped fore-quarters should be rejected.

29. When an animal is stripped for any cause, the butcher always uses the excuse "over sticking," although as a matter of fact he never does strip for over sticking, owing to the risk of having the meat destroyed by sanitary officials.

30. For illustrations as to quality, *see* Plates 8, *et seq.*, following page 34.

Sweetness—

31. To decide whether meat is sweet or tainted is generally simple, and merely requires the employment of the senses of taste and smell. Fresh meat is slightly acid to the taste, while stale meat is distinctly alkaline.

If a doubt exists about the sweetness of a hind-quarter, a clean wooden skewer should be thrust about six inches into the flesh just above the "os pubis," a part known as the "facing of the buttock." The skewer should smell sweet, although somewhat meaty on being withdrawn; if the smell is strong and disgusting, the meat is bone tainted.

32. Bone taint usually takes place in the centre of the buttock, and sometimes round the head of the humerus and scapula. It usually sets up when the animals are killed unfasted or excited, are not eviscerated with expedition, or are slaughtered in unclean surroundings or hung too closely together in badly ventilated buildings.

It occurs during the time the animal is cooling. If when the flesh is cool and properly set no bone taint exists, putrefaction takes place from the surface and lymphatic glands.

33. A fore-quarter may similarly be tested by probing the thickest portion of the meat, near the scapula.

34. In doubtful cases, the quarters may be more closely examined by having them cut right through, either at the pelvic bone, or chuck rib, but the contractor or his agent should be warned that the meat is being cut at his risk, and that cutting will not necessarily constitute acceptance.

35. Owing to the thickness of the flesh at both of the above probing places, the animal's heat takes a long time to escape

therefrom after slaughter, and consequently they are the first portions to go bad.

36. To promote a rapid passing off of animal heat from the hind-quarter, butchers often open the stifle joint, a simple and useful operation in warm and close weather.

37. Small joints of meat can easily be tested by smell.

38. In hot weather meat may become " fly-blown." This is most common in the thinner portions, in places where the meat is badly butchered, notched or jagged, and in parts which are much blood-stained. Fly-blown meat has a very strong smell, but the portions affected may generally be cut off and the remainder accepted, if sweet.

39. Ordinary putrefaction commences from the outside.

Dressing—

40. The conditions of contract require that carcases of animals killed in the United Kingdom shall be dressed as follows :—

> " In oxen, the root of the pizzle shall not be removed nor any portion of the cod fat. In heifers and cows, no portion of the udder shall be cut away."

Any violation of this clause should always be met by rejecting the meat.

If the kidneys are removed, the kidney fat must also be taken out.

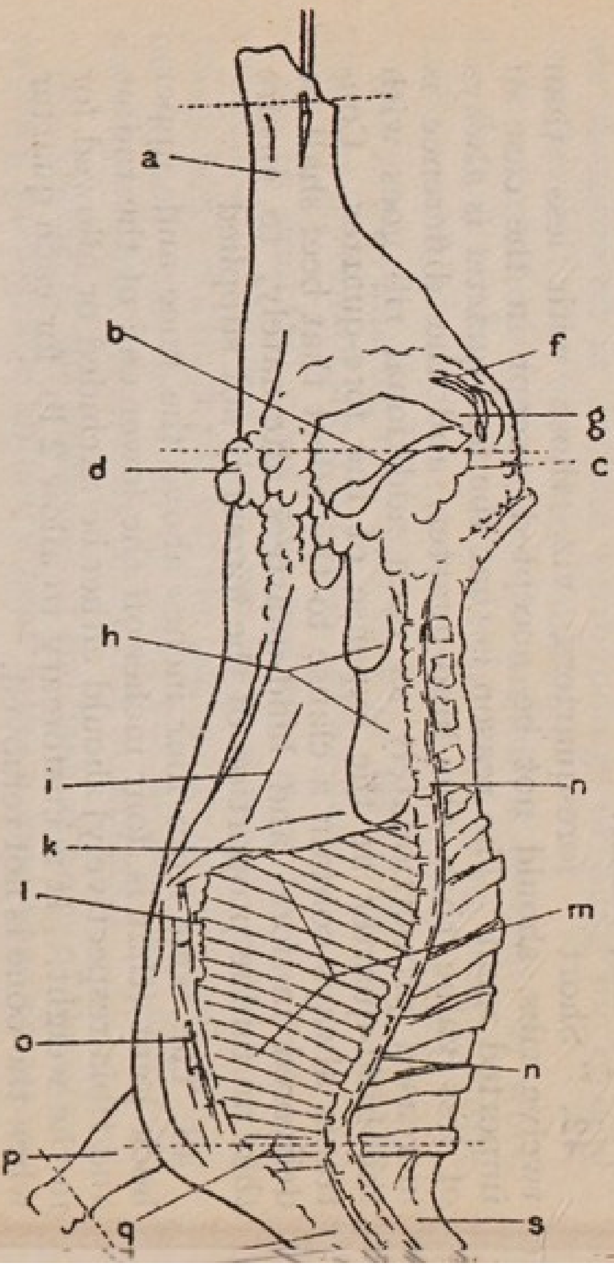
41. A clause is usually inserted in contracts to the effect that meat which is excessively fat will not be taken unless the contractor consents to remove all surplus fat, such removal not to take place until after the meat has been inspected by the inspecting officer.

42. " Short " fore-quarters, viz. those with less than twelve ribs, should not be accepted, except in the case of imported meat. The reason is that the fore-quarter is always of less value than the hind-quarter, and the difference is increased proportionately as each additional rib goes with the hind-quarter at the expense of the fore-quarter. Contracts always contain a clause to the effect that beef shall be delivered in fore- and hind-quarters alternately, to ensure that an undue proportion of the former is not supplied.

43. The bone from four inches above the knee and upper hock joint (that is, four inches off the lower end of the radius and tibia respectively) should either be excluded or allowed for in the weight. It is customary to allow 2 lb. for each quarter when the bone is not removed.

PLATE 7.—APPEARANCES OF THE SEXES, ETC.

Male



The object of this Plate is to show the difference in appearance of the sexes, and the names given to the various parts of a side of beef.

	Male	*Female*
The Shank	*a*	*a*
The Pelvic or Aitch Bone	*b*	*b*
The Pelvic Cavity ...	*c*	*c*
The Cod Fat	*d*	*nil*
The Udder or Duct ...	*nil*	*e*
The Pizzle	*f*	*nil*
The Erector Muscle or Root of Pizzle ...	*g*	*nil*
The Kidney Fat ...	*h*	*h*
The Peritoneum... ...	*i*	*i*
The Diaphragm or Thin Skirt	*k*	*k*
The Pericardium ...	*l*	*l*
The Pleura or Coating of the Ribs	*m*	*m*
The Vertebræ	*n*	*n*
The Brisket	*o*	*o*
The Fore Leg	*p*	*p*
The Chuck Ribs... ...	*q*	*q*
The Gullet	*r*	*r*
The Crest	*s*	*s*

The dotted lines drawn across the hind and fore legs show where these should be cut according to the contract.

N.B.—Officers are recommended when studying this and other plates to realize as far as possible the relation which exists between the different portions of dead meat and the same parts in the animal when alive and standing. This will be found of the greatest assistance in obtaining a knowledge of the subject. If this

Female

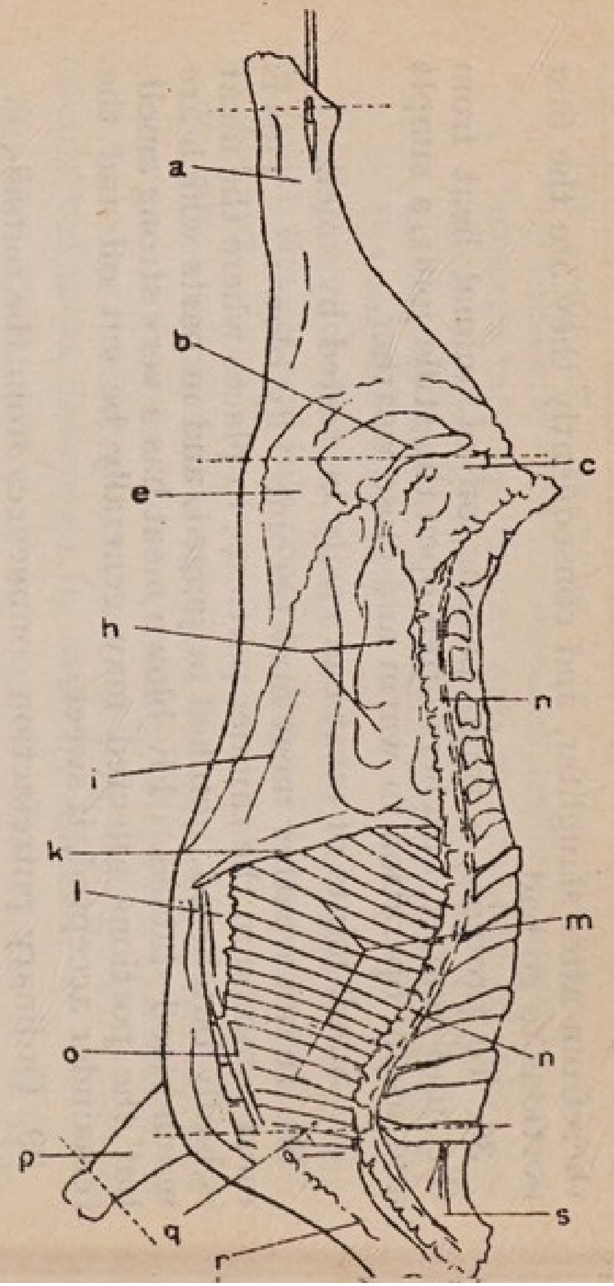


PLATE 8 PRIME JOINT OX BEEF.

EXPLANATION.

This Plate is intended to give some idea of a prime well-fed piece of ox-beef.

PLATE 9 HIND-QUARTERS OF OX AND BULL.

Fig. 1—OX.

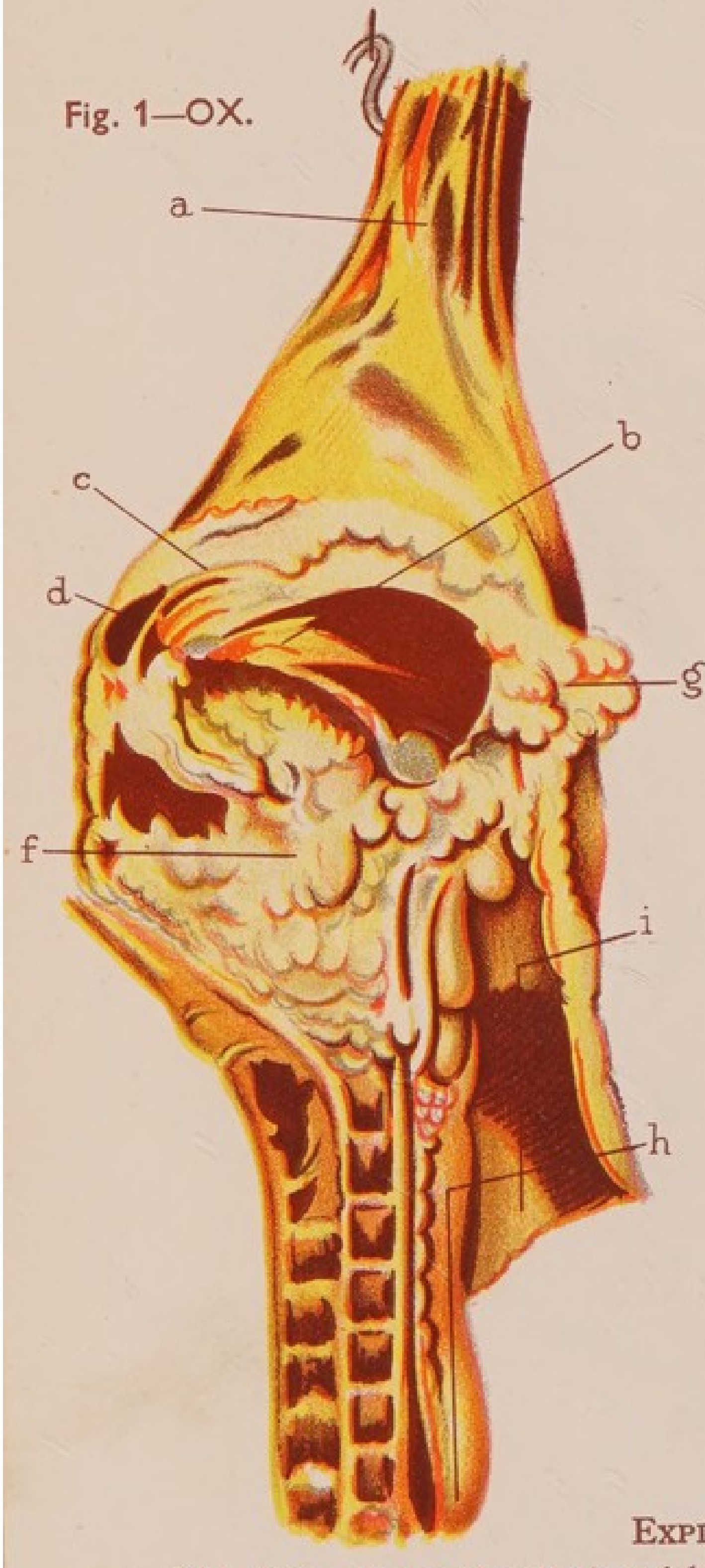
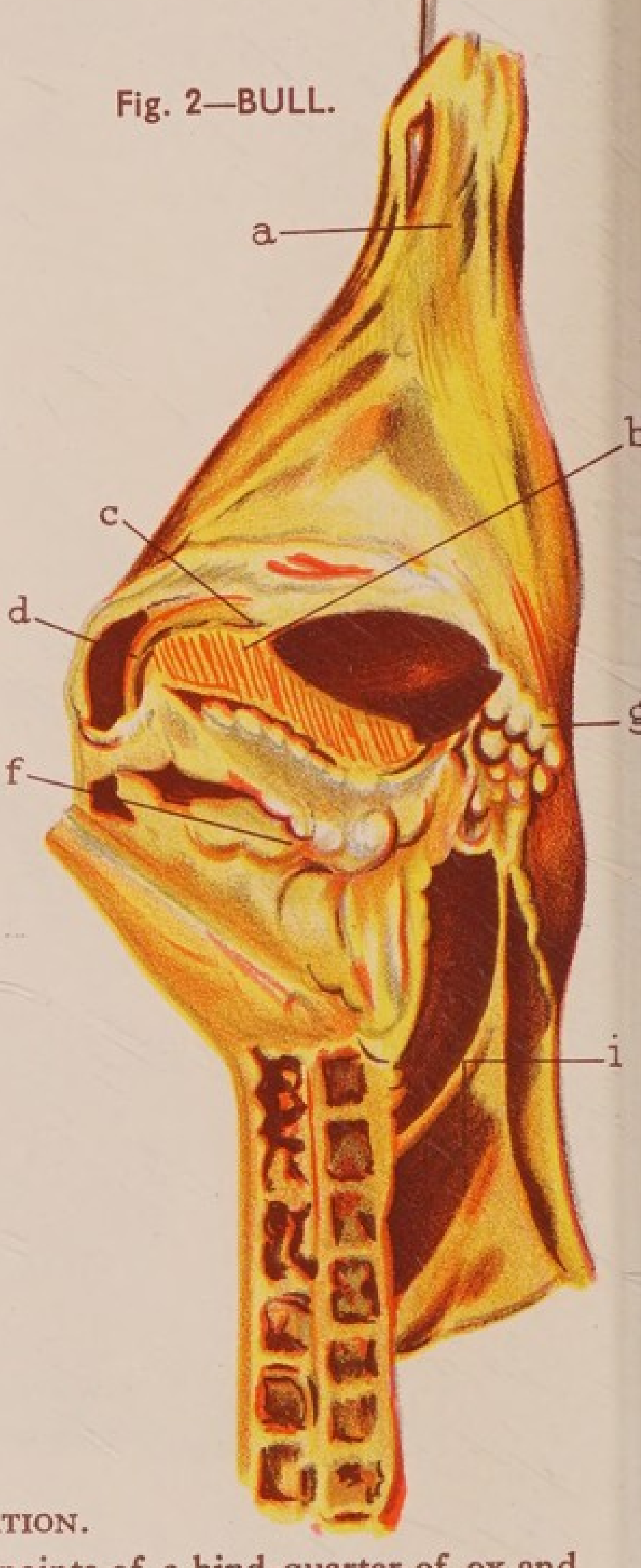


Fig. 2—BULL.



EXPLANATION.

This Plate shows the distinguishing points of a hind-quarter of ox and a hind-quarter of bull.

a a	The Shank.	*f f*	The Pelvic Cavity.
b b	The Pelvic or Aitch Bone.	*g g*	The Cod Fat.
c c	The Pizzle.	*h*	The Kidney Fat.
d d	The Erector Muscle or root of the Pizzle.	*i i*	The Peritoneum.

The kidney fat of the bull from which this drawing was made was so small as to be hidden by the vertebræ.

Plate 10 Pelvic Regions of Ox and Bull.

This is an enlarged drawing of the pelvic region of an ox and bull, showing the relative sizes of the different parts.

Fig. 1—OX.

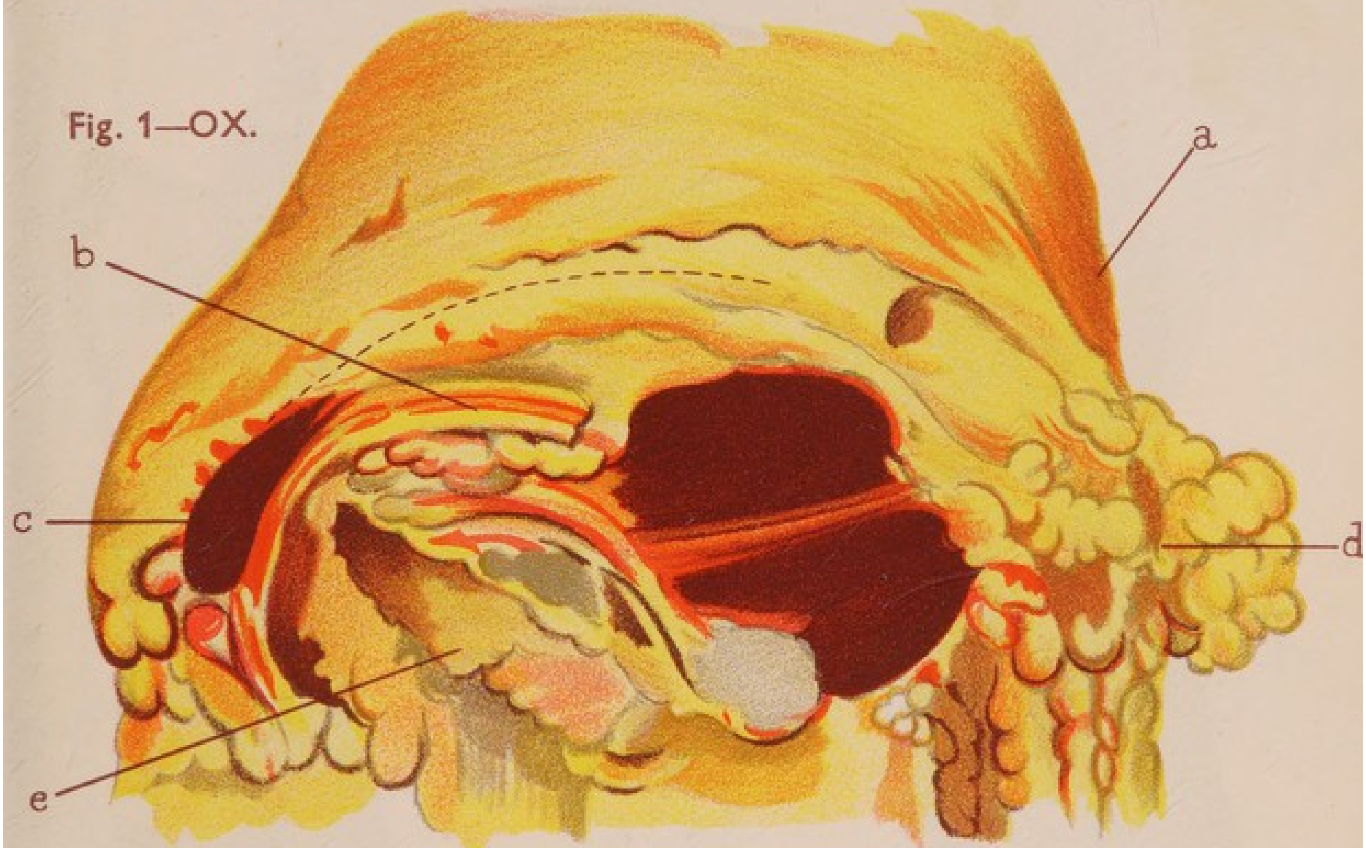
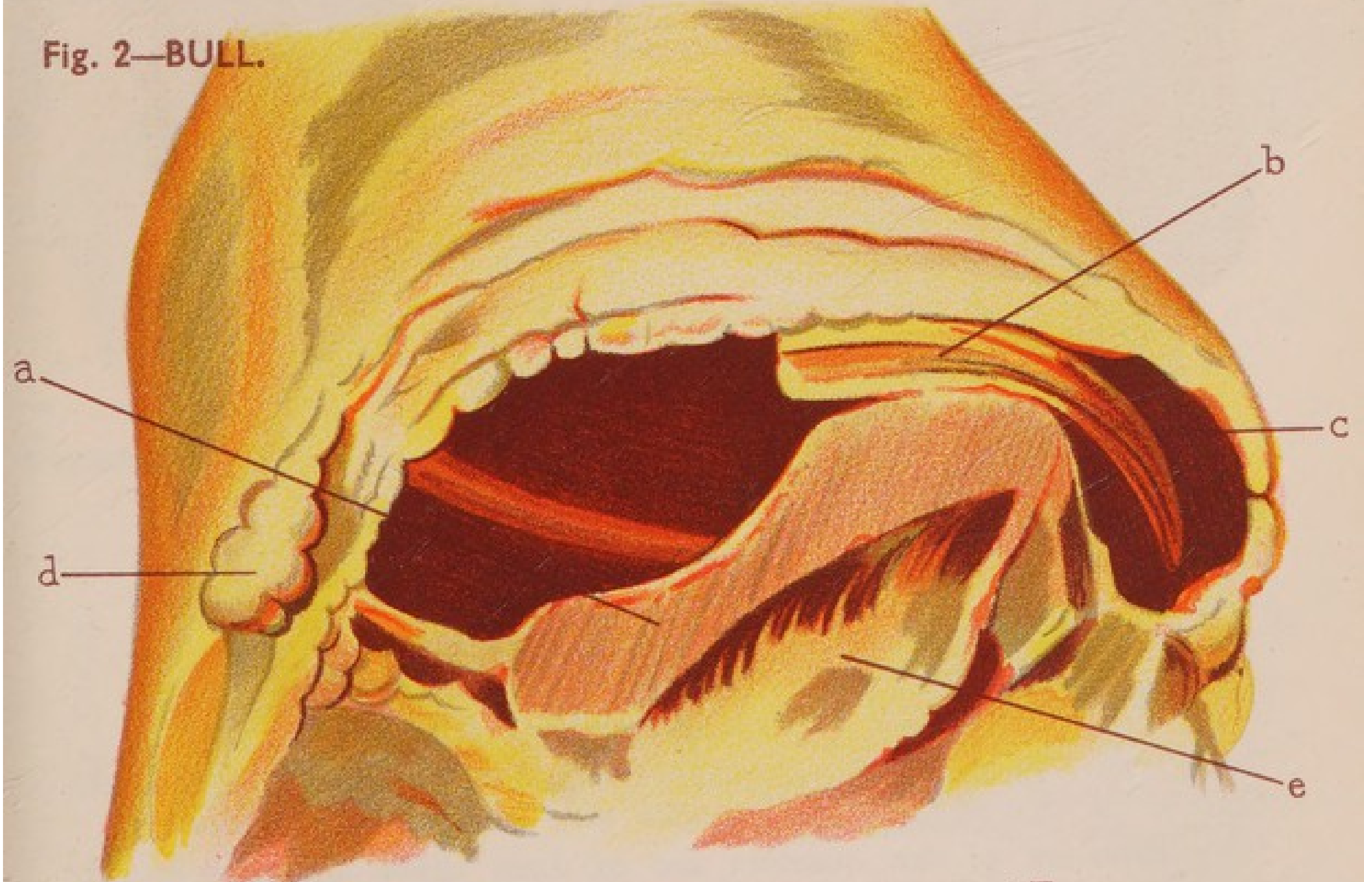


Fig. 2—BULL.



a a The Pelvic Bone.
b b The Pizzle.
c c The Erector Muscle.
d d The Cod Fat.
e e The Pelvic Cavity.

Plate 11
Fore-Quarters of Ox and Bull; Crest Muscles.

Fig. 1—OX.

Fig. 2—BULL

Explanation.

This Plate represents fore-quarters of ox and bull hung so that the difference of size of the crest muscles may be seen at a glance.

The exteriors of the quarters are in deep shade in order to give this point more prominence.

a A crest muscle or collar.

PLATE 12—FORE-QUARTERS OF OX AND BULL (SIDE).

EXPLANATION.—The object of this Plate is to show the difference between the fatty covering and muscular development of a fore-quarter of ox and that of a bull.

Fig. 1—OX.

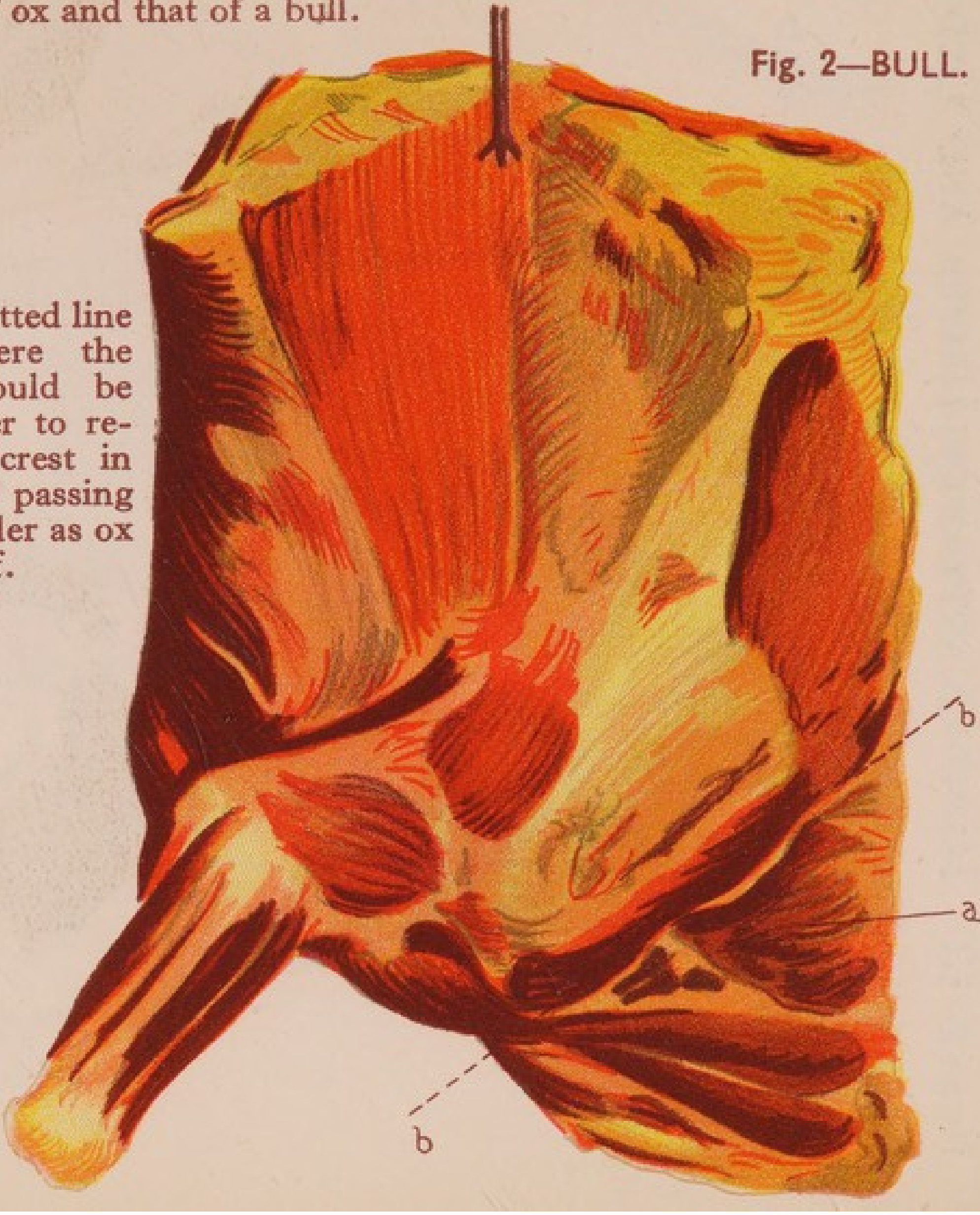
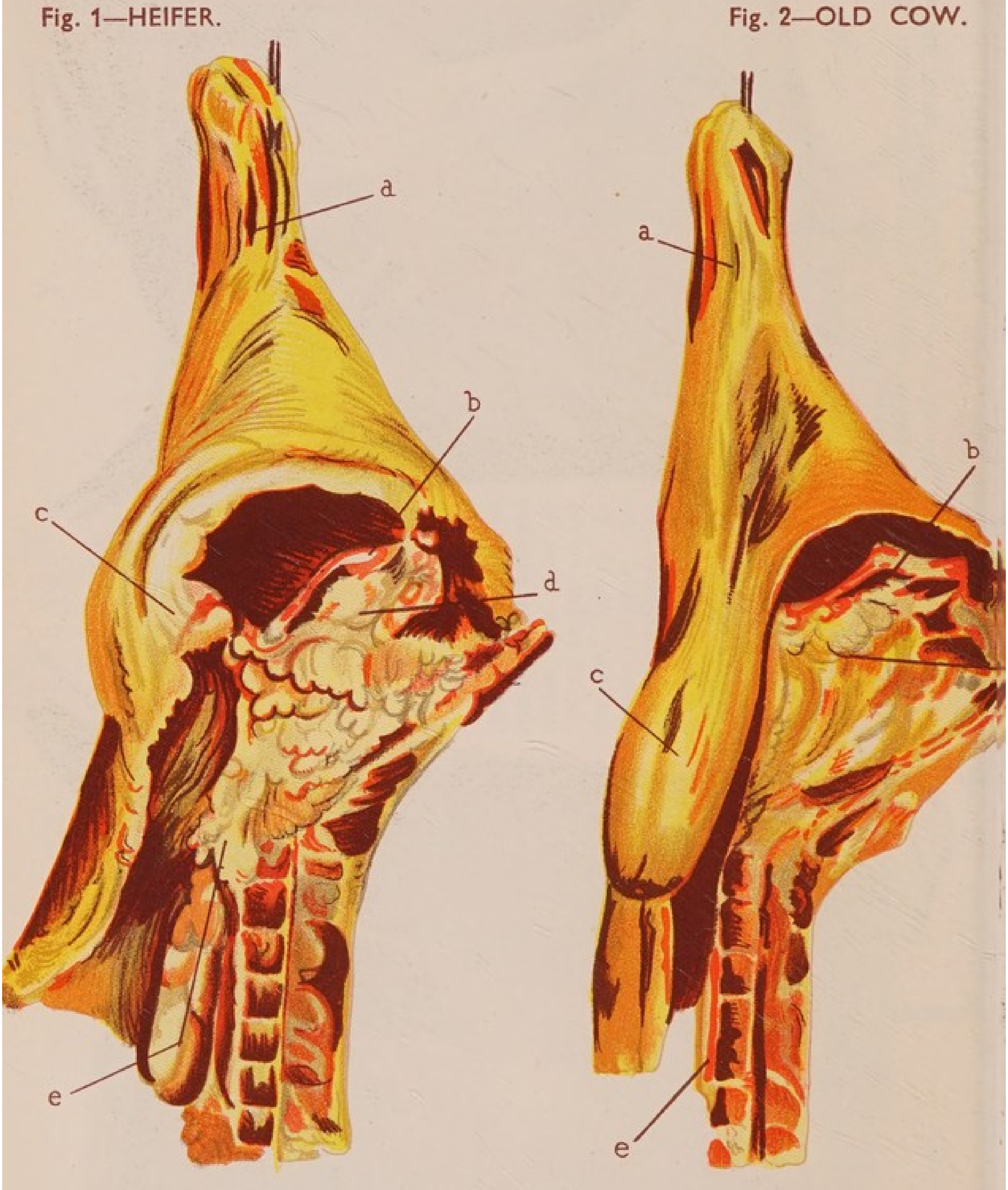


Fig. 2—BULL.

a a Crest.

b b The dotted line shows where the quarter would be cut in order to remove the crest in the hope of passing the remainder as ox beef.

PLATE 13 HIND-QUARTERS OF HEIFER AND OLD COW.



a a The Shank.
b b The Pelvic Bone.
c c The Udder.
d d The Pelvic Cavity.
e e The Kidney Fat.

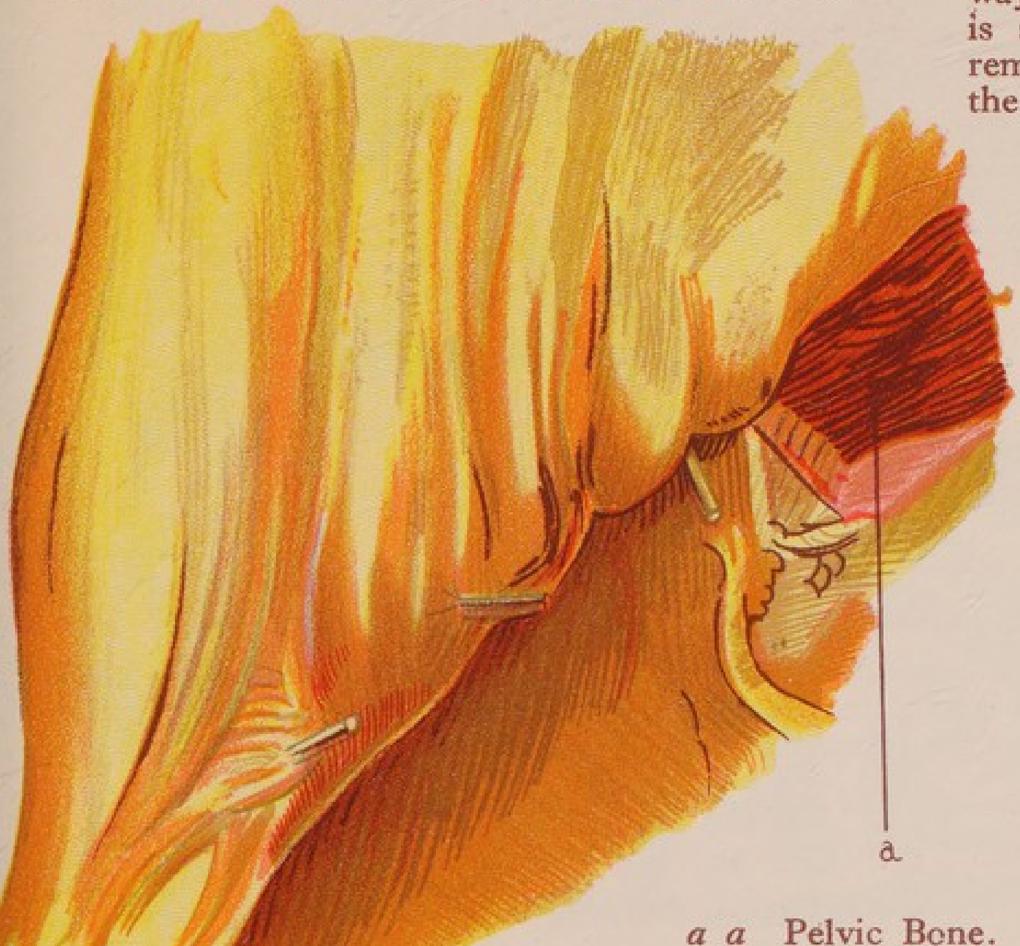
PLATE 14 UDDERS OF HEIFER AND OLD COW.

Fig. 1—HEIFER.

EXPLANATION

This Plate shows the appearance of the udder of an heifer when cut through, and also the way in which the skin is skewered after the removal of the udder in the case of an old cow.

Fig. 2—OLD COW (*Seat of Udder skewered over*).



a a Pelvic Bone.

PLATE 15 FORE-QUARTER OF OLD COW (EXTERIOR).

EXPLANATION.

This Plate represents the exterior of a fore-quarter of old cow.

The difference between the fore-quarter of an ox and that of an heifer is so slight that it could not well be represented in a drawing. This Plate should, therefore, be compared with the fore-quarter of ox in Plate 12.

a The Scapula or Shoulder Blade.

PLATE 10.—FORE-QUARTERS OF HEIFER AND OLD COW (INTERIOR).

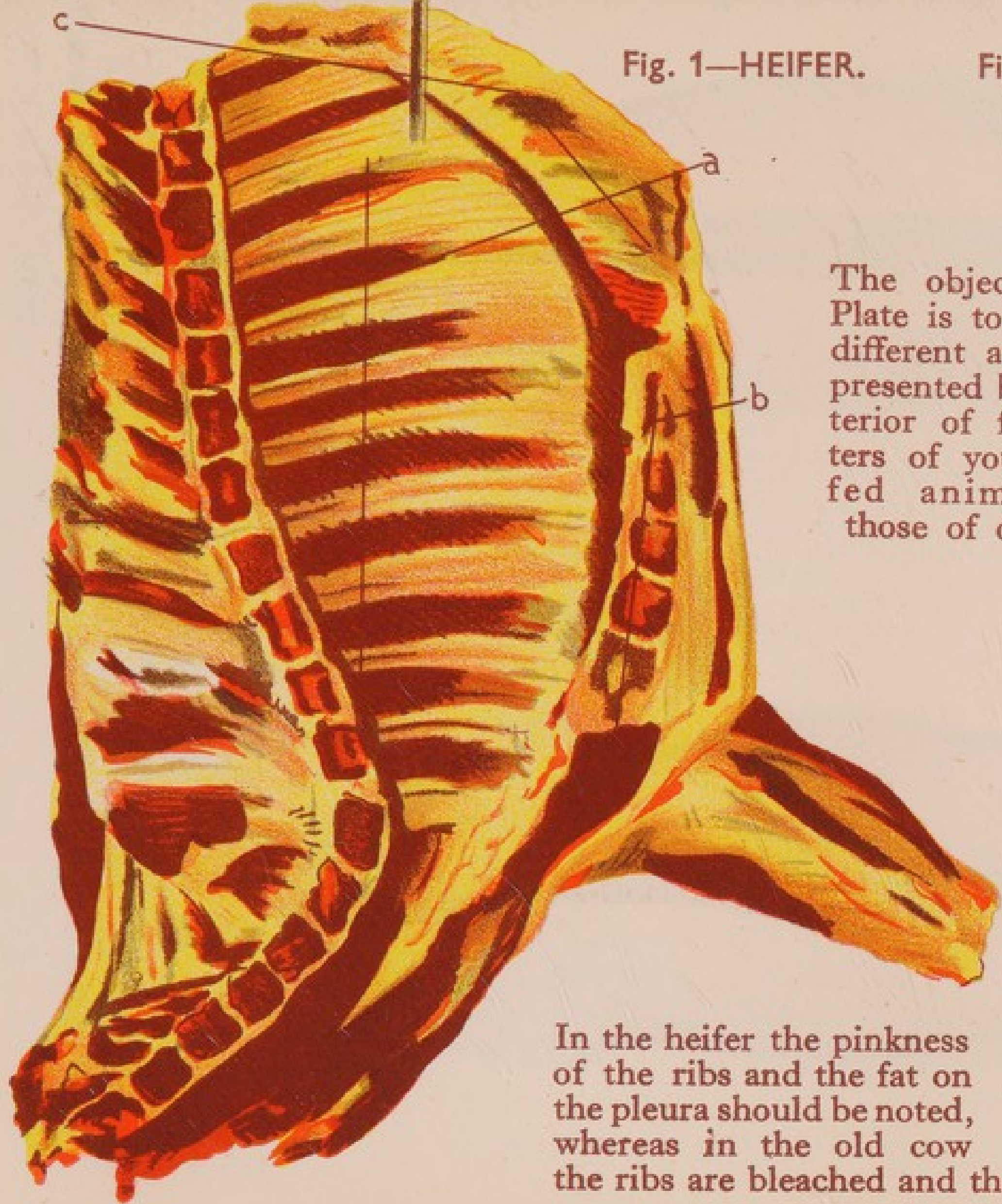


Fig. 1—HEIFER.

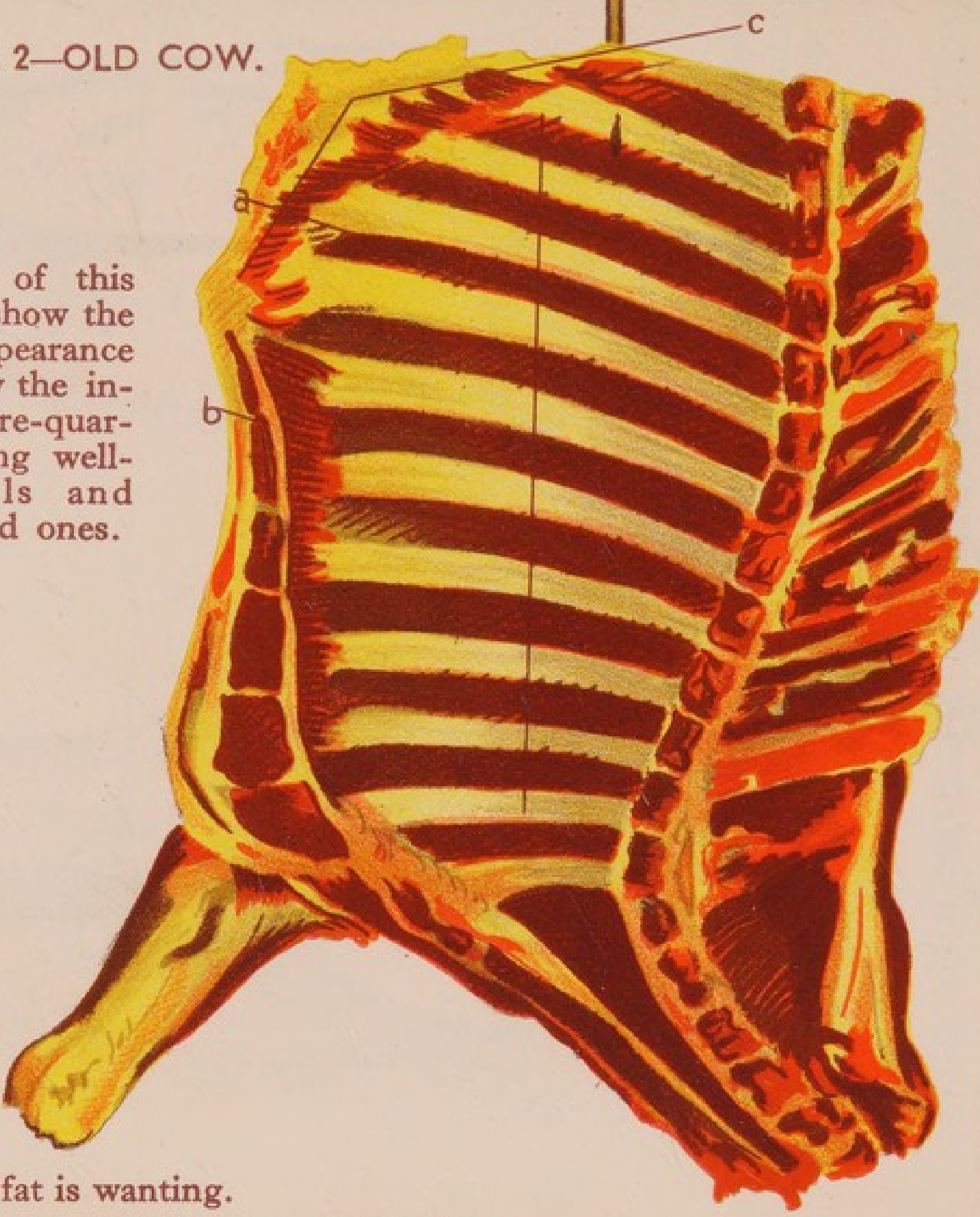


Fig. 2—OLD COW.

The object of this Plate is to show the different appearance presented by the interior of fore-quarters of young well-fed animals and those of old ones.

In the heifer the pinkness of the ribs and the fat on the pleura should be noted, whereas in the old cow the ribs are bleached and the fat is wanting.

a The Pleura. *b* The Brisket. *c* The Diaphragm or Thin Skirt.

Plate 17 Wether and Ewe.

Explanation.

This Plate represents the difference between a wether and a ewe.

Fig. 1—WETHER.

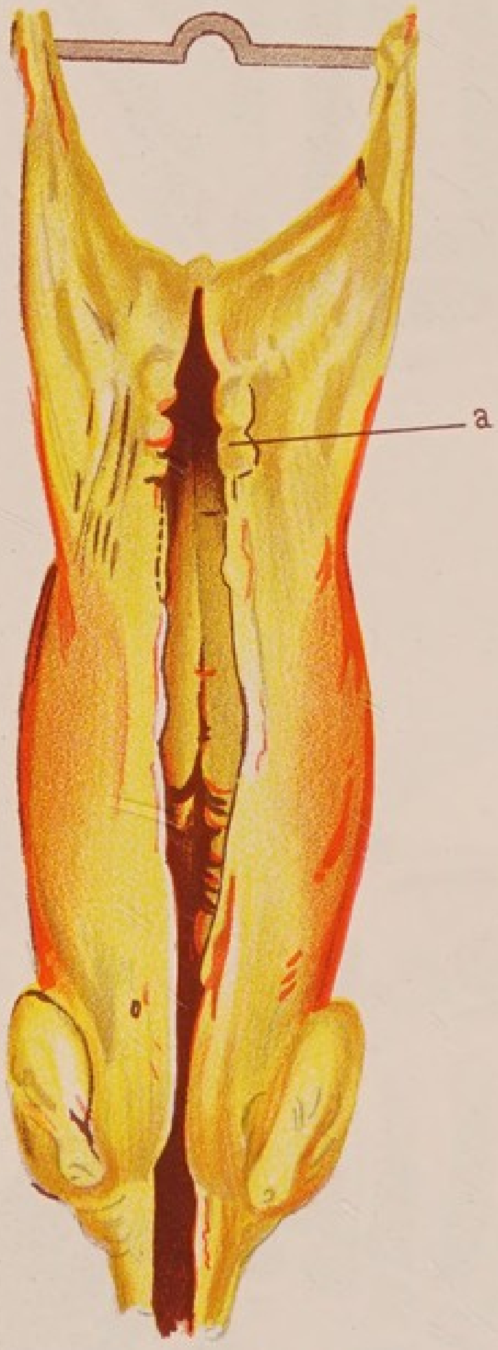
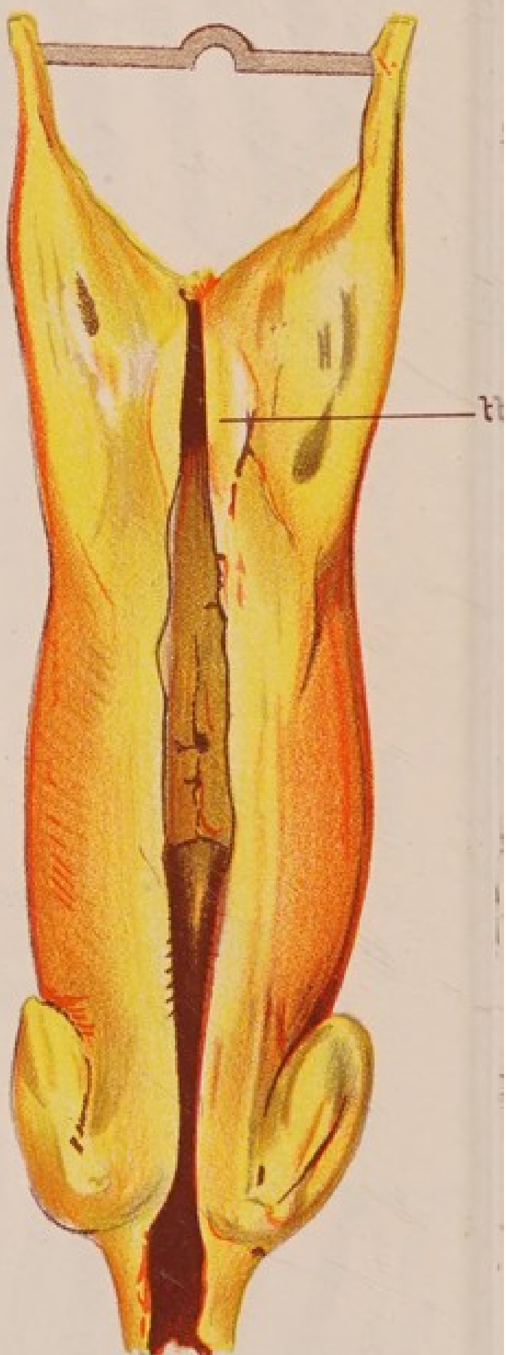


Fig. 2—EWE.



a The Cod Fat.

b The Udder of the ewe—the point to which the pizzle extends in the wether.

The dotted line in the latter shows where the pizzle is usually dressed.

Plate 18

Muscular Development of Wether and Ram.

Explanation.

This Plate shows the difference between the muscular development of a wether and that of a ram or "tup" sheep. It also gives the general appearance and colour of healthy well-fed animals.

Fig. 1—WETHER.

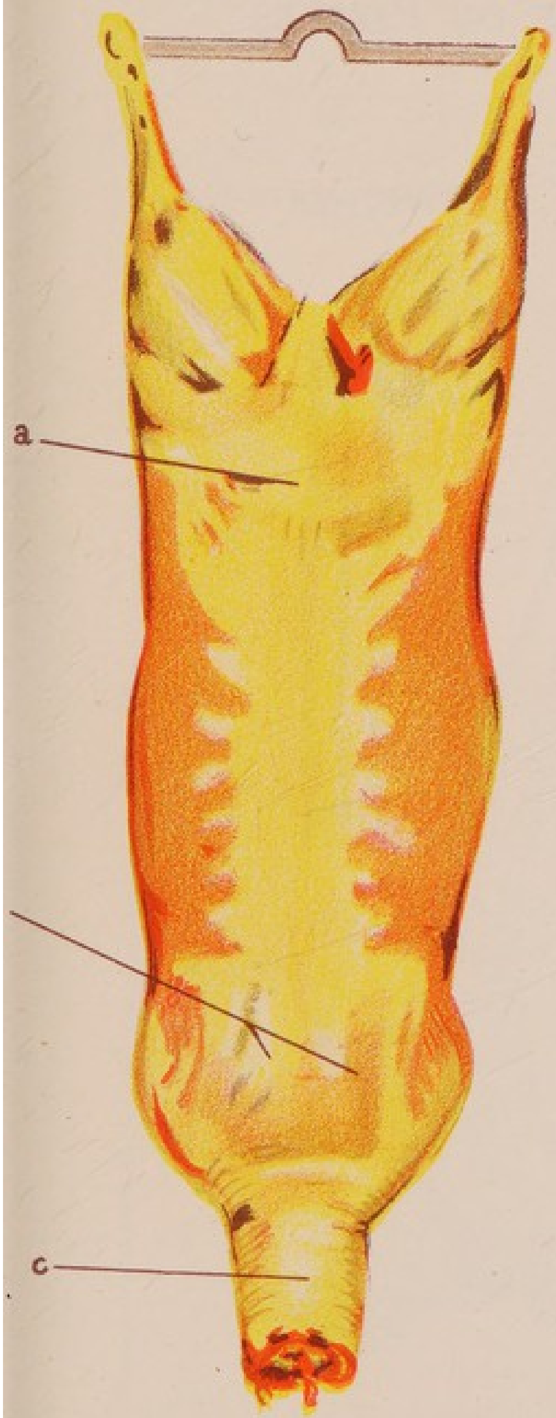
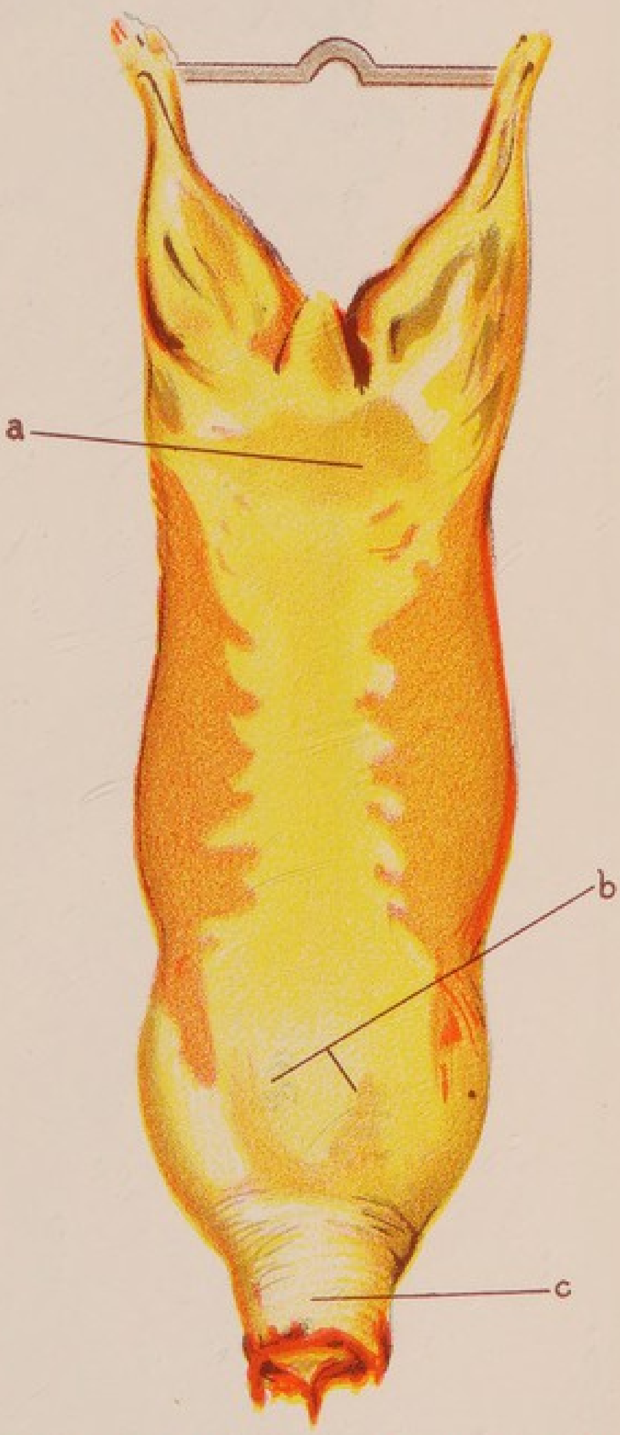


Fig. 2—RAM.



a a Chump end of the loin, where the stripping of excessive fat should commence.

b b The point where the bluish tinge, showing that the animal is not too fat, should be looked for.

c c The Scrag.

Plate 19 Portions of Pizzles

OF

RAM AND WETHER

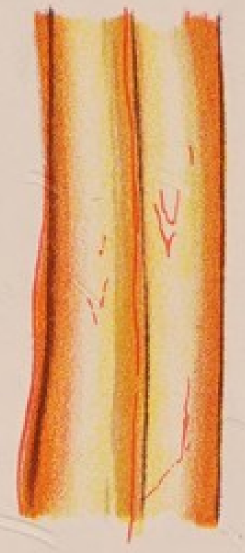


Fig. 1.

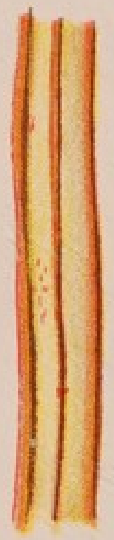


Fig. 2.

PLATE 20.—GLANDS.

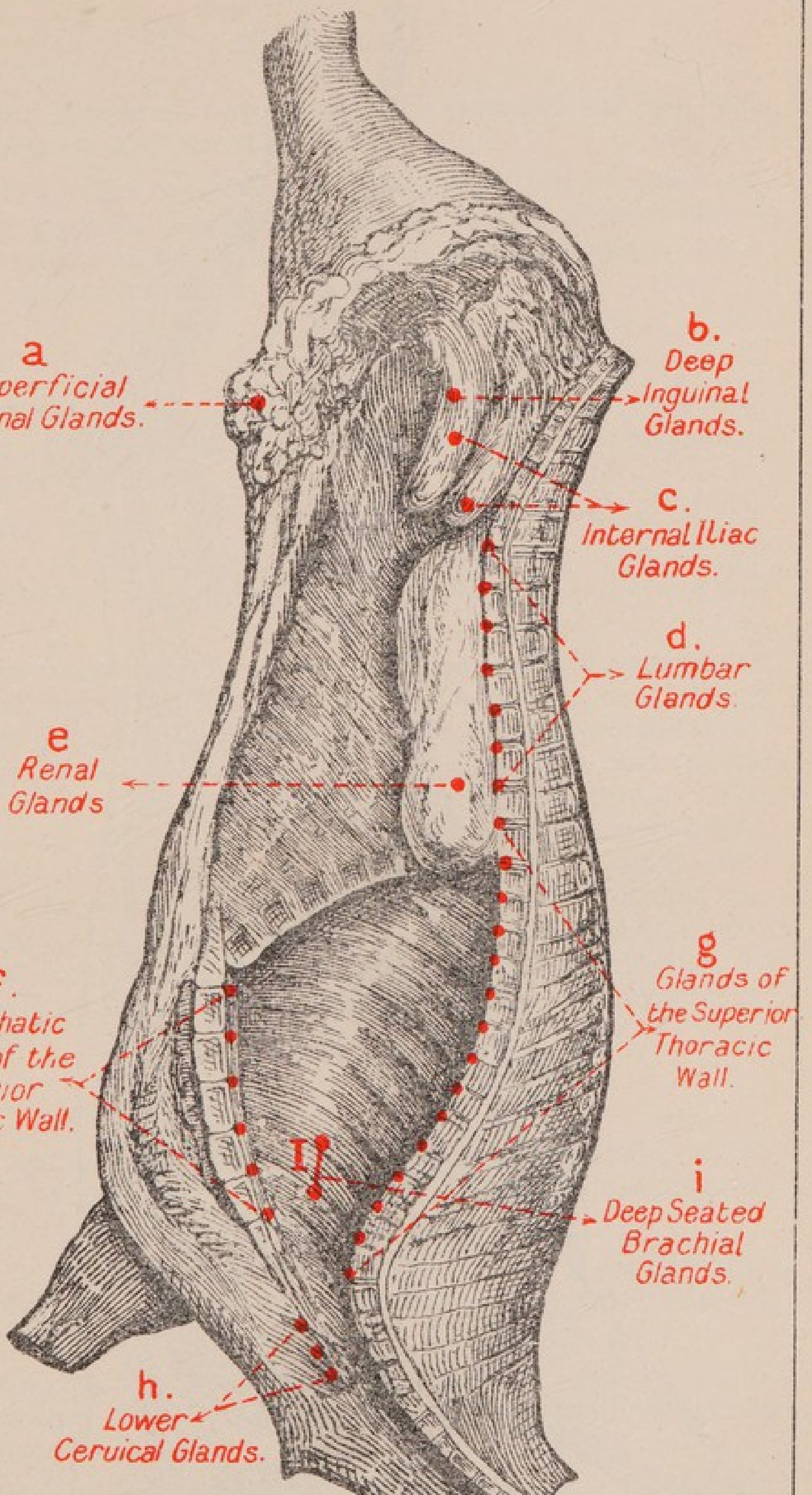
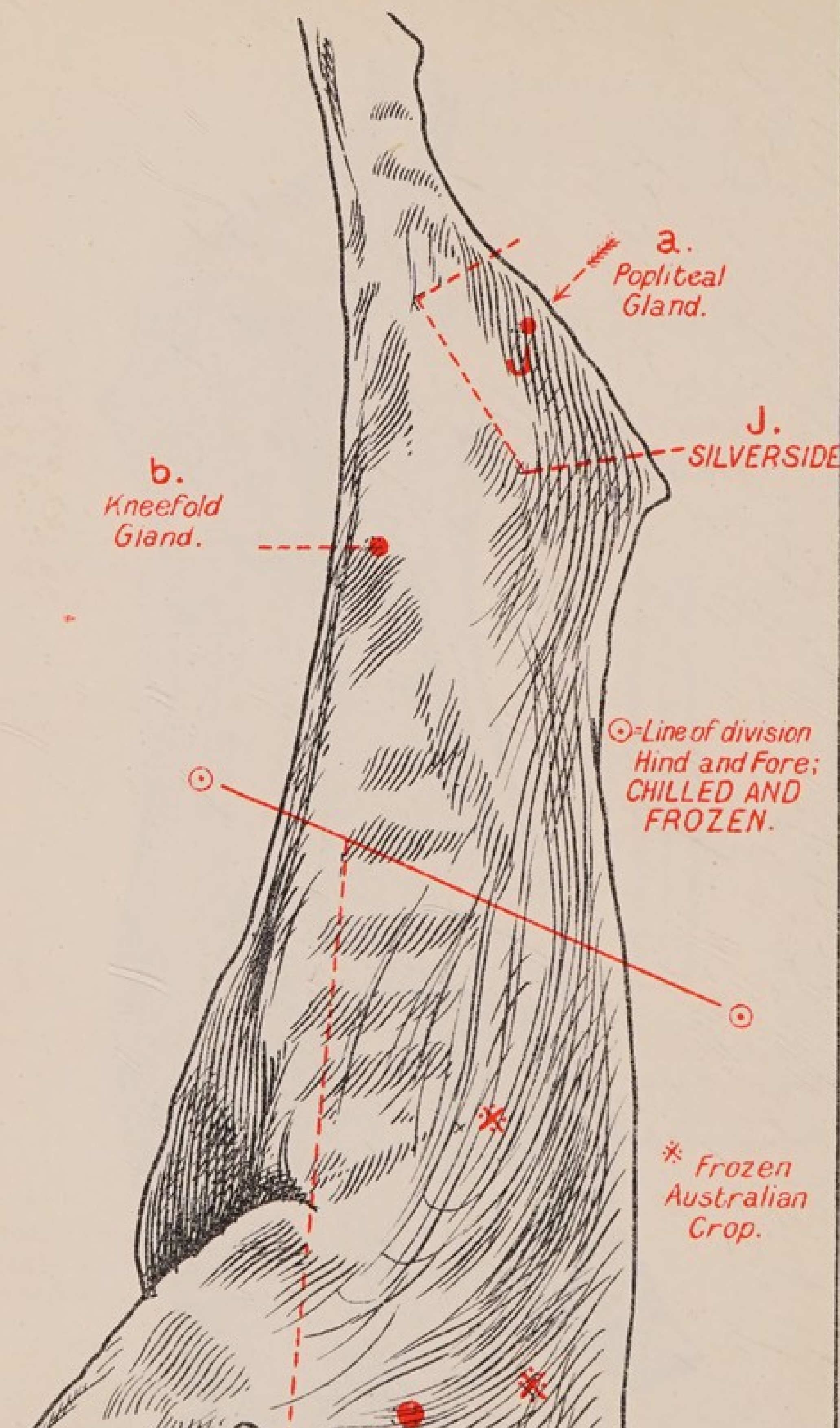


PLATE 21. - GLANDS.



Mutton

44. Mutton, like beef, requires to be examined for age, sex, quality, sweetness and dressing.

Many of the rules applicable to the inspection of beef can be modified to meet the requirements of the inspection of mutton, but mutton being delivered in whole carcases, some of the signs are not available.

Age—

45. The five-year-old wether is just as rare as the five-year-old ox. The old female, however, is frequently met with, and sometimes the ram.

In a young animal, the ribs and the knee, or hock joints, will be pink in colour and comparatively soft. In an old sheep, the ribs and leg joints will be white, and the bone dense and hard.

The age of mutton is, however, best told by the appearance of the sexual organs. The cod fat of the wether is a certain guarantee of youth. The udder of a gimmer is a smooth oval of solid fat, that of the young ewe is partly solid and white, and partly of a spongy consistency and brown in colour. The udder of the old ewe is a brown spongy mass which never sets. If any doubt exists—and the contractor will consent—the division of the carcase into two sides, thus exposing the spinal processes and the " os pubis " will settle the question, for the presence, or indications of the recent presence, of cartilage will be found in all animals within the prescribed limits of age.

Sex—

46. The wether is known by the " string " or pizzle, which should not be much thicker than an ordinary lead pencil. The cod fat is lobulated and bunchy.

The legs of the ram exhibit much greater muscular development, and the neck is very much thicker and heavier, showing a decided " crest."

In the case of the female the condition of the udder, as described above, shows plainly whether the animal has been allowed to breed.

If the ewe has had many lambs, small veins will be seen where the womb has hung, and the pelvic cavity becomes

larger with age. The knuckle bones are smaller in ewes than in wethers.

47. For illustrations on mutton, *see* Plates 17, 18 and 19, following in sequence after page 34.

Quality—

48. A carcase of good, well-fed mutton should be " mackerel-backed," that is, there should be alternate red and white bars over the loins. These marks are natural, being caused by the bark, and must not be confused with artificial marks often made by the butcher's knife. Too much stress must not, however, be laid on this marking, since its presence or absence is not infrequently due to breed. The flesh of mutton varies from a light red to a brick-red colour, is fairly firm to the touch, and has no fine fibres.

In well-fed specimens there is plenty of fat, especially under the skin and round the kidneys. Some of the best carcases display dense white fat at the rump and over the shoulders, and should be liberally pared at those parts, provided the contractor consents; otherwise they should be rejected.

Contracts usually specify that carcases of sheep weighing less than 50 lb. will not be accepted.

Sweetness—

49. The sweetness of mutton can be tested by probing at the "os pubis" and smelling the skewer or knife. This part is the first to go bad as it is the thickest portion of the carcase and retains the animal's heat longest.

As in beef, putrefaction, other than bone taint, commences in the neck, shanks and lymphatic glands.

Dressing—

50. The conditions of contract require the dressing to be as follows :—

> " In wethers, the pizzle shall not be removed. In ewes no portion of the udder shall be cut away."

Carcases having these parts tampered with should be rejected.

Ration mutton must be delivered in carcases, excluding heads and the shanks from below the knee and hock joints.

If the kidneys are removed, the kidney fat must also be removed.

Glands

(*See* Plates 20 and 21.)

51. No inspection of dead meat for health is complete until several of the lymphatic glands have been examined.

The glands of the body are secreting structures which in various ways alter the material brought to them by the blood, extracting and excreting waste products (of which action the kidneys afford a good example), or manufacturing valuable by-products, such as the bile in the liver.

The lymphatic glands, so called, are not glands in the proper sense of the word. Lymph which exudes from the blood is a colourless, or faintly yellowish, liquid, rather salt to the taste. It fills the lymphatics, which are a network of lymph vessels which lie in the cellular spaces of the body. The business of these lymphatics is to pick up the fatty products of digestion, and distribute them to the blood by way of the veins. The lymph passes through the lymphatic glands before discharging into the veins. Being fed by the blood, the lymphatic glands invariably receive and then provide a convenient resting place for such micro-organisms as may enter the body in such numbers as to escape immediate destruction through the normal action of the healthy body.

Incipient disease may accordingly be very often detected through examination of the lymphatic glands and, as a general rule, their condition is a valuable aid to the inspector and confirms or disputes the evidence furnished by the appearance of the exterior of the carcase.

Lymphatic glands are soft and elastic to the touch, of a greyish-yellow or greyish-brown colour, some uniform in colour, others manifesting many tints. They vary in size from a pin's head to a pigeon's egg. They are very numerous, and the most important groups are :

i. Superficial glands—

In the head ..	The "Pharyngeal"	A large gland in the throat at the inner side of the bone at the base of the tongue.
	The "Sub-maxillary."	An oval gland about half the size of the pharyngeal, found on the inner side of lower jaw.
	The "Sub-lingual"	Under the tongue.

In the viscera		The "Bronchial"	Generally 3 to 4 glands not larger than 1½ inches clustered around the branching of the trachea.
		The "Mediastinal"	Anterior and posterior. These numerous glands are scattered through the space between the right and left lung round the windpipe, gullet and heart. These glands may be of considerable length but are slender.
		The "Portal" or "Hepatic."	A group of 10 to 15 glands varying in size and found in the portal space of the liver.
		The "Mesenteric"	An important chain of glands draining the intestines. Some of the glands are large; they are found in the mesentery round the coils of the small intestine and colon.
In the carcase	In the hind-quarter.	The "Supra-mammary."	Found in females only, at the base of the udder.
		The "Superficial Inguinal."	Found in the cod fat of the male. (The "Deep Inguinal" is found near the circumflex artery.)
		The "Internal Iliac."	A group of 6 to 8 glands near the branching of the aorta into the iliac arteries.
		The "External Iliac."	Situated a little lower than the Internal Iliac near the iliac artery.
		The "Sub-lumbar"	Close to the lumbar vertebræ. These are small glands.
	In the fore-quarter.	The "Sub-dorsal"	Small glands found close under the dorsal vertebræ.
		The "Supra-sternal."	Medium sized glands found inside the ribs above the brisket bone.

The majority of the above may be found and examined without injury to the carcase. This is a very important

point, as mutilation of a quarter would (unless the meat is wholly unfit for human consumption) give the contractor the right to demand compensation in full for the meat rendered unsaleable.

ii. **Deep-seated Glands—**

These are :—

The "*popliteal*" or "pope's eye."—A large gland situated in the centre of the buttock. It lies between the thigh muscles, above and behind the stifle joint.

The "*precrural*" or "kneefold."—Also a large elliptical, flat gland found in the flank ; it is generally exposed when the thick flank is separated from the buttock.

The "*prescapula*." A long gland (4–5 inches) situated above the shoulder joint, just in front of the blade bone. This is one of the largest lymphatic glands in the body.

The glands of the mesentery will often be found infected, though no other signs exist elsewhere in the carcase.

When a fore-quarter is examined, it seldom happens that one of the sub-dorsal glands cannot be found either wholly exposed or only partially hidden in the fatty tissue which in a normal quarter clings loosely to the vertebræ of the spine. Failing these, one or more of the supra-sternal glands can generally be found in the fatty tissue near and about the brisket. These are often very small.

The sub-lumbar glands are as a rule to be found enclosed in the fatty tissue in the neighbourhood of the lumbar vertebræ. These are the glands which can be examined best of all the glands of the hind-quarter, without risk of injury to the quarter. Failing these the inguinal (or mammary) and the iliac glands can be opened without spoiling the appearance of the meat.

In the case of a cow carcase, the supra-mammary gland should always be examined.

Horse Flesh

52. Horse flesh may be readily distinguished from beef by the following characteristics :—The fat is always of a yellowish colour, is softer, and never sets. It has an unpleasant sickly taste and an oily feel. Horse flesh can never be mistaken for beef ; it is much darker in colour and coarser in texture, and even if chopped may still be detected by the unusually high content of glycogen. It has a disagreeable smell, like common margarine. The bones of the horse are relatively much larger than those of the ox, and they contain

more fatty matter, which is of a semi-fluid consistency. The differences in the conformation of oxen and horses are also a guide in detecting horse flesh. (*See* Sec. **4.**)

Goat Flesh

53. Goat flesh may be distinguished from mutton, being much darker in colour, and the fat less abundant, though there may be quite as much fat in the loins of the former as in the latter. When newly dressed, the flesh of the adult goat gives off a distinct " goaty " odour. The flesh of the kid, however, very closely resembles lamb, from which an untrained inspector would scarcely distinguish it. In the goat the vertebræ of the neck are more arched and the body is narrower and deeper than in the sheep, the lumbar transverse processes being curved downwards. The neck, body and quarters are all longer than those of a sheep of corresponding size.

11. *General characteristics of diseases*

(For further information, *see* Ministry of Agriculture and Fisheries Bulletin No. 1, Some Diseases of Farm Animals.)

1. Under the Diseases of Animals Acts, 1894 to 1927, the Minister of Agriculture and Fisheries may from time to time issue an Order which requires that every person having or having had in his possession or under his charge a diseased of suspected animal or carcase shall with all practicable speed give notice of the fact to a constable of the police force for the police area in which the animal or carcase is. The Orders now in existence affecting certain diseases, i.e. tuberculosis, foot-and-mouth disease, anthrax and sheep scab, are specifically quoted below.

2. The diseases which affect cattle and sheep are many. It is unnecessary to describe more than those that are most likely to be met with, and then only in general terms.

3. When the incipient stages of disease have been passed, diseased carcases usually assume one of two general conditions which may be described as " fevered," and " dropsical." In either of these conditions, the whole carcase is unfit for human food, whether or not the disease is one that of itself entails seizure of the carcase under the law. Carcases of animals that have died by accident, or from any other cause, will, in most cases, bear one or other of these characteristics, which renders them also unfit for food. Carcases of choked and drowned animals, or animals that have died from head, stomach and digestive derangements, such as staggers, fall under this last category.

4. " Fevered " carcases are dark in colour (even purple), not necessarily on account of the presence of a high temperature before slaughter, but because the animal is generally near the point of death before it is brought to the slaughter-house, and the flesh does not bleed well. Hæmorrhage is often apparent, and the organs and muscles are swollen, the latter having a soft, soapy feeling to the touch, and being generally abnormal in appearance. The carcase sets badly.

5. *Dropsy* is not a specific disease, but a condition arising from many causes. In dropsical carcases the flesh is pale in colour, wet and flabby to the touch. The fat shows a soft, sloppy and jelly-like condition and is very pale in colour. The carcase is generally emaciated, and in all cases should be rejected.

6. The principal characteristics of the more important diseases from the meat inspector's standpoint are as follows :—

(NOTE.—These diseases are mentioned without regard to classification.)

i. *Tuberculosis.*—Notification demanded under Tuberculosis Order of 1925, issued by the Minister of Agriculture and Fisheries.—This is the most common disease that affects cattle. It is very rare in sheep. It is characterized by the appearance of small nodules within or on the surface of the infected organs of the body, on the pleura and peritoneum, and, in extreme cases, in the muscular tissue. The nodules are also invariably found established in the lymphatic glands from comparatively early stages of the disease. The mediastinal gland is generally the first to be attacked. These nodules are caused by the presence in the system of the " bacilli tuberculosis " in large numbers. They set up a circumscribed inflammatory process which results in the destruction of the original tissue of the part affected, and the formation of a new substance, the nodule. The nodules become formed in bunches and clusters as the disease progresses ; the disease is consequently known in the trade as " grapes." Concurrently with this development of the diseased condition, the animal loses flesh, becomes emaciated if not slaughtered in time, and is called by the trade a " piner."

In the early stages, the disease is very difficult to detect in the live animal, the only symptoms being an occasional disinclination for its food, and often a slow irritable cough. But, as the disease advances, the animal becomes emaciated, the muzzle dry, the eyes glassy in appearance, the coat staring, and the cough more frequent.

Other important symptoms are nodular swellings of the lymph glands or udder and swelling of the joints.

The nodules vary in size from millet seed to pigeon's eggs; they are an indistinct yellow in colour, and cheesy in consistency, though in the more advanced stages they become calcified, and feel gritty to the touch when cut.

A carcase of tuberculous meat sets well if the disease is still in its initial stages, and the muscle is healthy in appearance, even though the tell-tale nodules may be present in large numbers on the pleura and peritoneum and embedded in the lymphatic glands. But there is no difficulty in detecting the disease, since the nodules are found in the lymphatic glands from the earliest stages. Should a section of the latter be exposed, the surface will be found to be discoloured, and to contain a cheesy matter in the early stages or be hard and gritty in the advanced stages. The butcher can never get rid of this internal evidence without so mutilating the carcase as to render it unsaleable. But in order to deceive the uninitiated, the pleura is sometimes removed by stripping.

The udder is a part of the body often affected. Small nodulous swellings can be felt in the quarters, which enlarge until the whole organ becomes a diseased mass. A tuberculous udder must not be confused with "garget." In the former there is little or no pain on pressure, and the swelling gradually increases; in the latter there is acute inflammation and severe pain.

Miliary tuberculosis is the form the disease takes when the bacilli get into the blood stream and become generalized. In this case the tuberculous lesions are densely congregated in one or more organs, usually in the lungs, and the nodules are, as a rule, about the size of a millet seed.

It is generally accepted that bovine tuberculosis is the same as phthisis in man, and that man can take the disease from eating infected meat. The law is therefore very strict on the subject. (*See* para. 1, above.)

The conditions of W.D. contracts lay down that the presence of tuberculosis in any part of the meat will entail rejection of the whole carcase.

The pig is also very liable to tuberculosis, and the disease spreads with such rapidity once it has obtained a lodgment in the body, that its presence in any degree is held to warrant the destruction of the entire carcase.

ii. *Pneumonia.*—This is a general term given to an inflammatory condition of the lungs. The portion of the lung tissue affected becomes solid and will sink in water, and the pleura is generally inflamed. Unless the disease has developed to some extent, there is little, if any, effect on the muscular tissue of the carcase, but extensive pneumonia is accompanied by fever, and the carcase is in such cases unfit for human

food. *Bronchial pneumonia*, and *pleuro-pneumonia*, are variations of the condition, which, as their names indicate, principally affect the bronchial tubes and the pleura respectively. The general characteristics in each case are similar to those appertaining to pneumonia proper, the lesions being found chiefly in the neighbourhood of the bronchial tubes or on the pleura.

iii. *Pleurisy* (inflammation of the pleura), *peritonitis* (inflammation of the peritoneum), *pericarditis* (inflammation of the pericardium), and *nephritis* (inflammation of the kidneys) are all characterized by inflammation of the part affected. In slight cases the flesh may be of quite good appearance, but in the advanced stages these diseases (with the possible exception of nephritis) are always accompanied by fever, and affected carcases then become unfit for food, the flesh being dark in colour, flaccid and soapy to the touch.

iv. *Pseudo tuberculosis*.—This disease is so called because its characteristics resemble some of those of tuberculosis. It is due to a small parasite which becomes encysted in the lungs, thereby creating small greenish-grey nodules. Sometimes the nodules are grouped together and appear like solid lumps.

The presence of the disease in the lungs may cause pleurisy with consequent effects on the flesh. All animals are liable to become affected, but it is mainly confined to sheep, about 60 per cent. of old ewes being found to be affected. Conversely, sheep are rarely affected by tuberculosis proper.

v. *Staggers*.—This is congestion of the brain, and often arises from overfeeding. The early stages are marked by tympany, and when brain symptoms ensue the carcase will not set properly, and the flesh will be found dark in colour, flabby and full of blood, and smells more or less offensively.

vi. *Choking* is a condition resulting from overfeeding, and eating whole turnips and potatoes. The characteristic appearance of the carcase is similar to that of an animal that has died of staggers.

vii. *Braxy*.—In Scotland the term "braxy mutton" is applied to the flesh of sheep which have not been slaughtered by man.

Red braxy includes all congestive conditions, and is characterized by signs of inflammation and fever; wet or water braxy is descriptive of all dropsical conditions; while turnip braxy results from eating turnips, the flesh of carcases so affected being wet and sticky. The characteristics of the last-named variety are much the same as those of staggers, and before being dressed the carcase is blown out. Should any doubt ever arise, it will be sufficient to cut into the kidney,

which, if the disease is present, will have a very strong and unpleasant odour of decomposition.

viii. *Actinomycosis.*—This disease is due to a vegetable (as distinct from an animal) parasite called " Ray Fungus " and may be mistaken for tuberculosis. The nodules have a similar appearance externally to those of tuberculosis, but are seldom caseous or calcareous, and when squeezed they exude a greenish-coloured pus. The disease is very common in cattle and pigs, but is extremely rare in sheep.

It is variously called " lumpy jaw " and " wooden tongue," terms which are descriptive of the two commonest forms which it assumes. In the one case the jaw-bone becomes abscessed and swollen, hence the term " lumpy " ; in the other the tongue is similarly affected, becoming lumpy and hard. Ulcers and nodules may also be found in the stomach, intestines and lungs, but in the great majority of cases the disease is localized in the head only.

In the live animal, the disease is easily recognized by the abscessed jaw and constant salivation. An affected tongue shows irregular abrasions, which must not be confused with the abrasions of foot-and-mouth disease, which are regular. On cutting the tongue open, it will be found that a new tissue has been formed, of a greyish colour, and that distinct nodules are embedded in the flesh.

ix. *Aphthous fever* (*Foot-and-mouth disease*).—Notification demanded under Foot-and-mouth Disease Order of 1928, issued by the Minister of Agriculture and Fisheries. The ox is the animal most frequently attacked, the sheep and pig suffer less often. The disease is characterized by small bladder-like eruptions on the side of the mouth, pad, lips and tongue, a stringy flow of saliva and a peculiar smacking of the lips. It is very contagious.

Lesions appear round the coronet and sometimes in the case of the cow on the skin of the udder. These break out into raw, red sores. When the disease has become acute, the flesh will be fevered and emaciated, having a unique brick-red colour. Affected animals shake their hoofs, are usually very thirsty and eat with difficulty.

x. *Rinderpest or cattle plague.*—This is a contagious fever. Oxen are the principal subjects, while sheep are but rarely infected. The carcase of an infected animal displays all the signs of severe inflammation and high temperature, the flesh is of a magenta hue, or mahogany or very dark red, and the glands are often hæmorrhagic. The blood in the veins is of a purple colour and the organs are, as a rule, congested. The whole carcase must, in accordance with the law, be destroyed, however slightly the animal may have been affected.

This disease is now seldom found in Europe, but it is prevalent in Africa, where it causes serious losses and spreads very rapidly.

xi. *Anthrax or splenic fever*—Notification demanded under Anthrax Order of 1928, issued by the Minister of Agriculture and Fisheries. Oxen and sheep are both attacked.

The disease is communicable to man and is very infectious, and therefore the law is very strict with regard to it. The carcase of an animal that has died, or is suspected of having died, of anthrax may not be removed until a drop of blood (taken from the ear) has been analysed. If the diagnosis indicates anthrax, the law requires that the entire carcase shall be destroyed by being burnt in a destructor or buried 6 feet deep in lime.

As a rule, animals affected with anthrax are found dead or dying, since the disease develops very rapidly, death following within thirty-six hours in most cases. The spleen will be found enormously enlarged and gorged with blood, and when cut open will appear dark and somewhat like tar; the carcase is dark in colour, and has the appearance of being imperfectly bled. The pleura and peritoneum are of a bluish tint and display large hæmorrhagic patches. The remainder of the organs are generally congested and bloody. The carcase does not set, as is the rule with all diseased carcases. Blood dripping from an anthrax carcase does not clot as does normal healthy blood, and looks very like the juice of the damson. This is a most valuable aid to the detection of a slightly infected carcase, which may in all other respects appear practically normal, especially when the spleen has been removed with the other organs in the ordinary course.

xii. *Blackquarter* (alternative names, black leg, quarter ill, murrain).—This disease principally affects young cattle. It is quickly fatal, death following in 24–60 hours. Sheep also contract it fairly readily. It is characterized by the presence of a dark swelling on one of the limbs, generally a hind limb. The contents of the swelling are gaseous and the skin crackles under the pressure of the hand, like parchment or stiff paper. The lesions will be found to extend very deeply into the muscle and look like broken-down muscular tissue gorged with blood. They emit a peculiarly unpleasant smell, rather like rancid butter. The smell and deep-seated character of the lesion are sufficient to prevent its being mistaken for a severe bruise, or *vice versa*.

xiii. *Red water*.—The disease is rare in the United Kingdom. The internal organs, especially the liver, are congested; the flesh is pale, and sometimes flabby and watery. The urine contained in the bladder is highly coloured. The entire carcase is unfit for human food.

xiv. *Milk fever,* or parturient apoplexy, attacks cows immediately before or a few hours after parturition, and is generally fatal. If the animal is slaughtered immediately the disease is noticed, little change will be found in the flesh and it is still wholesome. In the later stages, however, the carcase has a dark red appearance due to a fullness of the blood vessels, and decomposes rapidly.

xv. *Parasitic diseases.*—Cattle and sheep, in common with most animals, are subject to the attacks of animal parasites which lodge in the muscles, the blood or the internal organs. With the following exceptions, these parasites are not transmissible to human beings through eating infected meat, and therefore there is no danger attached to its consumption, but the carcases of badly infected animals are generally much emaciated, pale and watery in appearance, and must be rejected on that account alone.

The most important diseases of this type are described in the following paragraphs.

xvi. *Measles.*—Pigs, and to a certain extent cattle, are the animals most likely to be affected by the larval forms of certain tape worms, which only develop when they find a lodgment in the intestines of man. Infected meat is, therefore, unfit for human food.

The disease is characterized by numerous little white bladders or bags in the muscle resembling grains of rice, but containing a clear fluid. Hence the term "measles." These bladders may dry up through exposure to the air, but the holes in the flesh remain. Measly beef and pork manifest all the general characteristics of meat infected with parasites, namely, a watery, anæmic appearance.

xvii. *Trichinosis.*—This is the name applied to a disease which is characterized by the presence of the larval forms of another group of worms which will develop if they find their way to the intestines of human beings. Almost all animals, especially pigs, are liable to be attacked, but the disease is not common in this country. Unless the disease has advanced very far, when the meat is dotted with little white specks, there is no means, except by the microscope, of detecting the presence of these worms.

xviii. *Scab.*—Notification of sheep scab is demanded under the Order of 1928, issued by the Minister of Agriculture and Fisheries. This is a disease of the skin caused by the presence of a group of animal parasites known as acari.

In advanced stages of this disease, the carcase will often be found emaciated and dropsical.

xix. *Rot* (*Fluke disease*).—Flukes are rarely seen in any animal other than the ox and the sheep, but all animals, as

well as human beings, may be affected. There is a large variety of flukes, of which the commonest is like a miniature flat fish, about half an inch long.

As a rule they are found in the bile ducts of the liver, but sometimes they invade other organs. When established in the liver, the flukes set up inflammation in the walls of the bile ducts, which become very much swollen and congested. Eventually they become so completely stopped that no bile can pass through, and the animal wastes away, the carcase becoming emaciated, anæmic and dropsical.

The sheep suffers far more than the ox, probably because it feeds much closer to the ground, where the larvæ cling to the stems of grasses and cereals. Moreover, the ox is the stronger animal and has the bigger liver, and is therefore better able to resist the attack of the parasite.

Sheep affected may thrive for a time, but at a later age, and particularly in breeding, they become emaciated and dropsical.

xx. *Onchocerciasis.*—This is due to a parasite causing a growth of worm nodules under the hide in the brisket, fore-quarter flank and shin in fore-quarters of Australian meat and occasionally in the stifle joint of the hind-quarter.

The brisket, fore-quarter flank and shin are consequently removed before shipment to the United Kingdom, the remainder being known as the " crop " (*see* Sec. **15**, 12).

The stifle joints of hind-quarters are inspected and any worms which are encysted are removed.

The nodules are oval, about one inch long by about half an inch wide, and are most numerous in the fat on the sternum and between the muscles of the flesh.

12. *Issue of meat to troops*

1. Meat loses a certain proportion of weight by drying after hanging.

When hung in quarters the loss is as follows :—

In 24 hours,		1·23 per cent.	
,, 48	,,	2·02	,,
,, 72	,,	2·46	,,

2. The conditions of the " live cattle " contract state that the weight of the meat is to be taken after it has hung for a period not exceeding forty-eight hours. In view of the above figures it is important that this rule be strictly observed.

3. Hind- and fore-quarters (and, where necessary, smaller joints), are issued in rotation to each regiment or detachment.

The master butcher should keep a book for recording the joints issued to each unit, in order that a fair division of the carcases may be made. The hind-quarter is of relatively greater value than the fore-quarter.

4. All frozen meat (beef and mutton) received from cold store is taken on charge at gross weight including wrappers.

5. Particulars of allowances for bone (*see* Sec. **10**, 43) and wrappers, and for cutting-up, are laid down in Regulations for the Allowances of the Army and in Army Council Instructions.

CHAPTER II

CHILLED AND FROZEN MEAT

13. *General*

1. Refrigerated beef is transported either as *frozen* or *chilled*.

Frozen beef is carried at a temperature of 10° to 15° F., chilled beef at a temperature of about 29½° F.

2. The Argentine, Brazil, Chili and Uruguay constitute the only areas which are at present large exporters of *chilled* beef.

Chilling is used only for quarters of beef; sheep are shipped from all countries in a frozen state.

3. *Frozen* beef is exported principally from Australia, New Zealand and South America.

4. Experiments have been made from time to time to transport chilled beef from Australia and New Zealand. These experiments have proved it to be possible to maintain beef in good condition at a chilled temperature during the period of transportation, but considerable difficulties have to be overcome before a regular trade in chilled beef from Australia and New Zealand can be established.

14. *Chilled beef*

1. Animals for chilling must be of a high pedigree, young and fairly fat.

The cattle used are mainly of the Aberdeen Angus, Hereford and Shorthorn type. The basis of the herds is British; stock raisers, for many years, having been eager buyers of British pedigree bulls.

The cattle attain maturity at about two and three-quarter years, when they give an average of 800 lb. of dressed meat.

3. The cattle are frequently dehorned during the first two months after birth in order to avoid bruising during drinking or when being railed.

The buyers of the freezing companies buy at the farms, and after purchase the cattle are railed down to the freezing works. Great care is taken to prevent the animals suffering in transit. Among the precautions adopted are locked couplings to prevent

jolting and bruising, sprinklers so that the cattle do not get overheated, abundant drinking water and, in the case of long journeys, mid-way rests.

Cattle from a distance are usually turned out to pasture near the freezing works before being killed.

4. The works are models of up-to-date efficiency, no part of the beast being wasted.

5. Beef which is to be chilled is taken immediately it has set to chilling chambers, where it is gradually reduced in temperature to about 30° F.

After approximately twelve hours in the chambers the meat passes through various departments, where the animals are halved and quartered, inspected, graded and then placed in a covering of cotton bearing the mark of the establishment and that of the sanitary inspector.

The quarters are then hung until the time of shipping.

6. The quarters are always hung on meat rails spaced about 12 inches apart on the under decks. Between decks the heights are usually regulated to allow one hind-quarter and two fore-quarters to be hung, the hind-quarters being hung direct from the rail and the fore-quarters suspended one below the other from chains.

Chilled beef is usually stowed tight enough to prevent swinging when the vessel rolls, but sufficient space is allowed to enable the air to circulate properly.

7. The beef is quickly marketed on arrival. This is a necessity as its limit of keeping is about five or six weeks, including time of treatment and transit. Storage is resorted to only when the markets are glutted.

Points of Distinction between Home Killed and Chilled Beef

8. In external, internal and general appearance, chilled beef differs materially from home killed, but joints of chilled beef are often impossible to detect, especially in cold weather.

9. The Sale of Meat Order, 1921, Part II, provides that any imported meat offered for sale must be clearly labelled as such, or alternatively, where all the meat on sale is imported meat, a notice must be exhibited to this effect.

10. The outside of a quarter of chilled beef is cold to the touch, and moist in proportion to the difference in temperature between the meat itself and the atmosphere. This accumulation of moisture, technically called "sweating," may be accompanied by a fusty, slightly unpleasant odour if the meat

is held any length of time or damaged. Being superficial, this condition is easily noted by inspectors. In such cases, the quarters or parts affected should be cut clean in two, when, if sweet, the outer surface may be removed by paring, or may be washed with a solution of salt and warm water, and the meat used. The meat must, however, be very badly damaged to require this treatment.

11. The exterior of the carcase always lacks the bright colour which is so characteristic of fresh-killed beef. A bluish sheen may be noted, on the external muscles, which disappears on exposure to the atmosphere. Chilled beef does not chip and the meat is not " polished up." The facing of the buttock is always soft and sodden when held for any length of time.

12. Any newly cut section of the muscle presents a brick-red appearance after a short exposure to the atmosphere. This is due to the elements of the blood becoming dissolved and permeating the tissue, which the cold has to a certain extent broken down. The fat of chilled beef, when fresh from the ship, is a bright rich colour, and is not inclined to become stained by the meat juices except when the meat is handled during distribution. Towards the end of out-turn of a consignment from store the fat loses its brightness.

13. When the meat is held over, in a market or a shop, the fat turns a dull colour and becomes stained. There is a distinct difference in the taste of the fat of chilled and fresh-killed meat.

14. A considerable amount of liquid drains from the lean of chilled beef as compared with fresh killed. This is thin in substance.

15. No defrosting process is used on chilled meat. It usually leaves the ship hard on the exterior.

16. The dressing also varies from that of home-killed meat. The vertebræ of the spine are sawn instead of chopped through, a process which gives a smoother surface and offers no jagged or cut edges which might be liable to harbour dirt, and so render the meat liable to become tainted. The hind-quarter usually contains three ribs instead of one.

17. As the process of chilling undoubtedly makes the meat tender and mellow (if properly hung and cooked) the prime joints command a high price, and are not easily distinguishable from fresh beef. Hind-quarters are dearer than fore-quarters, a fact which makes it necessary when inspecting deliveries to ensure that contractors have not substituted chilled fore-quarters and low-grade home-killed hind-quarters for chilled hind-quarters.

15. *Frozen beef*

1. Frozen beef for army contracts is normally imported from Australia and New Zealand.

2. *Australia.*—Every State in the Commonwealth is engaged to a greater or less degree in the meat export trade, but the chief centres are in Queensland, New South Wales and Victoria.

Unlike South America, Queensland has a beef " season " ; that is to say, killing does not take place throughout the year.

Usually the season begins in February or March, but may be as late as April. The end of the season is uncertain. If the rain has been heavy so that there has been plenty of water and feed, the cattle may be sufficient in numbers and finish to enable the works to operate until the closing months of the year. Sometimes, however, the season ends in or about the middle of the year, which means that the whole output for the season has been treated within three or four months.

The cattle raised for beef production are mainly of the Shorthorn and Hereford breeds. Aberdeen Angus exist to a smaller extent.

3. *New Zealand.*—The trade in frozen beef from New Zealand is less extensive than that from Australia.

The stock is British in origin, Shorthorns, Herefords and Aberdeen Angus being largely bred.

The New Zealand killing season comes after the Australian and usually begins in the North Island about November and in the South Island roughly a month later.

Slaughter, Dressing and Preparation of Frozen Beef

4. The animal is driven into a pen, where it is stunned by a blow on the forehead with a blunt hammer. After stunning the animal is thrown out into a bleeding pen. After a sufficient time has elapsed to allow all the blood to drain from the body, it passes to the dressing floor, where the operations of flaying, removal of viscera, etc., are carried out. The carcase is then suspended and divided by means of a circular saw. The final operations of trimming, washing, wiping, etc., are completed and the carcase is then ready for the chilling room.

5. During the above operations examination for disease is carried out by the government veterinary inspectors.

6. The beef remains in the chilling rooms at 30° F. for twenty-four to forty-eight hours, after which it is quartered, weighed, graded and labelled prior to being placed in the freezing rooms.

7. The beef is hung in the freezing rooms at a temperature of 10° F. for a period of about five days. On completion of the freezing process the beef is wrapped in an inner covering of stockinette and an outer one of hessian. It is then stacked in the freezing store, where it remains until loaded into the refrigerator hold of the ship.

Points of Distinction between Frozen and Fresh Home-Killed Meat

8. When the carcase is **frozen hard,** the fat is of a pale creamy colour, and darkens to a pale yellow when exposed to the normal atmosphere.

Whilst in the hard frozen condition the cod and suet fat appear crumbly.

The flesh is of medium red colour, and the meat is so hard that it cannot be cut with a knife in the frozen condition ; if cut with a saw particles of ice will be seen. The meat handles cold and if the warm hand is kept upon it for a few seconds it becomes wet. The meat collects condensation when brought into the normal atmosphere. The exterior of the carcase lacks the bright colour characteristic of fresh-killed meat.

The bark may be chipped and torn, due to handling in the frozen state.

9. When the meat is **thawed,** the quarter appears dirty and untidy. The meat on section is a dull red colour and may be very soft. It will " pit " if pressed with the finger.

The exterior of the carcase will sweat considerably and be watery in appearance, except when it has been " dried."

The fat when thawed absorbs the juices from the lean and becomes stained a red colour. This, after the meat has been exposed, changes to a leaden colour.

The most reliable guide to distinguish frozen from fresh meat is to be found in the appearance of the spinal vertebræ, which are sawn through and not chopped ; the exposed surfaces are always dark. The outer rim of the chine bone is very hard and of an ivory white colour, and the hind-quarter usually contains three ribs instead of one.

10. It is often difficult to distinguish chilled beef from frozen beef, but the ability to do so is not a matter of importance in connection with the inspection of beef supplied under army contracts, which normally specify frozen or fresh beef. Contractors are unlikely to tender chilled in lieu of frozen as the former is more expensive. If they tender either frozen or chilled in lieu of fresh, this can be detected as described above.

Grading of Frozen Beef

11. Frozen meat is inspected and graded before export. Practices differ in the various countries; those followed in Australia, New Zealand and South America are described in the following paragraphs:—

12. *The practice in Australia.*—Beef is sent to the United Kingdom in quarters, the fore-quarter being sent after the brisket, flank (or plate) and shank have been removed, in which form it is known as a "crop." (*See* Sec. **11**, 6, xx.)

The practice of cropping is not compulsory under the British Imported Food Regulations, but it is carried out in accordance with the Australian Meat Export Regulations. All beef has to undergo examination for disease by government veterinary surgeons prior to shipment.

The Australian Government recognizes two quality grades, i.e. "Good Average Quality" and "Fair Average Quality" commonly called "G.A.Q." and "F.A.Q."

The labels attached to quarters coming up to G.A.Q. standard are stamped with a six-pointed die bearing the words "Approved for export." These labels are affixed by employees of the firms.

The grading for quality is carried out by the employees of the meat works and not by government inspectors. Some of the meat works are strict in their grading and maintain a fairly uniform standard; others, however, are not so strict. *Hence the fact that a particular brand of meat is graded G.A.Q. is no guarantee that its quality or condition complies with the W.D. specification.*

The labels carried by quarters coming into the F.A.Q. grade are stamped with a circular die bearing the words "Passed for export." F.A.Q. meat is not accepted for W.D. contracts.

Some shipping firms divide G.A.Q. consignments into two grades, so as to identify the best quality. The three grades thus formed are distinguished by private marks and labels printed in three different colours.

Exporters also grade their beef by weight. The following is a typical example:—

	lb.
Ox crops, 10 ribs, U.K. cut; brisket, flank and shank off	100/under 100/140 140/up
Ox hinds, U.K. cut; 3 ribs, fat in	140/under 140/180 180/210 210/up

Cow crops, 10 ribs, U.K. cut ; brisket, flank and shank off	73/under 74/120 120/up
Cow hinds, U.K. cut ; 3 ribs, fat in	110/under 110/160 160/up

Code letters or numbers are commonly adopted to denote combined weight and quantity grades. Thus, even numbers may denote G.A.Q. and odd numbers F.A.Q., the numbers corresponding to the weight, as, for instance :—

	lb.		G.A.Q.	F.A.Q.
Ox crops	100/under	may be marked	22	23
	100/140		26	27
	140/up		30	31

13. *The practice in New Zealand.*—The grading is carried out at the freezing works by employees of the companies. Crops are not shipped from New Zealand.

The grades in use are :—

1. Prime ox, 160 lb. and under a quarter.
2. Prime ox, 161–180 lb. a quarter.
3. Prime ox, 181–200 lb. a quarter.
4. Prime ox, 201 lb. and over a quarter.

Second ox quality (X mark) all weights.
Prime heifer (H mark) all weights.
Cow beef, 1st quality (C mark) all weights.
Cow beef, 2nd quality (CX mark) all weights.

There are no marks on the beef itself, but a label is attached to each quarter giving the factory brand and the grade. The veterinary inspector's certificate of freedom from disease is on the back of this label. This only certifies that the meat is free from disease, and is not a guarantee of quality.

14. *The practice in South America.*—Quarters are customarily stamped with a letter denoting the quality grade. These letters vary according to the firms ; as a rule, each firm uses the letters of a five-letter word to denote the grades, e.g. A.N.G.L.O., S.W.I.F.T.

15. Details of brands, grades, etc., are laid down in the Handbook of Specifications for Supplies, and the various meat contract forms for each station.

Trade Allowances for Losses in Weight

16. The general practice in the trade is as follows :—

Animals are slaughtered and divided into sides. (A few firms then weigh the sides " hot " to serve as a check on live weight.)

The sides are then placed in " chillers " (freezing rooms) for a period of twenty-four to forty-eight hours. They are then in a chilled, not frozen, state. The greatest loss in weight occurs at this stage.

In the chilled state the sides are quartered (briskets being removed) and then weighed.

17. From the weights thus obtained, an allowance is made, generally from $1\frac{1}{2}$ to 3 per cent., the resulting figure being the shipping or Bill of Lading weight.

This allowance is made to cover " shrinkage " (losses in weight) during the time the meat is in transport and storage.

The practice of making allowance for loss of weight by chilling and freezing (i.e. from " hot " to " frozen " weight) is not uniform in all works.

The scales weigh to the nearest pound and the scalesmen, who become thoroughly experienced at the work, decide the exact allowance to be made.

The quarters are then frozen down ready for shipment.

Bill of Lading weights are guaranteed within half of one per cent.

18. In this country meat is landed and usually goes into cold stores direct without weighing. It is, however, " out-turned " from storage generally within fourteen days, when it is weighed, if desired.

On these " ex-store " weights any claim for loss is made.

No claim for loss in weight is made if it be not more than half of one per cent., but allowance is made to the buyer for the whole loss in weight if it is in excess of half of one per cent.

Gains and Losses in Weight of Frozen Beef during Transit and Storage

19. Frozen beef tends to gain in weight, owing to absorption of moisture from the air while in transit from the ship to the cold store. The amount of the gain depends on the time and distance of the journey, the humidity of the atmosphere and the temperature prevailing during the time the meat is exposed.

As these factors vary so greatly at different times of the year and at different stations, it is impossible to lay down any definite figures which will apply to all cases ; the following, however, is an example :—

Gain in weight during transhipment

Period beef exposed	$1\frac{1}{2}$ hours.
Temperature, dry (ship's hold)	10° F.
Temperature, dry (outside atmosphere) ..	60° F.
Humidity (ship's hold)	18° F.
Humidity (outside atmosphere)	58° F.

Commodity (1)	Weight in ship's hold (2)	Weight in W.D. cold store (3)	Gain (4)	Percentage gain (5)
	lb.	lb.	lb.	
10 hinds ..	1800·5	1809·5	9	·499
10 crops ..	1270	1275·375	5·375	·423
Total ..	3070·5	3084·875	14·375	·468

20. Frozen beef loses weight while in cold storage due to "shrinkage." The amount of loss is approximately proportional to the duration of the storage, but other factors affect it, such as the dimensions of the store, the type of refrigeration, the amount of piping, the amount of meat in store and the general conditions under which the store is operated.

It is therefore impossible to lay down figures which will apply to all cases. The following, however, is a fair example :—

Loss in weight during storage

	Weight when placed in cold store	Weight after 24 hours in cold store	Weight after 28 days in cold store	Weight after 56 days in cold store	Loss	Per-centage loss
Temperature dry, degrees F. ..	78°	14°	16°	16°	—	—
Temperature humid, degrees F.	76°	16°	17°	17°	—	—
Commodity	lb.	lb.	lb.	lb.	lb.	Per-centage
10 hinds ..	1738·5	1729	1710·5	1705·25	33·25	1·91
10 crops ..	1378	1372·75	1352·5	1350·75	27·25	1·97
20 pieces ..	3116·5	3101·75	3063	3056	60·5	1·94

16. *Frozen mutton*

1. Frozen mutton is exported principally from the River Plate, New Zealand and Australia.

The best quality comes from New Zealand, and is known as "Canterbury mutton." This is considered equal to English Southdown or Welsh mutton. That from Australia and the River Plate is on a par with average English mutton, such as that contributed by Hampshire, Lincoln or Suffolk sheep.

2. Mutton is transported from overseas at a temperature of 10° to 15° F., the hard frozen condition enabling the carcases to be piled on top of each other in the ship's hold.

3. Mutton is never carried in the chilled state as the fibre of the meat is not damaged by freezing to the same extent as in the case of beef, and if chilled it would require to be hung on hooks in the ship, whereas in the frozen state it can be piled and shipping space can thus be saved.

Frozen mutton is practically imperishable and when thawed shows little change from its fresh state. The time required for freezing is one-third of that necessary for freezing beef.

4. Carcases received from Australia, of 60-lb. weight and upwards, are usually very fat. River Plate sheep furnish a lean carcase, such as that contributed by Hampshire, Lincoln or Suffolk sheep.

5. *The characteristics of frozen mutton* are a cold and damp exterior, the fat white, distinct from the lean, and generally crumbly at the cod. The flesh is not so bright as in fresh-killed mutton. If the carcases have been roughly handled during transit, the bark will be without the shine of fresh-killed mutton, and will be dirty looking, chipped and torn.

As a general rule, however, owing to improved methods of transport, frozen mutton now bears little or no sign of damage, and the shine on the bark is frequently as bright as in fresh-killed mutton.

The shank bones are very brittle, a natural result of hard frost, and may occasionally be found snapped asunder.

The fore-legs are invariably bent towards the body and fastened by a string passed round the neck. This is done to economize space in packing. The fore-legs can, however, be made to resume their normal position if the carcase, or the jointed shoulder, is hung up by the knuckle end during and after thawing. As much of the pizzle as can be cut away from the outside is removed, and the kidneys and kidney fat are also removed both from New Zealand and Australian sheep.

As thawing proceeds, the fat which lies close to the lean becomes discoloured by the juices of the meat, and the flesh becomes wet and sodden. The exterior of the carcase sweats a great deal in warm weather. Since the conditions of contract require that the kidney fat be removed if the kidneys are absent, it becomes the regular duty of an inspecting officer to see that this is done.

To examine the carcase carefully, probe with a skewer in the region of the pelvic bone; if any bone taint exists, it will be found there, although in actual practice bone taint is seldom met with in frozen mutton. Although the outside of the carcase may be perfectly sweet, the inside may occasionally be found bad, owing to the animal heat not having been thoroughly expelled before freezing.

6. *Mildew* (*or mould*).—It sometimes occurs that mildew spots make their appearance inside the ribs.

Mildew (or mould) is due to storage in damp, badly ventilated stores, or to subjection to extensive variations of temperature.

In the early stages it is recognized by a white, furry, damp appearance on the surface of the meat, which, as the mould advances, gets dark in colour, eventually taking the appearance of black or dark-coloured patches.

In the early stages no harm is done. The mould can be wiped off with a cloth and the meat will then be quite fit for food. In the advanced stages, however, the mould eats into the tissue and renders the meat unwholesome. If the affection is local the part can be cut off, and the remainder will be found fit.

Carcases in any way affected by mould should not be accepted from a contractor.

Grading and Marking Frozen Mutton

7. *In New Zealand.*—The grading of mutton is carried out under the supervision of the New Zealand Meat Producers Board, and a high standard is maintained.

The standardized grades are as follows :—

Class	Weight	Grade mark
Prime wethers and maiden ewes ..	Under 48 lb.	1
,, ,, ,, ..	49–56 lb.	7
,, ,, ,, ..	57–64 lb.	3
,, ,, ,, ..	65–72 lb.	9
,, ,, ,, ..	73–80 lb.	5
,, ,, ,, ..	81 lb. and over.	0
Second quality wethers and maiden ewes	56 lb. and under.	X1
,, ,, ,, ..	57 lb. and over.	X2

8. *In Australia.*—The grading of mutton is carried out in the same general way as the case of frozen beef, the first quality or G.A.Q. bearing the Government " Approved for export " stamp, the second and third grades being stamped " Passed for export."

Owing to the size of Australia and the variation in the character of the flocks, the standardization of grading presents considerable difficulty.

17. *Inspection of frozen meat*

1. The inspection of frozen meat should be carried out in the same manner as laid down for fresh meat. (*See* Sec. **10**.)

There are however, certain special points which are applicable, particularly to the inspection of frozen meat, namely :—

i. Partial thawing is essential before pronouncing an opinion. This will enable the lymphatic glands to be examined for tuberculous infection.

ii. Care should be taken that no damaged meat is issued, i.e. meat that has deteriorated from being kept too long in store, from being damaged during a voyage, or from any other cause. Such meat may be detected as follows :—

(*a*) By its discoloration. The fat of beef will be of a very pale dull colour, and the lean parts dark brown or black. The mutton, when in the hard, frozen state, will be mis-shapen and will have lost its external brightness.

(*b*) By rubbing the palm of a warm hand on the fat of either beef or mutton for a few seconds, when, if the meat is stale, there will be a distinct tallowy smell.

(*c*) If quarters of beef are noticed to be bruised, by cutting, in order to test whether the bruises extend internally, particularly in the hind-quarters.

iii. The meat should be carefully inspected to ensure that it is of the brand and grade specified in the W.D. contract. In this connection it is, however, important to remember that meat may not be of suitable quality or condition even if it is of a brand or grading acceptable under the contract. (*See* Sec. **15**, 12 to 14.)

iv. Careful examination should be made for " stag " meat, which is frequently tendered in place of ox.

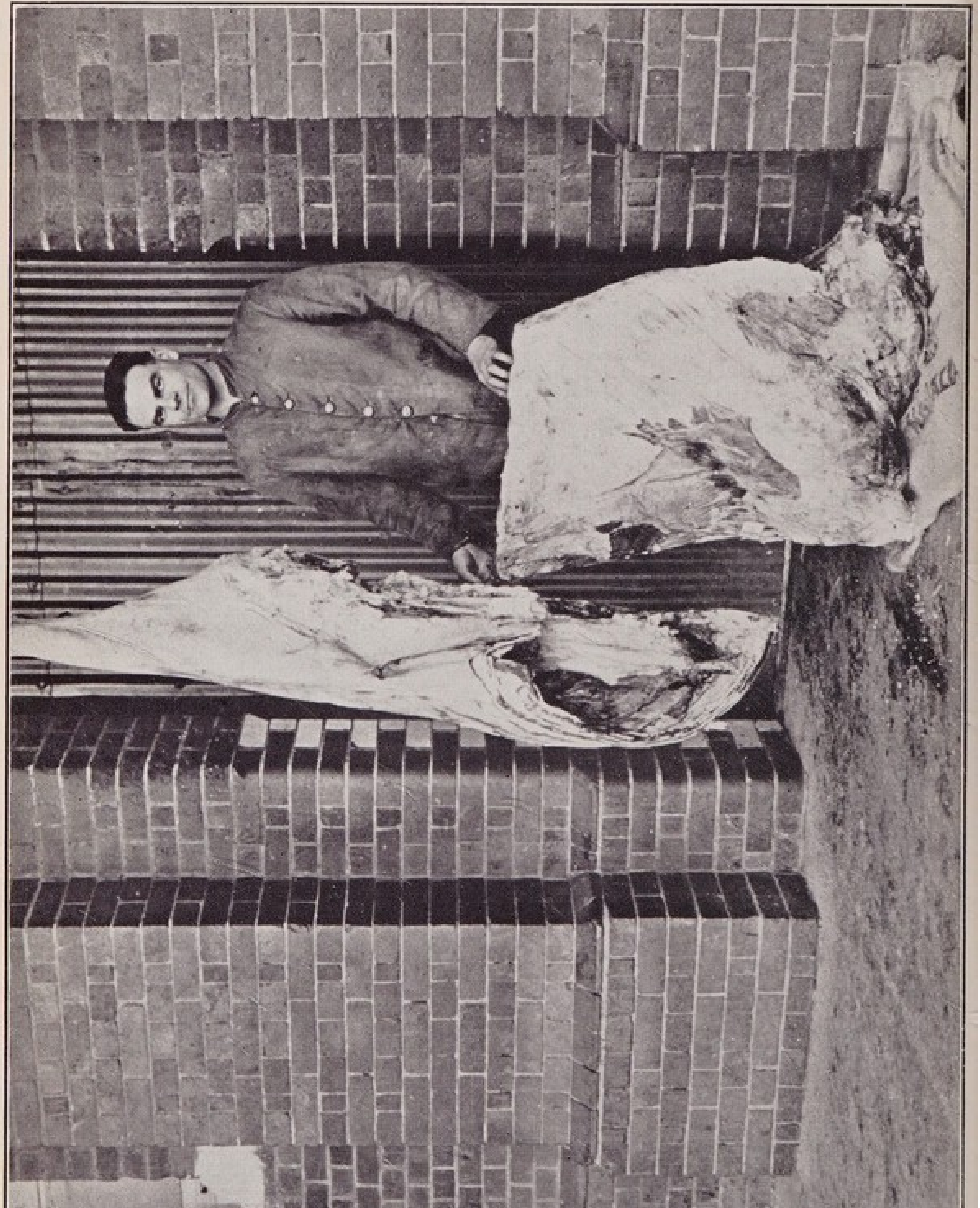
v. In cases where the contract specifies that labels should be attached to the quarters, care should be taken to see that they are present.

[*Facing page* 60

PLATE 22.—FROZEN BEEF.—Prime quality ox hind-quarter and ox crop

Reproduced by permission of Messrs. Perfect & Co., Charterhouse Square, London, E.C.1.

Plate 23.—Frozen Beef.—Fair average quality ox hind-quarter and very inferior ox crop



Reproduced by permission of Messrs. Perfect & Co., Charterhouse Square, London, E.C.1.]

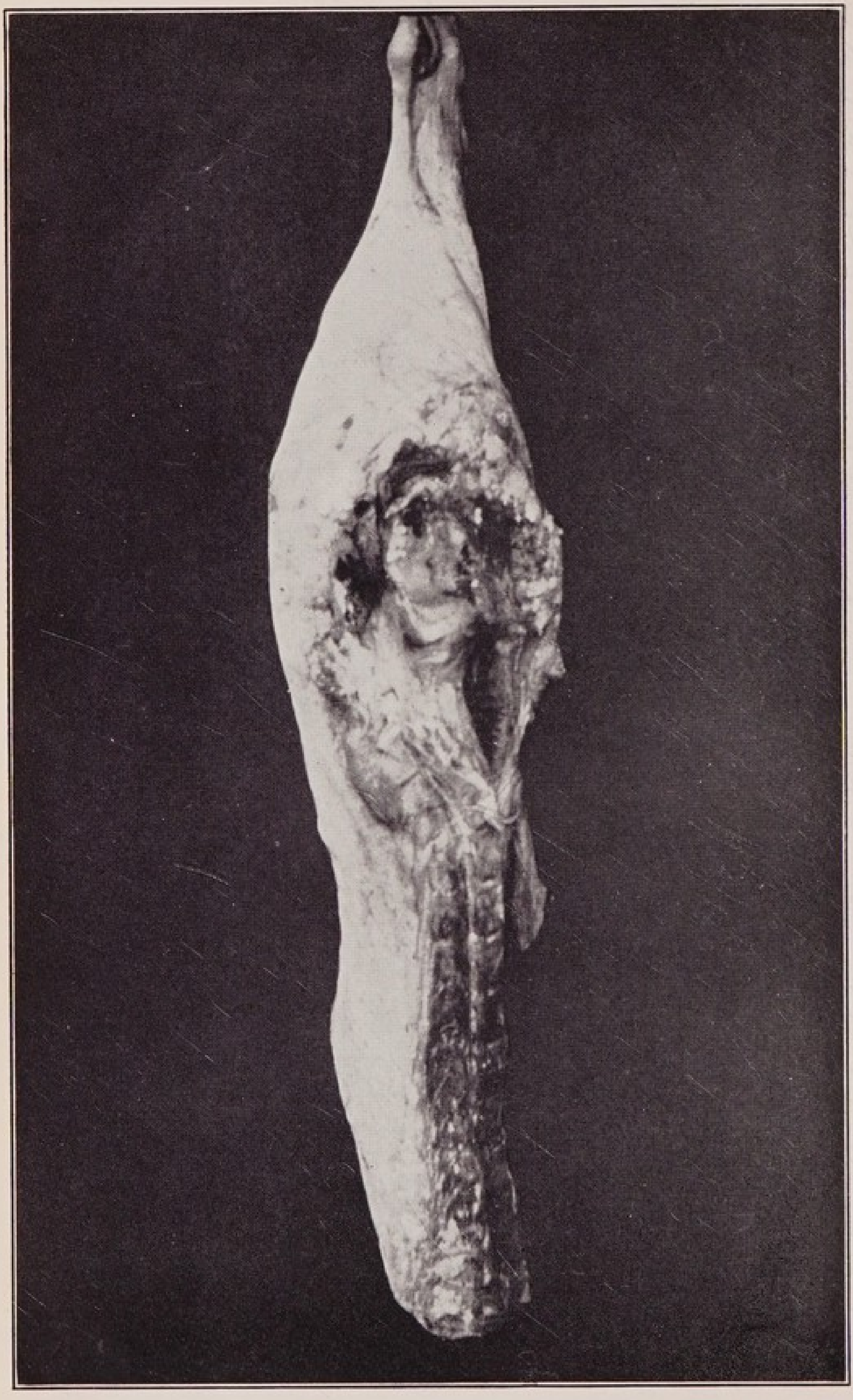
Plate 24.—Frozen Beef

Very inferior ox hind-quarter

[Reproduced by permission of Messrs. Perfect & Co., Charterhouse Square, London, E.C.1.

PLATE 25.—FROZEN BEEF

Poor quality " stag " hind-quarter



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2. The following is a summary of points to be noted in connection with frozen meat. (*See* Plates 22 to 25.)

Prime quality ox hind-quarter. (Plate 22.)

Note :—

1. Good cod fat.
2. Depth from front to back as shown by the dotted line.
3. Short shank.
4. Roundness of the buttock.
5. Plenty of kidney suet. (This is, however, badly bloodstained owing to bad dressing.)

Prime quality ox crop. (Plate 22.)

Note :—

1. Fullness of the shoulder.
2. Thickness of the chine.
3. Good covering of fat—a sure indication of quality.

Ox hind-quarter of fair average quality only. (Plate 23.)

Note :—

1. Hollowness in the loin and rump.
2. Narrowness of the buttock.
3. Bad dressing. The blood has drained down the backbone.

Very inferior ox crop. (Plate 23.)

Note :—

1. Hollowness of and absence of flesh on the shoulder and chine.
2. General absence of fat covering. (Compare with Plate 22.)

A very inferior ox hind-quarter. (Plate 24.)

Note :—

1. Absence of cod fat.
2. Lack of flesh in the loin.
3. Lack of covering fat.
4. Badly bloodstained (bad dressing).

A poor quality " stag " hind-quarter. (Plate 25.)

Note :—

1. Thinness and shortage of meat in the loin.
2. Absence of cod fat.
3. Bloodstained backbone (bad dressing).

18. *The quick-freezing process*

1. Meat preserved by the usual method is slowly frozen by exposure to air kept at a low temperature. This results not only in loss of weight through evaporation—calculated

approximately at $4\frac{1}{2}$ per cent.—but also in the partial breaking down of the cells of the muscle tissue, resulting on defrosting or thawing in a loss of meat juices, commonly known as "dripping." This probably accounts for the partial loss of flavour and, in many cases, the change of colour of meat frozen by this method.

2. A method known as "quick-freezing" has recently been introduced, which involves direct or indirect contact with a brine solution; this is a far better conductor of heat than air, and the quick-freezing process therefore takes a far shorter time. As the freezing effect extends to a depth of only a few inches, however, this method is not applicable to large pieces of meat, such as whole sides of beef or whole carcases of mutton or lamb; the practice is therefore to cut up meat into joints, to remove waste, and in some cases to bone before freezing. It is claimed that by this method the tissues are not damaged and there is no drip on thawing; discoloration and loss of weight are greatly reduced or even eliminated.

3. This method of freezing has made possible the distribution of frozen joints packed in sealed cartons or wrapped in transparent cellulose paper; it has not yet been sufficiently tested in practice, however, to enable its possibilities to be judged. Moreover, apart from matters of technique, there are certain difficulties in the way of the sale of pre-packed, quick-frozen meat. The chief is the difficulty of adequate inspection. It is desirable, in the interests of public health, that every carcase exposed for sale should have been inspected. In the case of meat imported pre-packed, however, it is obviously only possible for sample packages to be unpacked, thawed out and inspected. Apart from this, the inspection of isolated cuts gives no indication of the condition of the whole carcase from which they have been obtained. The development of this trade would therefore appear to depend mainly on the possibility of satisfactory official guarantees in respect of the hygienic condition of the carcases at the exporting end.

In the second place, until pre-packed meat is added to the list of pre-packed articles contained in Schedule I of the Sale of Food (Weights and Measures) Act, 1926, it would probably be necessary for a legible statement of the net weight to be given to the purchaser at the time of sale. This may present certain difficulties, in view of the fact that the meat is subject to evaporation between the time of packing and the time of sale.

A fairly large trade is already carried on in the U.S.A. in small quick-frozen joints, etc.

At present the maximum thickness of meat which can be successfully treated is 5 inches.

4. The development of this trade appears to depend on an abundant and cheap supply of " dry ice," since the use of ordinary ice to keep down the temperature of the product in transit is impracticable, owing to the extremely low temperature required.

19. *Solidified carbon dioxide (dry ice)*

(*See* Proceedings of the British Association of Refrigeration, Vol. XXVIII, No. 1, 1931/32.)

1. Considerable development has taken place in recent years in the use of solidified carbon dioxide or " dry ice " as a refrigerating medium.

The raw material for the production of " dry ice " is the gas carbon dioxide (CO_2). This gas can be obtained from natural wells or springs, or it can be produced artificially, e.g. by the combustion of coke. It is also a by-product of the brewing and fermentation industries. It is readily liquefied, and this form has been available in cylinders for some years, but it is not a convenient form for commercial use. The solid block form is produced from the liquid by further cooling and other operations.

2. The temperature of solid CO_2 at atmospheric pressure is approximately $-79°$ C. ($-110°$ F.). When brought in contact with a warmer substance it evaporates into a dry, non-inflammable and odourless gas. It is heavier than air, its density being 1·529.

Solid CO_2 gives a lower temperature than ice, or ice and salt, and is an ideal mobile refrigerant. Its refrigerating effect is greater than that of any other class of secondary refrigerant, when compared either on a weight or bulk basis, thus reducing the amount that has to be transported and correspondingly increasing the useful load of the commodity which is to be kept cool.

Furthermore, the fact that it passes directly from the solid state to gas eliminates mess and water leakage and consequent deterioration of vehicles and packages in which goods are transported.

3. Dry ice expands to about 700 times its original volume when performing refrigeration; on the other hand, water ice contracts and becomes liquid. The expansion of dry ice sets up an insulating envelope of CO_2 gas which prevents the infiltration of moist warm air into the container.

4. These advantages have led to the use of dry ice wherever mobile refrigeration is required, as, for example, in ice-cream

delivery tricycles and vans, and in the distribution by road and rail of frozen foods in cartons or other types of container.

5. Dry ice is transported in the same manner as water ice, but when sent long distances is usually enclosed in light wooden cases. This method limits the loss by evaporation to approximately 5 per cent. in twenty-four hours.

6. Carbon dioxide gas in high concentration is asphyxiating, and should "dry ice" have been used as a refrigerant in a sealed store, ventilation is necessary before the store may be entered.

Thick gloves should be worn for handling dry ice, or severe frostbite will ensue.

20. *Boneless meat*

1. Boneless meat is exported from Australia, New Zealand, and South America and, broadly speaking, comprises meat of bulls, cows and quarters of inferior quality generally.

The greater proportion is used for making mincemeat, sausages and other meat preparations.

A smaller quantity of better quality boneless meat is, however, imported for use in the restaurant trade, and this supply tends to increase.

2. Boning is carried out at the freezing works prior to the freezing of the meat, the quarters being chilled before being boned in order to set the meat and make the process easier.

3. Boneless meat occupies approximately three-quarters of the space of meat with bone. The saving in weight and space is an important matter not only in land transport but in relation to shipping tonnage and the capacity of cold stores.

4. Special regulations are in force in Australia concerning the inspection, freezing and preparation of boneless "cuts." These are as follows :—

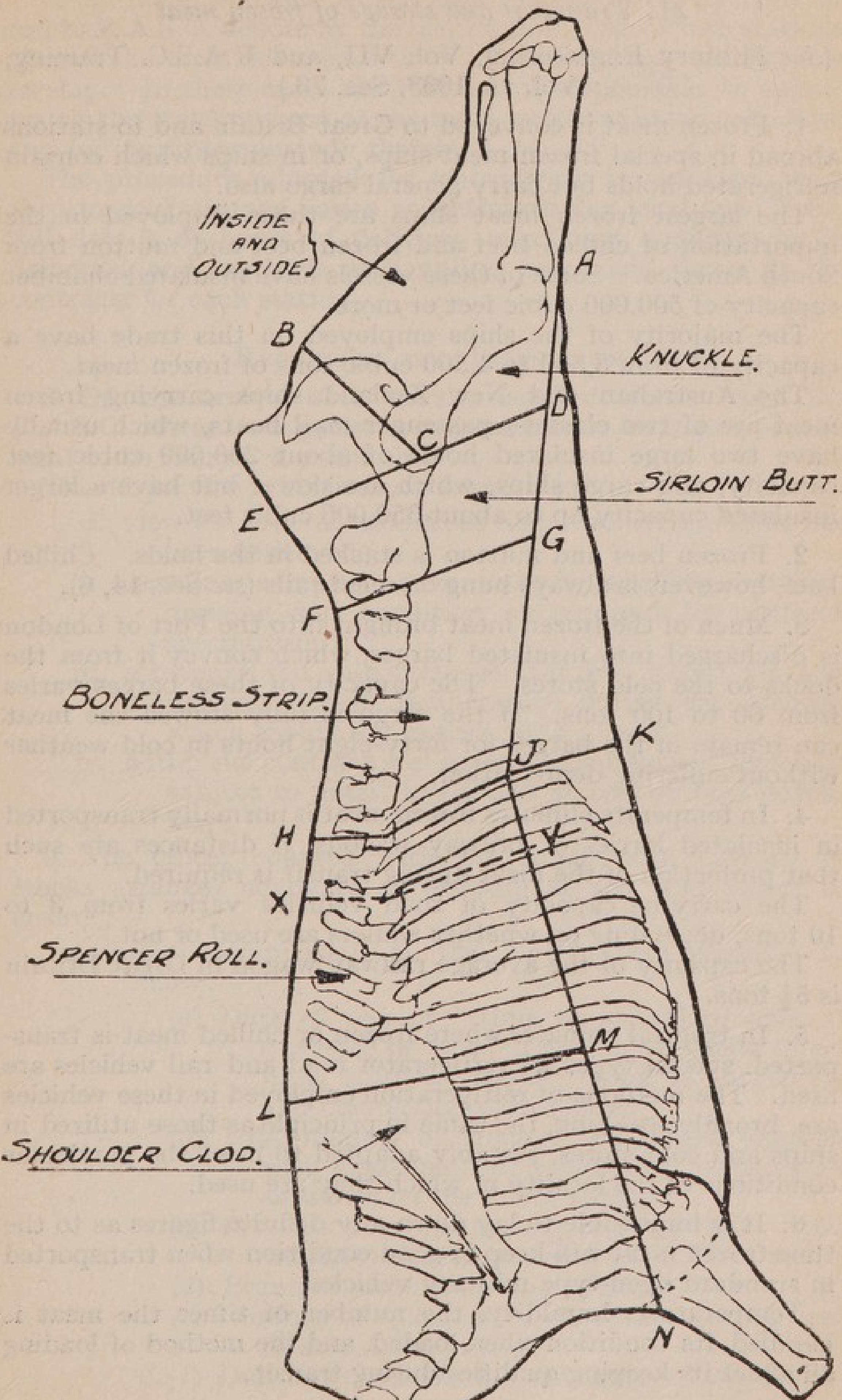
To facilitate the identification and character of the goods for Customs purposes,

i. there shall be true declaration of the contents of the bag or package, and
ii. "cuts" of one kind only shall be placed in each bag or package.

On arrival in Great Britain boneless meat is subjected to rigid inspection by the sanitary authorities, and must be certified by exporters as being free from disease. The glands are required to be left *in situ*.

5. The standard boneless cuts are shown in Plate 26 (page 65).

PLATE 26.—STANDARD BONELESS CUTS



21. *Transport and storage of frozen meat*

(*See* Military Engineering, Vol. VII, and R.A.S.C. Training, Vol. II, 1933, Sec. 73.)

1. Frozen meat is conveyed to Great Britain and to stations abroad in special frozen meat ships, or in ships which contain refrigerated holds but carry general cargo also.

The largest frozen meat ships are those employed in the importation of chilled beef and frozen beef and mutton from South America. Some of these vessels have insulated chamber capacity of 500,000 cubic feet or more.

The majority of the ships employed on this trade have a capacity of from 3,500 to 4,500 cubic tons of frozen meat.

The Australian and New Zealand ships carrying frozen meat are of two classes—passenger mail boats, which usually have two large insulated holds of about 200,000 cubic feet capacity, and cargo ships, which are slower but have a larger insulated capacity up to about 350,000 cubic feet.

2. Frozen beef and mutton is stacked in the holds. Chilled beef, however, is always hung on meat rails (*see* Sec. **14**, 6).

3. Much of the frozen meat brought into the Port of London is discharged into insulated barges, which convey it from the docks to the cold stores. The capacity of these barges varies from 60 to 100 tons. If the cargo is fully stowed the meat can remain in the barges for forty-eight hours in cold weather without suffering depreciation.

4. In temperate climates frozen meat is normally transported in insulated lorries or railway wagons, if distances are such that protection of the meat during transit is required.

The carrying capacity of road vehicles varies from 3 to 10 tons, depending on whether trailers are used or not.

The capacity of the average railway wagon in Great Britain is 5½ tons.

5. In tropical climates where frozen or chilled meat is transported, special types of refrigerator road and rail vehicles are used. The methods of refrigeration employed in these vehicles are, broadly speaking, the same in principle as those utilized in ships and cold stores, suitably adapted to meet the particular conditions of the locality in which they are used.

6. It is impossible to lay down any definite figures as to the time frozen meat will keep in good condition when transported in standard open-type military vehicles.

Temperature, humidity, the number of times the meat is handled, its condition when loaded, and the method of loading all affect its keeping qualities during transit.

7. At home stations frozen meat is delivered by road or rail to R.A.S.C. depots by the contractors. At certain stations abroad the meat is taken into W.D. cold-storage installations *ex* ship. In these cases the R.A.S.C. is responsible for supervising the transhipment of the meat to the military cold store and for its proper custody therein.

The procedure adopted for transferring frozen meat from ship to cold storage varies according to the local conditions, full details of hours of delivery, maximum quantity to be delivered and methods of handling being laid down in the contracts for each station.

Reception and Inspection

8. On the arrival of a consignment of frozen meat the R.A.S.C. officer i/c supplies is responsible for arranging for the meat to be examined in the ship.

This inspection is carried out in order to :—

i. view the general conditions under which the meat has been conveyed ;

ii. examine samples as to correct labelling, quality, dressing and condition as required by contract specification ;

iii. scrutinize the ship's refrigerator log record for any unusual rise in temperature during the voyage, which should not exceed 16° F. ; and

iv. notify the contractor of general acceptance or rejection subject to detail inspection at cold-storage hatchways.

9. The officer charged with the receipt and custody of stocks arranges adequate supervision at the cold stores to ensure :—

i. Careful compilation of the "off-loading record" to show :—

(*a*) Date of receipt ; time of arrival of ship at quayside or store (if delivery is made direct from ship to store) ; time of beginning and completion of discharge.

(*b*) Total number of carcases and pieces, together with gross and net weights of consignment as shown on the bill of lading.

(*c*) Total number of carcases and quarters. Also weight of meat as recorded on the W.D. scales.

(*d*) Brand of meat according to labels.

(*e*) Number of quarters or carcases rejected, and reasons for rejection.

(*f*) Duration of off-loading and causes of any delays.

ii. Careful checking of weights.

iii. Examination of carcases and quarters to prevent any being stored that are :—

(*a*) damaged by rough handling;

(*b*) not in accordance with the specification as regards quality, condition, weight and labelling;

(*c*) not in thoroughly hard and clean condition.

iv. Careful and economic stacking.

v. General supervision of conditions under which the meat is delivered, in order to bring to the notice of the contractor anything unsatisfactory regarding general conditions of delivery, such as wet or dirty barges, meat not sufficiently safeguarded from heat, rain or sea-water, too rapid discharge *ex* ships, etc.

vi. That the work of transfer from ship to shore is carried out as expeditiously as possible, and that the rate of discharge from the ship is regulated by the rate at which the meat can be taken into the cold chambers and properly stacked therein.

Note.—Exposure to the atmosphere is harmful and the period between ship and cold store must be reduced to a minimum.

10. *Weighing*.—Since the weigh-bridge or scales record usually forms the basis on which the contractor is paid, it is most important that the W.D. and contractor's representatives should be present, and in a position to watch and record all weighings, and to settle any dispute that may arise.

The weigh-bridge or scales should preferably be of the automatic variety, which stamp the recorded weight on a card. They should be checked at regular intervals by an officer in the presence of the contractor's agent during the period of the reception of a consignment.

Similarly if the meat is passed over the weigh-bridge in trucks or trolleys, the latter should be " tared " to identical "tare" weights before the weighing of the consignment is begun. These "tare" weights should subsequently be checked by an officer at regular intervals, and any variations adjusted by the addition or removal of the lead provided for adjustment purposes.

11. *Checking into chambers*.—It is essential that an additional check should be introduced at each chamber door to record the actual number of quarters and crops of beef or carcases of mutton taken in.

Tally boards or books should be kept on which are recorded the results of these checks. They assist in subsequent stock-takings, and form a useful record to be compared with the

tallies of whole consignments, which record actual weights. The tally boards or books should be checked and totalled hourly, and the numbers of pieces received at the chamber hatches should be compared with the numbers received at the scales.

12. *Mixing consignments.*—In no circumstances should meat of one consignment be placed in a chamber containing meat of another consignment.

The reasons for this are :—

i. Meat of one consignment is liable to become mixed with that of another.
ii. Accurate stock-taking and check on out-turn becomes impossible.
iii. Chambers must be periodically defrosted for inspection, cleaning, etc.; in the case of old chambers not less than once in six months.

Unless strict attention is paid to this rule it is impossible to tell with any degree of certainty how a particular consignment has run out, i.e. to what extent a surplus or deficiency has accrued on the accepted weights.

Owing to the difficulty of stock-taking meat when in cold chambers, it is advisable to receive frequent small cargoes rather than few large ones. If this is done, stocks in any one chamber can be quickly run out and the out-turn carefully checked.

13. *Stacking in cold chambers.*—High stacking of meat is undesirable, being uneconomical both in time and labour.

On an average it is undesirable to stack quarters or crops more than eight or ten high respectively.

Free circulation of cold air round stacks should be provided for by means of dunnage at the sides as well as underneath. For the walls, battens 2 inches square placed perpendicularly at intervals of 9 inches are suitable.

The work of stacking is difficult and heavy; consequently shifts should not exceed three hours. The approximate areas for storage and thawing are as follows :—

Storage, beef ..	..	..	100 cu.ft. a ton.	
,, mutton	..	..	120 ,,	,,
Thawing, beef ..	..	..	300 ,,	,,
,, mutton	..	..	250 ,,	,,

Administration

14. The Royal Engineers are responsible for the operation of the freezing plant. In order to enable them to carry out their duties they must be given ready access to the chambers when required.

15. The R.A.S.C. officer in charge, or his representative, must be present when chambers containing meat are opened, and he is personally responsible for the custody of the keys and for witnessing the opening and closing of chambers. He is also responsible for accounting for all stores placed in the chambers, and for the labour required to handle them.

16. Close collaboration is necessary between the R.E. and the R.A.S.C. representatives, in order to ensure efficiency and economy in the working of the plant and to avoid preventable loss.

17. Strict supervision and attention to detail are essential in all cold-storage establishments.

The work concerned with cold storage is highly technical and the charge a valuable one. To ensure that the duties are efficiently and economically carried out, particular attention should be paid to the following :—

i. Receipt and stacking should be carefully supervised.
ii. Issues should be carefully supervised, and should be made expeditiously and to a fixed time-table.
iii. Accommodation adjacent to cold chambers should be kept as cool as possible.
iv. A " Daily temperature record " will be kept in which will be recorded the temperature of each chamber as checked.
v. No detail issues or cutting up should be done on the premises, except as specially ordered by the officer i/c supplies.
vi. Stocks should be issued in rotation of receipt, separate accounts being kept of each consignment.
vii. Stocks should be so arranged that efficient and frequent stock-taking can be carried out.
viii. None but authorized stocks should be stored.
ix. Economy must be observed by keeping labour and material running costs as low as possible consistent with efficiency.

Administrative records—

18. A " meat consignment " book should be kept and initialled daily by the officer i/c supplies, two pages being used for each consignment.

The left-hand page should record the following particulars :—

i. Name of ship and date of off-loading.
ii. Numbers, gross and net weights of hinds, crops and carcases as shown on the bill of lading.

iii. Numbers, gross and net weights of hinds, crops and carcases as actually received.

iv. Deficiency or surplus in numbers, gross or net weights between bill of lading figures and actual receipts as checked.

The right-hand page should indicate the daily or other bulk issues by pieces and gross weights, as made to the detail store by the officer i/c cold stores or his representative, and as reported by him nightly on the " Issue order " form referred to in para. 19, below.

The officer i/c supplies, by keeping this administrative record, can see at any time the progress that is being made in the outrun of the chamber in current use, and should satisfy himself, towards the end of a consignment, as to the correctness of the " remain " of pieces ; an exact tally as to both pieces and weights should also be made on the day upon which the chamber is going to run out.

19. A form of " Issue order " should pass between the supply office and bulk store daily (or as required) indicating the poundage of meat to be issued in bulk, and to whom.

On termination of issue the N.C.O. should complete this form by inserting the numbers of pieces and gross weights issued, and return it to the supply office.

The " issue " entry, both as to pieces and poundage should be completed :—

i. by the master butcher on the issue side of the consignment tally sheet ;

ii. by the supply office on the appropriate " issue " page of the " Meat consignment " book.

20. Bulk and detail records should be rigidly separated by :—

i. using a separate A.F. F 754 monthly for " bulk " transactions, or

ii. recording " bulk " receipts and issues, and " detail " receipts and issues in entirely separate folios of the monthly A.F. F 754.

Whichever method is adopted, the " bulk " records should show no more than :—

(*a*) Bulk " Remains " plus bulk " Receipts " (consignments).

(*b*) Bulk " Issues " to detail issue store.

Similarly, the " detail " record should show the pieces and gross weights as received from cold stores, and the detail issues to troops, together with wrapper and bone allowances in the usual manner.

Factors affecting the Condition of Meat while in Cold Storage

21. The conditions which can be varied in cold storage are the temperature of the chamber, the relative humidity of the atmosphere, the movement of the air and the packing of the meat in the chamber.

22. *Temperature.*—It costs more to maintain a chamber at a lower than a higher temperature; therefore the actual temperature used must be no lower than is sufficient to preserve the meat in proper condition.

Bacteria and moulds are not killed by low temperatures, but their development is arrested. In general, lowering of the temperature is more effective in retarding the growth of bacteria than that of moulds, and there are no well authenticated cases of bacterial growth on meat below about 26° F.

Moulds and yeast-growth cease at about 19° F. At temperatures in excess of 19° F. the growth of moulds is possible and the more the temperature is allowed to rise the greater is the rate of growth.

23. *Humidity.*—A high relative humidity in the storage chambers is advantageous, as it keeps down the rate of evaporation of water from the meat and so prevents undue desiccation.

On the other hand, a moist atmosphere favours hydrolysis of fats and the development of moulds.

The upper safe limit cannot be stated accurately, but it is probably best to maintain a humidity of 85 to 90 per cent.

24. *Movement of air.*—Movement of air in the chambers increases the rate of evaporation of water; on the other hand, it tends to prevent the deposition of water on the meat and is a strong preventative of moulds.

25. *Packing.*—Close packing lessens the evaporation of water, but it is favourable to mould formation.

Defects which may occur in Cold Storage

26. **Moulds.**—When the temperature is favourable, moulds grow freely on meat, especially when the surfaces are damp through the condensation of moisture.

Numerous types of moulds and bacteria are developed on meat. They include species of :—

Mucor and *Thamnidium*, which are responsible for long white growths known as "whiskers." These are very prominent and may grow as much as an inch above the surface, though they collapse in dry air. Their presence

shows that the temperature has risen well to the neighbourhood of freezing point; they may be sponged away with vinegar and water if not developed to an excessive extent.

Cladosporium herbarum, which causes "black spot." This is in some ways the most serious and unsightly mould, because it causes dark patches of a quarter to a half inch in size, particularly on the skirt and pleura of beef, and the legs and interior of mutton. These patches are very difficult to remove.

Black spot may spread from carcase to carcase. A badly infested chamber must be cleaned and disinfected with chlorinated water (bleaching powder solution) or sulphur dioxide.

Penicillium and *Sporotrichum*, which forms blue or white or yellowish colonies on the meat, especially on the inside of the carcase.

Bacteria, e.g. *Bacillus prodigiosus* (red spot) and yeasts may also occur.

Yeasts often appear as white, pink or yellowish slimy spots, which are raised and translucent if moist, but become brown when dried. They grow only above freezing point.

There is no evidence that the moulds produce elements which are poisonous either in the raw or cooked condition, but when growth is extensive they may impart an unpleasant flavour to both lean and fat. Parts affected should be wiped with a cloth or cut out.

The presence of organisms in the store, not necessarily on the meat or multiplying at the temperature of the store, may also impart flavours to the fat, e.g. *Actinomyces* and *Achromobacter* may give rise to "musty" and "tainted" flavours respectively. It is therefore necessary to clean the walls and equipment in the store at regular intervals.

Moulds may be found growing on the walls of the chambers, especially on the woodwork and insulating material, which absorb moisture from the damp air. The superficial moulds which may infect the meat can be removed by washing the walls of the store (when empty) with a 2 per cent. solution of formalin.

27. *Dry rot.*—Dry rot of the structure timber is more serious. It is caused by a fungus growing in and disintegrating the wood.

The timber should not be in direct contact with water. It should be arranged so that it is well aerated on all sides, and, if possible, it should be treated with some substance which preserves it from decay, but which is odourless.

Precautions necessary to Preserve the Meat from Moulds

28. The following are precautionary measures which should be taken :—

i. Prevent the meat from contamination with spores by avoidance of dust and maintenance of scrupulous cleanliness in the cold store.
ii. Ensure that the refrigeration plant maintains the correct temperature without serious fluctuations.
iii. Ensure that the circulation of air in the cold store is sufficient to remove excess moisture.
iv. Do not store meat longer than is absolutely necessary.

Improvised Method of Preserving Frozen Meat

29. An improvised method of preserving frozen meat with the use of hay will be found in R.A.S.C. Training, Vol. II.

Defrosting and Thawing

30. The terms "defrosting" and "thawing" are frequently used synonymously. This is incorrect, although both processes are employed to bring meat from its cold storage temperature to that of the ordinary atmosphere. The former requires special plant and appliances not found in army cold storage installations, and need not therefore be considered.

31. Frozen beef which is restored to atmospheric temperature while its surface is exposed to the ordinary air laden with a certain amount of moisture is apt to exude moisture, i.e. " drip," and become discoloured.

The atmospheric moisture also condenses on the colder surface of the meat and causes a " weeping " appearance.

Unless the process of thawing is carefully carried out, the meat will not only appear unsightly, but there will be a serious loss of the juices through " drip."

There may be occasional drip when frozen mutton is being thawed, but it is slight compared with beef.

32. To obtain the best results, frozen meat should be subjected to a very gradual process of thawing, preferably extending over a period of seventy-two hours. This period will, however, vary according to the temperature and must therefore be adjusted to suit the local conditions.

Where suitable insulated chambers are available the thawing process can be carried out without difficulty.

Where the quantity of beef to be thawed is small and insulated chambers are not available, hind-quarters should

be hung up and surrounded by at least three brown bags or wrappers. These bags or wrappers act as an insulation whereby the temperature of the meat is gradually increased. They also collect moisture which would otherwise settle on the meat.

Crops and fore-quarters should be stowed three high on bags on the floor and well covered with bags.

It is essential to prevent the heat and moisture from the atmosphere from coming too suddenly into contact with the meat.

Frozen meat decomposes rapidly on thawing and should in no circumstances be returned a second time to cold storage.

22. *Storage temperatures for meat and other commodities*

Various commodities require different cold storage temperatures and the following may be taken as a guide :—

Commodity	Degrees F.
Apples	34–36
Bacon (mild cured)	28–30
,, (salt-packed)	*See* Sec. 32, 4.
Beef (fresh)	32–36
,, (chilled)	28–32
,, (frozen)	18–20
Butter	Down to 0
Cheese	30–50
Chickens	18–22
Eggs	30–35
Fish (fresh)	25–30
,, (dried	30–35
,, (S.W.) frozen	10–15
,, (salt) frozen	10–15
Fruit (fresh)	35–40
Game	18–22
Ice	25
Margarine	18–25
Milk (fresh)	32–36
,, (condensed)	35–40
Mutton (fresh)	32–36
,, (frozen)	14–18
Oranges	32–45
Vegetables	34–40

CHAPTER III

BACON

23. *Quality*

1. The carcase of the pig is distinctive and impossible to mistake. The fat is very white, greasy and rather soft. The flesh is somewhat flabby. It is pale in colour in young animals, and even in old carcases it is lighter than beef or mutton. The carcases of boars are simple to detect, owing to the deep red colour of the flesh, the strong root of the genital organ, and the fact that the skin, being hard and fibrous, is impossible to cut (it should be noted that large boars are sometimes skinned).

2. Pigs are prone to disease; the flesh of diseased animals is generally either fevered, or anæmic and emaciated. Health is indicated by the clear colour of the flesh and fat, the absence of lesions anywhere in the carcase, and a normal appearance of the lymphatic glands.

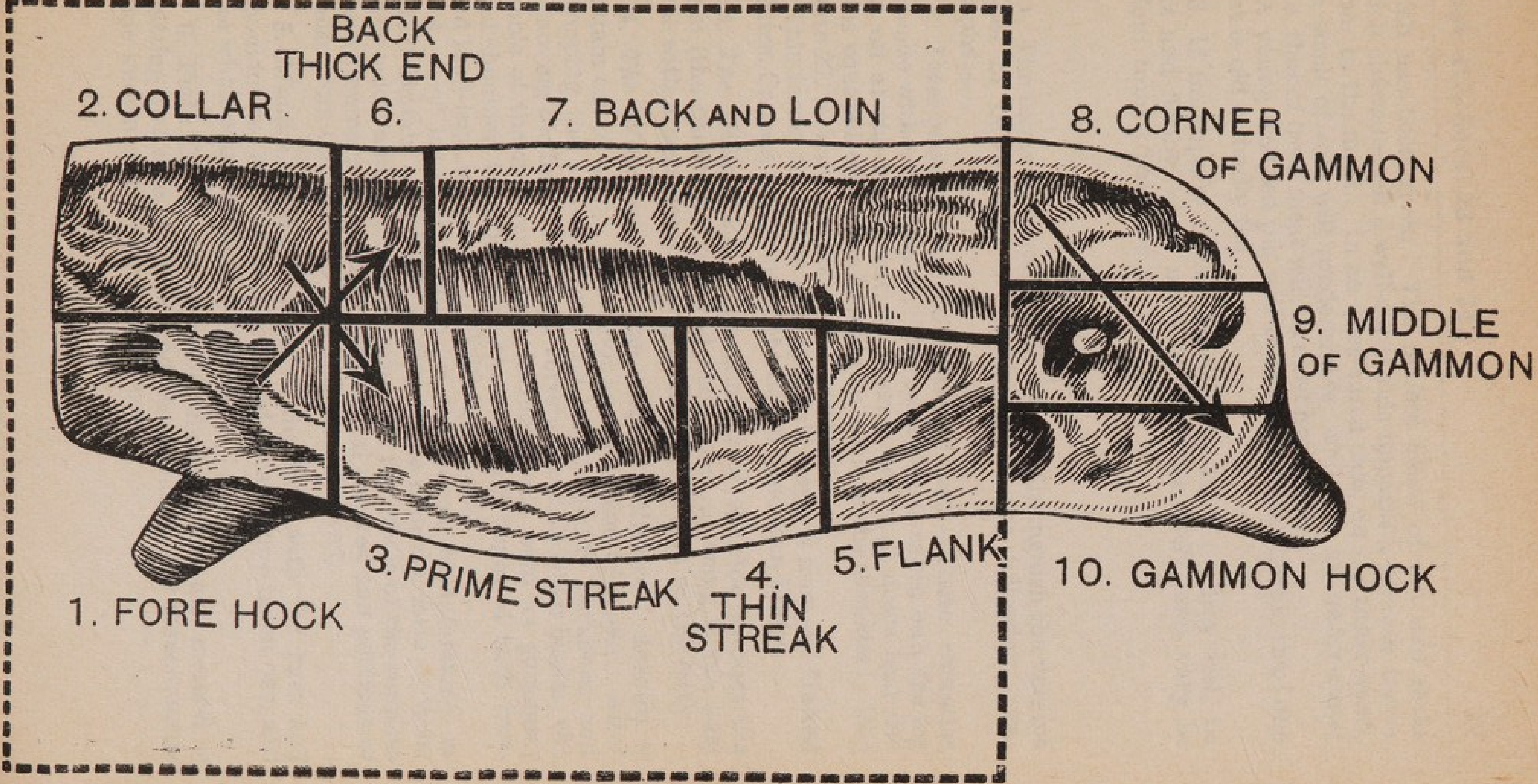
3. The fat of hams and of bacon should be firm and white, the flesh firm and free from holes. The solidity of the belly fat is a sure indication that the side of bacon is of good quality. Any tinge of colour in the fat is suspicious. Bacon should be tested for sweetness by probing with a wooden skewer or trier in the direction shown by the arrows in Plate 27, facing this page. On withdrawal it should smell sweet and be without taint. Bone taint will usually be found under the ribs or near the bones in the legs.

The cause of bone taint, described in Sec. **10**, 31, *et seq.*, is applicable to ham and bacon also.

4. Other points to be noted in examining bacon are as follows :—

i. See whether it is well or lightly cured; if the latter, the keeping properties are small and taint is likely to arise.
ii. See that the sides are not too fat or too lean, that they are well butchered, and that the general condition is satisfactory.

5. An experienced judge can determine the quality of a side of bacon by touch and smell as well as from its appearance, and can estimate with the aid of a trier the degree of cure



NOTES.—1. The three-quarter side, indicated by dotted lines, is known as the "Cumberland-cut."
2. The arrows show the direction in which probing should be made.

which has been given. The perfect blend of salt and meat which characterizes a well-cured side imparts a definite bacon odour to the meat. In an over-cured side, on the other hand, the smell of salt will predominate, while, in an under-cured side, that of fresh meat will be most noticeable.

A young well-fed pig will take the cure far better than one that is old or badly fed.

6. If improperly cured, bacon may have a slimy feel, be soft and flabby, smell more or less offensively, and vary in colour from a pale hue to dark red.

24. *Bacon cuts*

1. The terms most commonly used to distinguish the various types of bacon cuts are described in the following paragraphs :—

2. *Three-quarter sides* (*Cumberland cut*).—These comprise the side without the ham ; the backbone is taken out, the leg cut off at the knee joint, the breast-bone cut down and the ends squared off. The bladebone is left in the shoulder. (*See* Plate 27, facing page 76.)

This forms one of the principal cuts shipped from the United States, Canada and some of the South American States.

3. *The Midland cut.*—This consists of the side without the ham (the backbone, ribs and bladebone all being taken out) and with a considerable proportion of the lean of the back.

4. *The Wiltshire cut.*—The term " Wiltshire " denotes a certain cut of bacon, and is not an indication of origin. After chopping the carcase down the length of the backbone and removing the head, feet, tail, vertebræ and shoulder blades, the whole of the side remaining, including the ham (or gammon) and shoulder, together with the ribs and bones of both fore- and hind-legs, is termed a " Wiltshire " side.

A very large proportion of the bacon manufactured in Great Britain and the Irish Free State is in the form of Wiltshire sides, and it is in this form that the whole of the supplies from Denmark and other continental sources and portions of those from Canada and America are delivered.

5. *Middles.*—These consist of the side, with the ham and shoulder cut off, the backbone and breast-bone taken out, and the whole squared off at the ends.

6. Plate 27, facing page 76, shows the usual method of cutting up a side of bacon, and also indicates the three-quarter side known as the Cumberland cut.

25. *Bacon curing*

1. In a modern bacon factory the various operations of curing are carried out in regular order with a view to limiting handling as far as possible. The following is an outline of a typical process :—

After being stunned the pig is killed by severing the aorta with a knife, and the carcase is hung until the blood has run out. It is then scalded in a tank of water, at a temperature of from 140° to 180° F., to remove the hair.

On removal from the scalding tank, the carcase is scraped clean by hand, or by a scraping machine, after which it is passed through a furnace, where it is singed for approximately thirty seconds, in order to complete the de-hairing process, and to harden the skin.

The carcase is thoroughly sprinkled with water and scraped clean ; it is next opened and the intestines removed, after which it is hung until the animal heat is removed ; it is then split down the back and the vertebral column is removed.

The sides are separated, and after the feet, head and kidney fat have been removed, they are cooled down to 38° F. in a chilling-room.

The curing process proper is next carried out.

2. Curing processes may be classified under two main headings :—

i. The dry-cure or dry-salt process ;
ii. The tank-cure or brine-cure or sweet-pickle process.

It is contended that dry curing produces bacon of a better flavour and keeping quality ; tank curing is the cheaper method.

3. i. *The dry-cure process*.—This is the method chiefly adopted in Great Britain.

In the " Wiltshire-side " home trade the sides are laid on benches and a " pickle " composed mainly of salt, saltpetre and sugar is injected into the fleshy parts of the gammon and shoulder and the exterior part of the sides, under a pressure of 80 lb. or more to the square inch.

The sides are then packed in layers, piled four or five feet high with the rind downwards, and well covered with " dairy salt." In this condition they remain for from ten to fifteen days. When this part of the process is complete the salt is brushed off, and the sides are re-stacked for a further seven or nine days to ripen, after which they are again brushed and hung up to dry.

In the "Midland" trade, bacon is cured by the dry-salt process, but, unlike the "Wiltshire-side" cure, no pickle is injected into the sides. Shoulder bellies normally remain in dry salt for from eight to ten days. After curing, Midland bacon is washed in tepid water to remove superfluous salt, and is hung from seven to ten days to stiffen and dry.

ii. *The tank-cure process.*—This is the method most commonly adopted in Europe, Canada and the United States.

In Sweden and Denmark brine is injected into the bacon under a pressure of at least 80 lb. to the square inch. The sides are then piled up in large concrete or slate tanks containing a strong brine or "pickle" composed of salt and saltpetre, where they remain for periods varying from four to seven days.

After pickling they are drained and allowed to mature from two to seven days, after which they are ready for packing for export.

Canadian bacon is generally pumped with brine at heavy pressure, and subsequently given four days in the brine tank, and four days dry cure.

Most of the supplies from the United States are tank-cured, though not as mildly cured as Continental bacon.

American Wiltshire-cut sides normally remain in cure from ten to twenty-two days.

4. All imported bacon normally arrives in the "green" state, and is smoked or otherwise processed (e.g. pale dried) by wholesalers according to requirements.

Smoking is generally confined to Southern England and Scotland, while pale drying is more commonly used in Northern England.

26. *Smoking*

1. The process of smoking is as follows :—

The sides of "green" bacon are drained from seven to ten days, and are then washed, wiped and trimmed.

They are next dusted over with pea-meal and smoked in bacon stoves for thirty-six to seventy-two hours at a temperature of about 85° F. The temperature varies to a certain extent, but should not exceed 90° F.

The smoke stoves require a good deal of watching and care; they should always be under the charge of a competent man.

A sawdust fire is used; dry hardwood sawdust is most suitable, that from the oak and elm being preferred. The object of the smoking process is partly to dry and harden the bacon, as a protection against dirt, and partly to give it the

distinctive smoky or aromatic flavour, and the rich brown colour on the skin. These are absent in pale-dried bacon.

2. Shrinkage as the result of the smoking process, for the ordinary trade, should not exceed 5 to 7 per cent.

3. *Pale drying.*—This process also dries and, to some extent, hardens the bacon. The sides are hung either in a room warmed by hot-water pipes, or in long chambers through which a forced draught passes, or in the open air, but under cover. Sometimes coke braziers are used to heat and dry the bacon.

27. *Bacon issued to troops*

1. Bacon issued to troops at home is usually Canadian, Dutch or Baltic. It is mild-cured, and is suitable only for temperate climates.

2. For hot climates specially hard-cured bacon is utilized, and this is despatched in a special pack. Each piece is wrapped and sewn in stout calico and packed into strong wooden cases lined with paper; the boxes are filled with fine kiln-dried salt, which should be thoroughly rammed down so as to fill the interstices between the sides of the bacon and the box.

3. When circumstances permit, mild-cured bacon is shipped to certain stations abroad, either salt packed in cases or in refrigerator space. Immediately on arrival the mild-cured bacon should be unpacked from the cases, wiped thoroughly dry, particularly the pockets, and the pockets dusted with a mixture of ginger and salt in the proportion of three parts to one; the bacon should then be hung in the refrigerator.

If any signs of taint are shown, the affected part should be immediately cut off and destroyed, as the remaining portion of the side may be fit for consumption.

28. *Grading and marking*

Grading

1. The bacon consumed in Great Britain comes from a variety of sources, under different conditions of production and distribution. Variations exist in the methods of grading adopted in each exporting country, and in the degree to which the grading meets the requirements of the market. No standardized grading systems are yet enforced. In general, although the whole of the bacon from some countries, such as Denmark, Sweden and Holland, is closely and uniformly graded, the grading is done mainly by the factories and there is little or no external control. In the English industry, each factory grades according to its own ideas, and there is no approach to a national standard.

MARKING

2. Two kinds of marks are in common use on imported bacon—the overriding official stamp of the country of origin and the brands of individual factories.

By arrangement between the British government and the governments of most of the principal supplying countries, all bacon exported to this country bears an official stamp or brand to indicate that it has been inspected and certified free from disease.

3. In Canada, in addition to the government export stamp, an official export certificate is issued by the Government veterinary inspector.

29. *Defects in bacon*

1. However carefully it is processed and packed, bacon is still liable to become bad in hot climates. One of the chief causes of condemnation is *Piophila casei*, a fly which is a world-wide pest of preserved meat, bacon, cheese, etc.

2. This fly is dark bronze in colour and frequents storage and curing rooms and other situations where suitable breeding places may be found. It usually deposits its eggs in groups on the surface of food material, particularly in cracks or broken surfaces, the number of eggs on an area of 1 sq. cm. varying from 55 to 85. In bacon the parts soonest affected are the " pocket " in the fore-end and where the bladebone has been taken out. The development of the egg ceases below 10° C., but it remains alive for some weeks and might hatch if exposed to warmer temperatures. The period of incubation is :—

4 days at 10° C.
2 ,, ,, 18° C.
1¼ ,, ,, 21° C.

and less than a day at higher temperatures.

3. The newly hatched maggot (larva) is transparent and so small as to be hardly visible. At temperatures of 65° to 95° F., full growth is reached in eight to fifteen days, and at this stage the larva is yellowish-white, tapering towards the head and about ⅜-inch in length. Its peculiar habit of curving both ends together and then suddenly springing to a distance of three to six inches has given it the name of " skipper." The larvæ seem to be somewhat gregarious, are fond of the dark and can withstand starvation for a long time.

4. When mature the larvæ come to the surface, seek a secluded place which is dark and dry, and change into the pupæ enclosed in a hard-shelled brown case about ⅕-inch

long. Pupæ may be found under the bacon cloth or in dark places in the store-rooms. At 65° to 95° F. the adult fly may emerge from the pupa in seven to twelve days. Thus the entire life cycle may be passed in about seventeen to twenty-nine days, and it is estimated that it is possible to have two generations a month at a temperature ranging from 77° to 86° F.

It is possible that development of the fly from the maggot may be delayed if the conditions are unfavourable, that is to say if the temperature inside the case has not risen much above 50° to 55° F.

5. Cases of bacon which have become infected will frequently be found to contain both live and dead maggots and flies.

Condemnations of bacon due to this cause are considerable in Egypt, Iraq and other hot climates, particularly during the months of July and August, but it should be noted that flies become numerous from June to October.

6. Bacon may become " fly struck " :—

i. Before or during the packing operation.
ii. During transit to, and storage at, overseas stations.
iii. When the cases are opened on arrival.

7. Infection can be prevented only if strict attention is paid to the following points :—

i. The bacon should be carefully inspected before packing.
ii. The packing and storage premises should be clean and free from flies.
iii. The packing should be carefully carried out, the salt being of the right quality and well rammed down between the sides of the cases and the bacon.
iv. The calico covers should be of good quality and carefully fixed.
v. The cases should be sound, as otherwise maggots will find an inlet through cracks or faulty joints and so infest the bacon.
vi. The bacon should be consumed as soon as possible after the cases have been opened.

30. *Condemnations*

1. Recovery in respect of bacon condemned is possible when supplies are warranted by the packer, subject to the following factors :—

i. That at least 10 per cent. of the contents of a case has been condemned.
ii. That claims are made within fourteen days of the date of condemnation, if the quantity condemned exceeds 10 cwt.

iii. That condemnation is made immediately the case is first opened at the issue store overseas.

iv. That the grounds of condemnation are such as to provide good *prima facie* evidence that the contractor is responsible.

2. All condemnations are required to be reported to the War Office, whether claims for recovery are admissible or not.

31. *Shrinkage*

Bacon is subject to loss of weight from "shrinkage" or "dryage."

The percentage of loss may vary considerably according to climate, season and the length of time which elapses between the packing date and the issuing date.

In tropical climates losses in salt-packed bacon through this cause may be as much as 6 per cent. or even higher in special circumstances.

32. *Bacon storage*

1. The storage of bacon is not a straightforward matter like the storage of frozen beef or mutton.

2. Where it is necessary to place mild-cured bacon or ham in cold storage, the temperature of the chambers should be maintained at from 28° to 30° F. At temperatures above 32° F. spoilage is likely to occur owing to the growth of yeasts (slime) or moulds on the surface. At lower temperatures these organisms do not grow so readily, but the fat gradually develops rancidity. Even when the bacon is frozen in the sharp freezer (below 0° F.) and stored at 14° F., the fat becomes rancid after about four to six weeks' storage. Smoking helps to retard the development of rancidity, but does not entirely prevent it.

3. As regards salt-pack bacon, whether mild or hard cured, there is a certain amount of prejudice against storing it in refrigerated space. The reason for this is that the humidity may cause the formation of a brine which may flow out of the packing, thus causing damage to floors and ships' holds. There is also a tendency for the bacon to take up more salt and thus become unpalatable.

The use of special waterproof paper to line the cases, and of a specially pure salt dried immediately before use, is sometimes effective in overcoming these defects.

4. Tests which have been carried out at the Supply Reserve Depot, Deptford, and at certain stations abroad have shown that hard-cured salt pack bacon can be kept in cold storage for a period of at least one month at a temperature of 16° to 17° F. without causing brine formation or increasing the salt content.

5. It is an important principle in bacon supply that stocks should be kept as short a time as possible. It is essential, therefore, that the provision of supplies of this commodity should be worked to a carefully pre-arranged plan so as to provide for a continuous and rapid turn-over.

CHAPTER IV

BREADSTUFFS

33. *General*

1. Bread is made by mixing together flour, water, salt and yeast. These form a dough which is maintained at a temperature of about 80° F. whilst fermentation proceeds. The yeast ferments the small amount of sugars present in the flour as well as the additional sugar produced in the dough itself during the fermentation period. The fermentation converts the sugars into alcohol and the gas carbon dioxide. It is the amount of this gas and the gas retaining properties of the dough which largely determine the quality of the loaf. Small quantities of acids and other substances are also produced during the fermentation, and these acids bring about the ripening of the dough.

2. It is not enough for dough to have attained the right size or become sufficiently distended with gas; it must be knocked back, i.e. have the gas squeezed out of it several times during the fermentation. This working of the dough helps the ripening process and bread of better colour, texture and flavour results.

3. The quality of the bread produced in the bakery depends upon the following factors :—

i. The character and quality of the flour.
ii. The quality of the yeast.
iii. The suitability of the plant and premises.
iv. The proficiency of the baker.

34. *Wheat characteristics*

1. Flour derives its character from the wheat from which it is prepared ; its quality depends upon the wheat and upon the milling grade. Wheats vary in character and this variation is reflected in the flour. For comparative purposes they may be divided into three classes, strong, medium and weak. The term "strong" means that the flour obtained gives a high yield of bread, handles well in the dough and gives well-risen loaves. The term "weak" is applied to flour that takes up less than the normal amount of water in making the dough, and to flour that gives sticky runny dough that is

difficult to handle and has little stability. Such flour gives a low yield of bread and the loaves have little height or volume.

Strong flours are therefore the best for breadmaking. Weak flours are used for biscuits and pastry.

2. On account of the variation in wheats the miller exercises great care in the selection of wheats to form his grist, in order that his flour shall be as nearly uniform as possible and yield a good loaf.

35. *Sources of supply*

The greater proportion of the wheat employed in Great Britain for the production of flour for breadmaking is imported.

36. *Description of principal wheats*

1. *Manitoba wheats.*—These are strong wheats, the grain being red and hard, and containing 10 to 13 per cent. moisture. They are officially graded. No. 1 is the pick of the wheat and may have a weight as high as 65 lb. a bushel. The lower grades, such as fives and sixes, have a lower natural weight, a little more moisture, some of the grain may be slightly frosted and they do not yield as well in the milling.

2. *Australian wheats.*—These are medium to weak wheats. The grain is light in colour and bold, weighing 60 to 64 lb. a bushel, with 10 to 13 per cent. moisture. The wheat mills well, giving a high yield of flour of good colour.

3. *Indian wheats.*—Several kinds of wheat are received from India, e.g. Karachi, Calcutta and Bombay. They are generally dry, hard, flinty and brittle, with about 9 per cent. moisture. Indian wheats are good water absorbers, and in this respect profitable to a miller. The weight a bushel (58 to 61 lb.) is low. The wheats are of medium strength, Bombay being weaker than the others. Flour solely derived from Indian wheat tends to give short, rather flavourless bread, but the wheats are useful to give stability to blends of other wheats.

4. *U.S.A.—Northern Spring (formerly Northern Duluth).*—These are strong wheats, officially graded ; the grain is small, red, plump and hard, weighing up to 64 lb. a bushel, with 11 to 13 per cent. moisture.

5. *U.S.A.—Hard Winter (grown in the Middle States).*—The grain is red, medium hard, with 11 to 12 per cent. moisture. It is a fairly strong wheat.

6. *U.S.A.—Red Winter.*—This wheat is rather weak ; the grain is red, with 12 to 14 per cent. moisture, weighing 60

to 62 lb. a bushel. Flour from this wheat is softer and is a good pastry flour.

7. *U.S.A.—Pacific Coast.*—These wheats are usually weak, similar to English and like them suitable for biscuit flour. The moisture content is 10 to 11 per cent.

8. *U.S.A.—Durum.*—This is a medium strength wheat; the grain is long, transparent, yellow and flinty, weighing 59 to 61 lb. a bushel, with 11 to 13 per cent. moisture. The flour is yellow and sweet. The wheat is useful for blending with poorer wheats.

9. *Argentine wheats.*—These wheats are variable in character, generally of medium strength. The grain is thin, red, and of medium hardness; the moisture varies, 11 to 12 per cent. being about the average. The weight a bushel also varies between 59 and 64 lb.

10. *Russian wheats.*—These are noted for their high gluten content, but they are only of medium strength. The weight a bushel varies from 58 to 62 lb., the moisture being from 11 to 13 per cent.

11. *Continental wheats.*—These are similar in character to English. The moisture is high, and the flour has little strength.

12. *English wheats.*—Flour from English wheat is noted for its good flavour and good colour. There are many varieties, white wheats, red wheats and special varieties such as Yeoman. All the ordinary varieties are weak, and by itself the flour is not very suitable for breadmaking. Where English wheat is employed for breadmaking, the best results are obtained by the "sponge" system, using a strong flour for the sponge and mixing in the weaker English at the doughing stage.

Flour from Yeoman wheat is stronger and of better baking quality than that from other English wheats.

English wheat has a high moisture from 13 up to even 20 per cent. in a wet season. It produces very good biscuit flour.

37. *National Mark scheme*

1. The National Mark scheme has been applied to flour derived solely from English wheat. This scheme aimed at improving the demand for English wheat flour by establishing standards of quality, and the marking of these standard qualities with distinctive marks.

2. Flour bearing the National Mark has been prepared by a miller approved by the Ministry of Agriculture, and is in accordance with the grade standards laid down.

Plain flour is supplied in packages, the labels of which are printed in blue, Yeoman flour in yellow, and self-raising flour in red.

3. Details of grade standards, etc., are given in a publication issued by the Ministry of Agriculture and Fisheries.

38. *Wheat quality*

Good wheat is even in size, clean, sweet, dry, and free from damaged grains. The weight varies, 60 lb. a bushel being a fair average figure. Wheat is bought and sold by weight.

39. *Flour, milling*

1. Before 1880 wheat was ground between millstones, and the products sifted or bolted to separate the bran from the flour or meal.

Roller milling has now almost entirely superseded stone grinding, because it is more efficient and gives a much better product.

2. The efforts made in the modern mill to bring the wheat into the best condition for milling, to free the particles of endosperm from the bran before these particles are ground into flour, and the care bestowed on the reduction process are responsible for the better quality of the flour produced.

3. *Wheat grain.*—Plate 28 (page 89) illustrates the structure of the wheat grain.

4. Large port mills have an output of 200 to 400 half sacks of flour an hour. The offals, bran, etc., produced at the same time amount to 10,000 to 20,000 cwt.

5. The milling process comprises two distinct sets of operations :—

i. The cleaning and preparation of the wheat.

ii. The conversion of the cleaned wheat into flour and offal.

It is impossible to deal with the complicated mechanical process of milling in detail ; the main operations involved are as follows :—

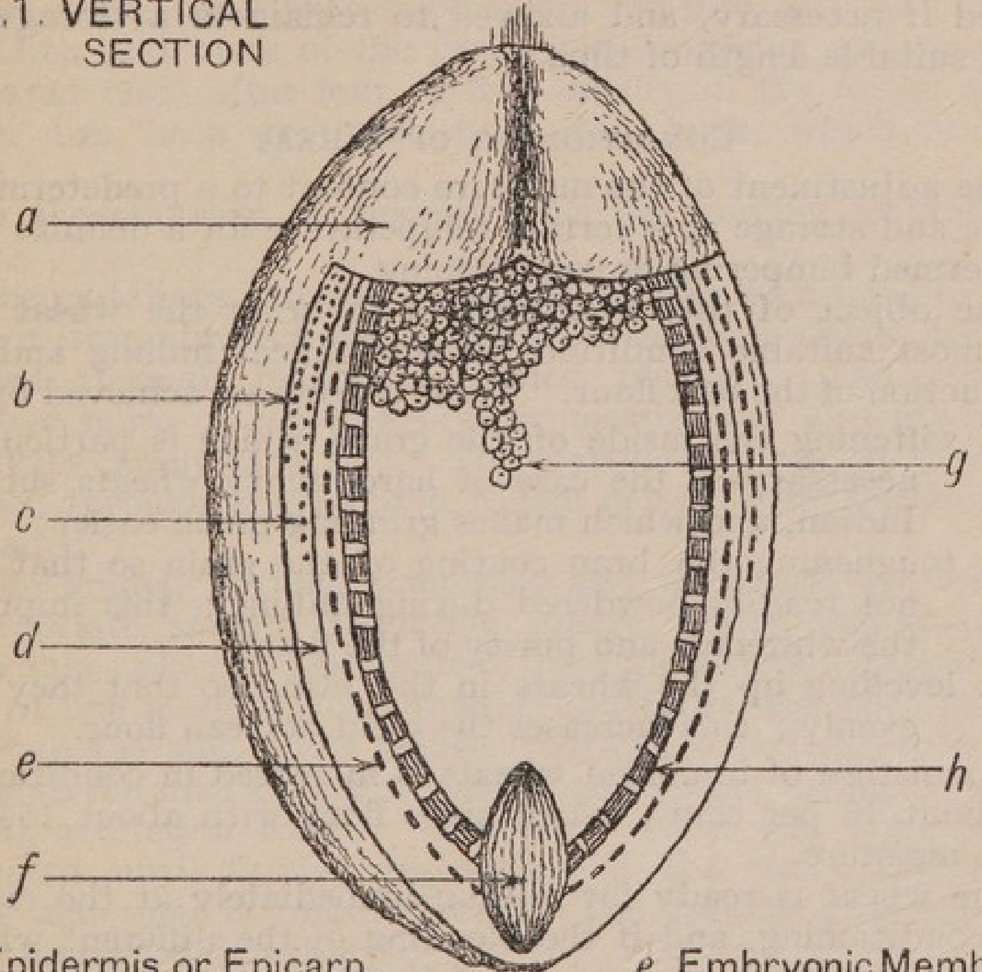
Cleaning of Wheat

The wheat is first subjected to dry cleaning by conveyance from the silos, at a predetermined rate, through a series of machines which remove dust, weed seeds, barley, oats, maize, imperfect and small wheat grains and pieces of metal. The dry-cleaned wheat may be stored until required or passed straight on to the washing process. In all up-to-date mills the dry-cleaned wheat is washed ; the washing removes

Plate 28.—Wheat Grain

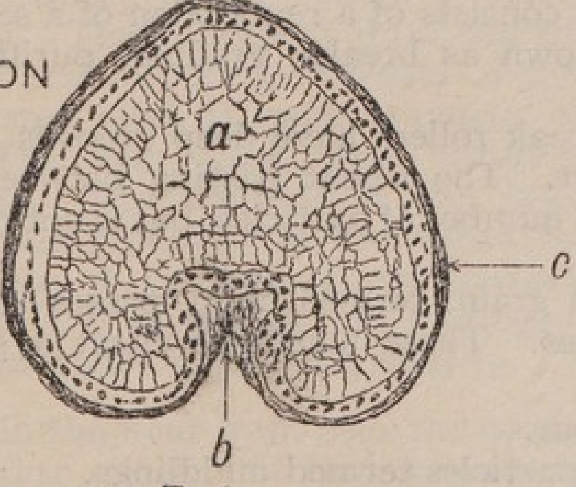
Part vertical section of a grain of wheat (magnified twelve diameters) and a cross-section.

Fig. 1. VERTICAL SECTION



a Epidermis or Epicarp.
b, Mesocarp.
c, Endocarp.
d. Testa or Episperm.
e, Embryonic Membrane.
f. Embryo or germ.
g. Starch Cells.
h. Cerealin Cells.

Fig. 2. CROSS SECTION



a. Endosperm
b. Crease
c. Seed Coating

surface dust, crease dirt, small stones, smut and any foreign seeds that still remain after the dry cleaning. The cleanings are sold for poultry feeding. The washed wheat is whizzed, dried by a current of warm air to a definite moisture content, cooled if necessary, and allowed to remain in a storage bin for a suitable length of time.

Conditioning of Wheat

The adjustment of the moisture content to a predetermined figure and storage at a certain temperature for a definite time are termed tempering or conditioning.

The object of this treatment is to bring the wheat into the most suitable condition for economical milling and the production of the best flour. These objects are achieved by :—

i. softening the inside of the grain, which is particularly necessary in the case of hard, flinty wheats such as Indian, and which makes grinding much easier;

ii. toughening the bran coating of the grain so that it is not readily powdered during milling; this improves the whiteness and purity of the flour;

iii. levelling up the wheats in the blend so that they mill evenly; this increases the yield of clean flour.

The moisture of imported wheats is increased in conditioning to about 16 per cent., which gives flour with about 15½ per cent. moisture.

The wheat is ready for milling immediately at the end of the conditioning, and if the blending of the different wheats has not already been carried out it takes place at this stage. A final brush up is usually given to the wheat as it passes to the mill.

Milling Process

The milling consists of a replication of a series of operations which are known as breaks, grading, purification, reduction and dressing.

The first break rollers have deep grooves and are set some distance apart. The wheat passing between these rollers is cracked into a number of particles, but is not reduced to powder to any extent.

The broken grain, termed chop, passes to scalper or plansifter machines. These machines effect a separation of the chop into :—

i. Fine flour.

ii. Larger particles termed middlings.

iii. Still larger gritting particles termed semolina.

iv. A residue consisting of the husk of the grain with large pieces of the kernel still adhering to it.

A small amount of powdered husk is removed during the process and this is mixed with other offals.

The residue forms the feed to the second set of break rollers. The same process of separation into flour, middlings, semolina and husk of the grain with adhering endosperm is repeated until after four or five breaks all the inside of the grain has been removed from the husk, which becomes bran.

In the majority of modern mills the number of breaks is four.

The middlings and fine semolinas, having been freed to some extent from fibrous branny matter in the plan-sifters, are then passed through machines termed purifiers. The purifiers remove more of the fine branny matter and also grade the particles closely as to size. The coarse semolinas are generally passed through finely fluted rollers before being purified and regraded.

The graded purified semolinas and middlings are sent to appropriate smooth reduction rollers, where conversion to flour takes place. The product from the rollers is passed over silk of fine mesh in flour-dressing machines, the flour passing through the silk. The coarser particles which failed to pass through the silks are again purified and passed through another set of reduction rollers. The purification and reduction is repeated until further separation of the small amount of flour and offal is impracticable. The residue goes into the offal known as fine sharps.

40. *Flour grades*

1. The flour produced by the reduction rollers is not all of the same quality. That obtained from the early reductions of the semolinas and middlings consists of purer endosperm freer from powdered offal, is more granular, and is the best quality flour. The flour from these reductions forms the "patents" grade. The flour from the later breaks and reductions and that produced on the break rollers is poorer in quality because it contains finely divided particles of branny matter, and is dirtier, or has undergone more severe milling which depreciates the baking quality.

2. The gluten in the flour from near the coating of the grain has not the baking quality of that from near the centre; the flour obtained on the later breaks is derived from near the bran coating.

These poorer flours are known as *bakers* and *household* grades.

3. *Straight-run* is the term applied to the flour obtained by combining all the flour streams ; in practice it is often a flour equivalent to such a combination.

4. The miller invariably applies proprietary names to his grades of flour, but these grades in order of quality and price are substantially *short patent, long patent, straight-run, first bakers* and *household*.

41. *Milling offals*

1. It is impossible to separate the whole of the flour in the grain from the seed coating, about 10 per cent. remaining with the "offals."

2. The offals are :—

i. *Bran.*—The coarse particles of the outer envelope of the grain.

ii. *Sharps.*—The finer particles of bran, the matter removed by the purifiers, and a certain amount of flour.

iii. *Germ.*—The embryo of the seed ; this is separated early in the milling process.

3. Bran may be sold as straight-run bran, but is more often sieved, giving broad bran and fine bran. Broad bran is most favoured for horses and commands a higher price than does fine bran, which is used for poultry feeding.

4. Sharps are usually divided into two classes, coarse and fine ; they are used for poultry, pig and stock feeding.

5. The germ is the most nutritious portion of the grain ; it contains about 15 per cent. of oil and 40 per cent. of protein.

It cannot be milled satisfactorily, and owing to the tendency of the oil to develop rancidity, and to the presence of other active principles termed enzymes, it does not keep sound for any length of time and is therefore excluded from the flour.

Germ offal consists of light, flaky particles, which have a sweet taste. A certain amount of germ, after subjection to suitable treatment, is incorporated into the meals from which Hovis, Daren and Turog breads are prepared. The vitamin preparation known as Bemax is wheat germ which has been treated so as to improve its keeping properties. Germ meal is largely used for the feeding of dairy cattle.

6. The proportion of the various products obtained on milling are approximately as follows :—

Flour	72 per cent.
Sharps	16 ,, ,,
Bran	10 ,, ,,
Germ offal	2 ,, ,,

42. *Composition of flour*

1. The composition of flour varies with the grade and the blend of wheats from which it has been derived, but all commercial white flour may be taken to have a composition within the following limits :—

		Average figures for a straight-run flour
Water	13–16 per cent.	14·5 per cent.
Starch	65–70 ,, ,,	68·0 ,, ,,
Proteins (as gluten)	9–15 ,, ,,	12·0 ,, ,,
Cellulose and fat ..	1–2 ,, ,,	1·5 ,, ,,
Sugars	2½ ,, ,,	2·0 ,, ,,
Mineral matter (ash)	0·3–0·7 ,, ,,	0·45 ,, ,,

2. The higher grade flours contain more starch and less gluten, cellulose, fat, sugar and mineral matter than do the lower grades from the same blend of wheats. This is due partly to the wheat grain not being of uniform composition from the centre of the grain to the seed coat, and partly to the better refinement of the higher grades.

3. The following are comparative figures of ash and gluten content for these grades of flour from one lot of wheat :—

	Patent Per cent.	Straight-run Per cent.	Households Per cent.
Ash	0·35	0·45	0·65
Gluten	11·0	12·0	13·0

4. The flour supplied to army bakeries has an ash content of 0·55 to 0·60 per cent. and a gluten content of 12·0 to 13·5 per cent.

43. *Quality of flour*

1. The term " quality " applied to flour is relative ; there is no absolute standard of quality and in a wide sense quality includes milling quality or grade, and should be judged from the point of view of the use to which the flour is to be put. Different types of flour are required for biscuit manufacture, pastry, breadmaking in the home and in bakeries.

2. Biscuits, short pastry and cakes require a weak flour of a soft nature, which should have very little spring in the dough stage. Flour containing little gluten and soft gluten is the best.

3. Puff pastry and boiled puddings require a rather stronger flour ; a little strong flour blended with the weak is suitable.

4. The main use of flour is for the production of bread in the bakery and quality will therefore be considered as referring to baking quality.

44. *Baking quality of flour*

1. The baking quality depends upon a number of factors which need individual consideration.

Colour and Bleaching of Flour

2. The colour of flour is important because every one expects bread to be white, and white bread cannot be produced from flour of a dark colour.

The colour of flour is due to the presence of a yellow pigment known as carrotin, which is associated with the small amount of oil and also with the small amount of branny particles which introduce a brownish colour.

Good grades of flour have a pale cream colour, and are practically free from bran powder ; the lower grades are darker and browner.

In order to meet the public demand for white bread, the greater portion of the flour produced in Great Britain is bleached. The question of the bleaching of flour was considered by a Government Committee some years ago, but as no strong evidence was available of any harmful results, the practice has not been prohibited.

Recent investigations have shown that carrotin, with which vitamin A is associated, is destroyed by bleaching ; this is undesirable.

The bleaching of flour supplied to the Army is not permitted, and this is the principal reason why the bread produced in the army bakeries is not as white as the normal civilian bread.

Common bleaching agents are nitrogen peroxide (electric bleach), chlorine, agene (nitrogen trichloride) and novadel (benzoyl peroxide). The first three are applied in the gaseous form at from ½ to 4 parts per million of flour ; the latter is used as a powder in the proportion of about 1 oz. to the sack of flour.

Water Absorption of Flour

3. This means the amount of water it is necessary to add to flour to give a dough of the right consistency for handling and working. Flour with a high-water absorption gives a high yield of bread, and therefore such flour is popular with bakers. Judgment as to the right consistency of a dough is

largely a matter of experience; it must be soft enough to mould easily, but not wet enough to be sticky. Strong flour such as would be obtained from Manitoba wheat might be expected to take up 55 to 60 per cent. of water, i.e. about 16 gallons to each sack of flour; flours of average strength take up 50 to 55 per cent. (or 14 to 15½ gallons a sack), and weak flour, such as English, from 12½ to 14 gallons a sack.

Where tinned bread is made, more water can be added to the dough, or what is termed a "slacker" dough made, as the sides of the dough are supported by the tin during the proving and baking.

Flours have individual peculiarities; the best bread is made from some flours by making tight doughs, which slacken during fermentation, while other flours give the best results with slack doughs, which tighten during fermentation.

Water absorption depends largely upon the gluten content of the flour.

Gluten

4. Gluten is the name given to the nitrogenous or protein matter in flour, and it is the gluten which gives dough its powers of cohesion and elasticity, and makes possible the production of a fine open textured loaf.

The character of the gluten and the quantity present determine the strength of the flour and to a large extent the baking quality.

Good gluten is elastic yet tough, and while capable of fine vesiculation yet retains gas. These properties lead to the production of a well risen, bold loaf and one of fine texture. Doughs made from flour in which the gluten is of good quality are more easily handled in the bakery, and after moulding the pieces of dough retain their shape. High gluten content and good gluten quality occur together in the case of the strong wheats, such as Manitoba, though in flour this is not always the case.

Some flours of low-milling grade have a high-gluten content, but the gluten is not of good quality, being soft and runny instead of tough and elastic. Such flour may give a good yield of bread, but the loaves are small, of coarse texture and heavy.

Gluten may be separated from flour in the following manner:—

Place 1 oz. of flour in a basin, make into a ball of dough with about ½ oz. of water; the handle of a spatula or a spoon serves to make the dough into a ball.

Cover the ball of dough with cold water, allow it to stand one hour and then gently knead with the fingers. The

starch is thus worked out of the flour, and with a little practice it will be found possible to keep the dough in one piece and avoid loss through fragments becoming detached. The milky looking mixture of starch and water should be poured away two or three times, and it will be found that after 10 minutes' kneading practically all the starch has been removed, and fresh water remains clear. The ball of sticky substance left in the hand is gluten. The weight of wet gluten divided by three gives the approximate weight of dry gluten in the flour.

Stability

5. A dough has good stability when it can be handled easily in the bakery, does not stick to machinery and boards, and retains its shape after moulding. Good stability indicates good gluten.

Coburg loaves cannot be made from dough with little stability.

Weak flour, such as English, gives dough of little stability.

Fermentation Tolerance

6. It has been stated in the introduction that the yeast ferments the sugars present in the dough and ripens it. The aim of the baker is to get the dough into the oven whilst the yeast is fermenting actively, and when the dough is sufficiently ripened, but not over-ripened or over-fermented.

If a dough batch is made using 1 per cent. yeast, and loaves baked from this dough at hourly intervals up to ten to twelve hours, the earlier loaves are small and stodgy, successive loaves improve in volume, colour, spring, texture and flavour, but the later loaves decrease in volume and character until they become obviously sour through over fermentation. There is one particular loaf better in all respects than any of the others.

With a good Manitoba flour the best loaf may be thrown under the above conditions at six or seven hours.

The loaves on either side will be but little inferior to the best; in other words, there is a considerable period of time during which satisfactory bread may be made.

An All-English or other weak flour will throw its best loaf at four to five hours, and the loaves on either side of this best loaf will be much inferior to it.

Manitoba flour is therefore termed a long fermentation flour and of good fermentation tolerance. An All-English or other weak flour is a short fermentation flour and has poor fermentation tolerance.

The conditions for obtaining the best loaf therefore vary with the flour, and with weak flour of little fermentation

tolerance deviation from the best condition in respect of fermentation time, dough temperature or amount of yeast has a marked effect on the quality of the bread produced.

Gas Production

7. Flour contains 1 to 2 per cent. of a sugar termed maltose, which is converted by a chemical substance, termed an enzyme or "ferment," into a simpler sugar "glucose"; another enzyme converts glucose into alcohol and the gas carbon dioxide. The two enzymes are made only in the living yeast cell. The small amount of maltose in flour is soon used up by the yeast, but another enzyme present in flour converts the starch into maltose, and so keeps up the supply needed by the yeast. In some cases flours which are really strong do not ferment well in the dough and give small loaves. This is because the flour is deficient in maltose and in the enzyme which converts the starch into sugar.

Malt is rich in the enzyme which converts starch into sugar, and therefore malt extract and malt flour are used by bakers to improve the gassing power of flour.

Deficiency in the initial gassing power of a dough is due to deficiency of maltose, and in such cases the addition of cane sugar brings about an improvement. Other substances are also used to increase gassing power, but they are of the nature of yeast foods and are mentioned under yeast.

Uniformity

8. The above factors affecting baking quality explain the need for care in blending wheats before milling. Flour should not vary in its properties, as the baker would have to vary his process with each lot of flour supplied. In order to maintain a uniformly high-baking quality millers use substances termed improvers.

Improvers

9. Improvers act as strengthening agents in the dough, rendering the gluten tough and more stable and of greater fermentation tolerance and giving a bolder, better loaf with a fine texture or grain.

Common improvers are (i) acid calcium phosphate (sold under many brands); (ii) ammonium persulphate (Salox); (iii) benzoyl peroxide (Novadelox). These are powders and are added to the flour in approximate proportions of 12 oz., ¾ oz. and 1 oz. a sack, respectively. (*See* Sec. **52, 3.**)

The gases chlorine and nitrogen trichloride (Agene) have a marked improving action as well as being powerful bleaching agents. The Agene process is employed in many mills.

The treatment of flour with these chemicals, even though the amount used is exceedingly small, is not regarded very favourably by a large body of medical opinion, and recently the milling industry has paid some attention to the improvement of flour by physical methods.

The first method tried consisted of heating the flour to a temperature of about 140° F., after which it had an increased dough toughness, stability and water absorption, and the loaf better volume, colour and texture. Later it was found that if flour was overheated (8 hours at 180° F.), it was useless for breadmaking, but had acquired the power of improving greatly the baking quality of other untreated flour, when mixed in the proportion of about 2 lb. a sack. This overheated flour is on the market under the name K.-J. flour; its effects are similar to those of the chemical powders. There can be no objection to these latter methods of improving the baking quality of flour, as nothing of a foreign nature is added to it; they are not at present much beyond the experimental stage.

45. *Aspects of the treatment of flour*

It is impossible to prove conclusively that bleaching by chemical means reduces the nutritious value of flour. Bleaching is carried out because the public demand white bread, and unless the lower grades of flour were bleached there would be no use for them. Improvers assist the baker by helping to maintain a uniformly high-baking quality in flour, and unless they were used bread production would be more difficult where the flour was derived from soft wheats or was of a low-milling grade.

46. *Keeping properties and moisture content of flour*

1. The length of time flour can be kept depends upon its moisture, type and grade, and on the storage conditions and the climate.

2. Flour milled with the usual moisture content of about 15·5 per cent. will keep a few months, but where longer keeping properties are desired the moisture content should not exceed 13 per cent. Such flour may be prepared either by milling wheat of lower-moisture content or by drying in a special plant after milling. The moisture content can only be determined with any degree of accuracy by the use of a chemical balance and a special drying oven. The baker is able to tell an excessively moist flour by the feel and by the fact that the flour takes up less water to form a dough.

3. Flour from hard wheats has better keeping properties than that from soft wheats. High-grade flour keeps much better than low grade, as it has a much lower bacterial count and the enzyme activity is much less. Flour does not keep well in moist or hot climates, and dry, well-ventilated storage conditions are desirable.

4. Flour goes out of condition by becoming musty, or becoming infected with mites or other pests, or by the gluten losing its power of cohesion.

5. The colour and baking properties of flour (except the lowest grades) improve on storage for two months.

47. *Diseases and pests which attack wheat and flour*

1. Certain diseases of a fungoid nature attack wheat during its growth ; two such diseases affecting the grain are :—

i. Smut, shown by a black powder adhering to the ears of the grain, and

ii. Bunt, a form of smut developing inside the grains and filling them with a black, foul-smelling powder.

The washing and cleaning process removes the smut to a great extent, but, should any escape extraction, it causes a darkening of the flour.

2. *Insect pests.*—These may cause serious damage to stored grain and flour, particularly in warm climates. The most common are :—

i. Grain weevils ..
ii. Rice weevils ..
iii. Flying beetles ..

These are small insects of the beetle tribe. They are visible to the naked eye on careful scrutiny, but the infection or otherwise of doubtful flour is best seen by putting a few pounds through a fine sieve. The insects, about $\frac{1}{8}$-inch long, will be left on the sieve.

Wheat which is infected may be put over a screen which holds up the wheat, but allows the insects to fall through. This treatment does not remove the eggs or larvæ which are inside the grain. Special methods of treatment by heat or with carbon tetrachloride or carbon dioxide and ethylene oxide are necessary where there is risk of a great loss.

	Airtight storage is the best way to keep wheat from attack by these pests. Flour infected with weevil has a pungent odour and soon goes out of condition. It may be usable, but should be put through a fine sieve to remove the insects.
iv. Moths	Moth is the most common pest in flour mills in Great Britain; not only is flour consumed, but the webs spun by the caterpillars clog the spouts and machinery in the mill.
v. Meal worms ..	These are the larvæ of various small moths and beetles. The grubs can be seen with the naked eye, but their presence in flour is best established by sieving. The caterpillars and the threads which they spin remain on the sieve and are readily seen.
vi. Mites	These are small creatures, similar to cheese mites, and a good magnifying glass is necessary to see them. Their presence in flour is best detected by gently smoothing off a portion of the suspected flour on a flat surface. The appearance of minute heaps of flour like miniature worm casts shows the presence of mites in the flour, and the mites may be seen by observing the small heaps through a magnifying glass.

3. These pests thrive in flour which is stored under warm, damp, badly ventilated conditions, and the best preventative is to obtain flour with a moisture content below 13 per cent., and to store it in a cool, dry, well-ventilated position.

4. Rice cones are also subject to attack by the above pests.

5. Flour which is badly infested is unfit for use, due to the disagreeable odour or flavour or to the gluten losing its cohesive properties. The excreta of the pests sets up bacterial contamination. Suspected supplies should be examined

and, if found heavily infected, condemned. Where the infection is slight the flour should be sieved and used up as early as possible. Admixture with sound flour may result in a passable loaf being obtained from doubtful stocks.

48. *Inspecting and judging flour*

1. *Condition.*—Flour should be sound and sweet, free from any foreign odour or flavour, and from mustiness and the pests described above. It should be pale yellow or nearly white in colour and should not contain an undue number of specks of fine branny matter.

2. *Colour.*—The colour is best observed by the Pékar test, using a known sample for comparison purposes. This test is carried out by placing small heaps of the flours to be examined near each other on a piece of smooth board about 2 inches wide, the heaps being smoothed off by a spatula. The appearance of the sample should be examined in the dry state as the fine branny particles are then best seen. The board should then be dipped slantwise into a bowl of clear water for a few seconds and withdrawn. Good grades of flour do not darken after wetting, low grades go brownish very quickly. The difference in colour between different samples is often very marked after wetting. Poor colour generally indicates a low-milling grade.

3. *Baking test.*—The most satisfactory method of judging flour is a practical baking test, the quality of the flour being judged from the manner in which the dough handles, the yield and the quality of the bread.

The following details relate to a small scale test baking, such as might be applied to a tender sample of a few pounds of flour.

Flour ..	3 lb.
Salt	½ oz.
Yeast ..	¾ oz.
Water ..	As found necessary, usually about 25 oz.

The relationship between the water absorbing capacity shown in this test and absorption on the large scale is given by the following table :—

21·4 oz. water in the test	= 50	quarts a sack of flour	
23·5 ,, ,, ,, ,,	= 55	,, ,, ,,	
25·7 ,, ,, ,, ,,	= 60	,, ,, ,,	
27·4 ,, ,, ,, ,,	= 64	,, ,, ,,	

Weigh out the flour and place it in a bowl ; put aside about 1 oz. in a cup for dusting the board, etc.

Weigh the salt and mix it into the flour with the hands. Measure out sufficient warm water (90° F.) in a jug; make a hole in the flour and put in most of the water; mix the weighed yeast thoroughly with the water, rubbing the lumps down with the fingers. Knead the whole into a dough, adding a little more water from the jug as required. Allow the dough to ferment at 80° to 85° F. for 3 hours, and knead (or knock back) at about 1½ hours and 2¼ hours.

The dough is then moulded to the desired shape, either tinned or coburg, and will give either one loaf about 4¼ lb. or two loaves just over 2 lb. The remainder of the flour from the cup should be used for dusting the board and cleaning the fingers and be mixed into the dough.

Allow the dough to prove a suitable time (40 to 50 minutes), and then bake.

A test on the above lines gives the baker an idea of the strength of the flour, the way it is likely to handle, and the approximate yield, appearance and general quality of the bread.

4. *Other examinations.*—Where it is impossible to have a baking test, an opinion as to the suitability of the flour may be formed by the following means :—

i. The condition and colour should be examined, *see* paras. 1 and 2, above.

ii. The water absorption should be tested (*see* Sec. **44.** 3). Breadmaking flour should absorb 50 per cent. of its weight of water when made into a dough, that is 2 oz. of flour treated with 1 oz. of water should yield a stiff dough; where less water is taken up, the yield of bread will be lower.

iii. The gluten should be determined as in Sec. **44.** 4; 12 per cent. is a reasonable figure for breadmaking flour.

iv. The best grades of flour are lively and free running. Rubbed gently between the fingers the flour is felt to be slightly granular. Lower grades tend to be softer, and the lowest grades and very moist flour tend to be sticky. (*See* Sec. **40.**)

49. *Adulteration of flour*

The adulteration of flour supplies in the United Kingdom may be said to be non-existent. Gross adulteration with foreign matter, such as pea-flour or soya-flour, is apparent by the colour, feel, taste or smell. Attempts at skilful adulteration with maize or other starches are unlikely, as they are not normally economical. They can only be shown in a direct manner by microscopical examination, when the foreign

starches may be readily distinguished. Wheat, and to a much less extent rye, are the only grains which contain gluten and are thus capable of giving bold, well-risen loaves ; adulteration of flour with other cereal matter therefore results in decreasing the proportion of gluten and giving small, badly risen loaves.

50. *Types of flour used in army bakeries*

1. The specification for flour to home bakeries requires the flour to be of the same grade as the tender sample, to be warranted for three months, to be free from bleaching and improving agents, and to be such that 280 lb. of flour will produce at least 186 2-lb. coburg loaves of good appearance ; i.e. a yield of 132·8 per cent. Its gluten content is 13 per cent. and its moisture content from 15 to 15½ per cent.

2. The flour supplies for a good many years have been a household grade, and although this flour does not produce such a white, bold, fine-textured loaf as the more expensive grades, the bread is reasonable in colour and of a palatable flavour. The loaves are of fair volume, the yield of bread the same and the bread is considered more nutritious than that made from the highly refined grades.

3. The flour shipped from the Supply Reserve Depot, Deptford, to overseas stations is a straight-run flour, which has been dried to a moisture content below 13 per cent. and has a gluten content of 12 per cent.

This flour has better keeping properties and more uniform baking properties and gives a whiter, finer-textured loaf than the home stations flour.

4. A certain amount of National Mark flour is also supplied at each station, and is used principally for purposes other than breadmaking. (*See* Sec. **36**, 12, and Sec. **37**.)

5. It is always desirable to buy flour on tender sample, and if possible, to have the tender sample and a sample from the bulk supply baked into bread and the resultant loaves compared.

6. Where contractors supply flour not up to the quality required by the conditions of contract, rejection should be made under the appropriate clause of the contract.

7. The practice of permitting suppliers to deliver a better flour to mix with the unsatisfactory flour is undesirable, as it enables him to take the risk of delivering flour just below an acceptable quality, as he is only slightly penalized in the cases where the malpractice is discovered.

51. *Yeast*

Types of Yeast

1. Yeast is a minute single cell vegetable organism. There are numerous varieties and strains, and they differ in their rates of fermentation. All yeasts, however, possess the power of fermenting sugar solutions giving alcohol and carbon dioxide gas.

2. Some form or other of yeast is usually present in the atmosphere, but these so-called wild yeasts are not sufficiently active or reliable to be cultivated for use in the bakery. The baker requires a fast-working yeast and therefore compressed yeast is grown from a selected vigorous strain of distillery yeast.

3. Before the introduction of compressed yeast, bakers were dependent upon barms or patent yeasts brewed in the bakery. These barms were usually derived from the slower working brewery yeasts. Compressed yeast was first marketed as a by-product by the distilleries, and its use has become almost universal, and the increased demand and improved methods of manufacture have led to factories being devoted solely to its production.

Manufacture of Yeast

4. The manufacture of yeast consists in the production of a wort or sugar solution from malt and maize or from molasses, to which solution certain yeast nutrients and acids may be added. A portion of this wort is run into a large tank, 20,000 gallon capacity, and inoculated or pitched with a pure strain of yeast; the yeast commences to grow rapidly and the rest of the wort is then run into the tank.

The condition and aeration of the tank are adjusted to secure rapid propagation of the yeast, and in about twenty-four hours maximum growth has been secured.

5. The yeast is then separated from the large volume of liquor in centrifugal separators on the principle of cream separation. The creamy sludge of yeast is washed and pumped through filter presses. The yeast is obtained in the form of slabs or cakes from the presses and is packed by machinery into 1 lb. cartons or 7 lb. bags.

Description

6. Compressed yeast is light buff in colour when fresh, and goes browner with age. It has the consistency of soft cheese, dissolves readily in the mouth and has a not unpleasant odour or flavour. Compressed yeast is more reliable and uniform than any other form of yeast, but except in cool storage it does not remain sound more than a few days. In cold storage it can be kept several weeks.

Test of Compressed Yeast

7. The following test indicates whether compressed yeast is of average quality, and may also be made to serve for the comparison of different lots of compressed yeast :—

Flour	..	1¾ lb.	Make a dough at 80° F., scale at 2 lb. 3½ oz., place in a 2-lb. baking tin and allow to ferment at 80° F.
Yeast	..	½ oz.	
Salt	..	⅓ ,,	
Water	..	About 18 oz.	

With yeast of average quality the dough rises level with the top of the tin in one and a half hours.

Cut back and allow to ferment; with average yeast the second rise should take about three-quarters of an hour.

Cut back, prove thirty minutes and bake.

The quality of the yeast can be gauged from the time taken for the two rises, and from the appearance of the loaf.

A more rapid test can be made as follows :—

Flour	..	1½ lb.	Dough and ferment at 80° F. for ½ hour. Scale at 1 lb. 2 oz. into small tin. Prove ½ hour. Bake ½ hour.
Yeast	..	½ oz.	
Salt	..	5 drams	
Sugar	..	1 dram	
Water	..	13 oz.	

Average quality yeast will raise the dough satisfactorily and give a reasonable loaf.

52. *Yeast foods*

1. Yeast working in a dough is a growing plant, and as such, requires not only sugar but also nitrogenous compounds and mineral salts. Flour supplied to the army bakeries contains sufficient of these substances, but where high-grade flours and quick processes are used yeast foods are employed to stimulate the yeast. Such foods are sold under proprietary names and they usually contain one or more of the following :— Ammonium phosphate, chloride, sulphate, potassium, calcium and magnesium salts, together with malt flour or extract.

2. The main action of malt is given in Sec. **44**, 7. It has, however, in addition a certain proteolytic or protein splitting effect which gives simple nitrogenous bodies and assists in the ripening of the dough.

3. When yeast foods are stated to give an increased yield of bread, it may be assumed that they also act as improvers, and their action on the gluten increases the water-carrying capacity of the latter.

4. Flour used in the Service does not require yeast foods.

53. *Malt and hop barm; patent or compound barm*

1. The above names are applied to the barms which must be prepared by the baker himself when compressed yeast is not available.

RECIPE FOR MAKING

2. There are many recipes for the production of these barms, but the following is recommended :—

8 oz. hops.
10 gals. water
28 lb. crushed malt or malt flour.
8 oz. sugar.

These quantities produce 10 gallons of barm.

The hops are boiled in a large pan with all the water until the pods sink. This decoction is allowed to stand until its temperature reaches 170° F. The whole of the malt and sugar is then stirred in until it is all completely wetted. The pan is covered with a clean sack and allowed to lie for three hours, being stirred from time to time in the interval. The idea is to keep the liquor as near as possible about 140° F. while it is standing, and to this end it may be necessary to re-heat it once or twice; care should be taken that the malt and hops are not allowed to settle at the bottom, and that the temperature does not rise above 140° F. This liquor, with its contents, is called a " mash "; when it has lain the time stated, it is strained through a hair sieve, the grains being squeezed in handfuls to express as much of the liquor as possible. A clean oak tub, previously scalded with boiling water or steam, is the most suitable type of vessel in which to store barm; but, until it is stored (or " stocked "), it may be strained into the pan in which the mash was made, in order to facilitate cooling.

When cooled to 80° F. in winter, or to 74° F. in summer, the liquor is " stocked " with 1 quart of barm from a previous making, or, failing that, with 2 oz. of ordinary compressed yeast.

Where neither barm nor compressed yeast is available it is desirable to have a few tins of dried yeast available to act as a starter. Dried yeast is prepared in Great Britain and its keeping properties are fairly good.

Where no other starter is available 2 half-pint bottles of stout well shaken may serve. In warm climates the barm will very quickly begin working without any starter; barm which has commenced fermenting spontaneously should not be used for breadmaking, but after twenty-four hours part of it may be used as a starter for a fresh lot.

After " stocking " the barm should be kept at an equable temperature for about twenty hours (or in warm climates about twelve hours), when it should be ready for dough making.

Essential Points of the Process

3. The essential points in making these barms are the same as for making compressed yeast.

The water and hops are boiled to extract the bitter matter from the hops, as this is inimical to the increase of bacteria in the mash whilst the yeast is growing. The yeast manufacturer suppresses bacterial growth by increasing the acidity of the wort. As mentioned in Sec. **44**, 7, malt contains a large amount of the substance for converting starch into sugar and the mashing with malt at 140° F. produces 10 gallons of a solution containing nutrients and sugar on which yeast can grow. The temperature is kept at 140° F. at this stage because wild yeasts and bacteria in the air which may gain access to the mash are destroyed, or are unable to multiply at this temperature. The temperature must not be above 170° F. when the malt is added, as above this temperature the enzymes of malt are destroyed and no conversion of the starch of the grain to the simple sugars needed by yeast would take place.

Provided the apparatus has been well cleaned and scalded, the baker has obtained, by the mashing operations, a solution of various sugars suitable for yeast growth, and one that is reasonably free from wild yeasts and bacteria.

The baker stocks this with the best barm or yeast obtainable in the same way as the yeast manufacturer stocks or pitches with a pure yeast culture.

The main principles to be observed in brewing yeast are, therefore, cleanliness of the plant, adherence to the right temperatures and stocking with the best available strain of yeast or barm. If these conditions are not observed a slow working barm and one that sours quickly is likely to result.

Method of Use

4. The most satisfactory method of making bread with barm of this kind is by sponging (*see* Sec. **62**).

54. *Spontaneous yeast or barm*

1. A kind of barm largely used in Australia and South Africa is very suitable for use in army bakeries, if pressed yeast is not available. The ingredients in this barm are as follows :—

Hops	10 oz.
Potatoes	28 lb.
Sugar	7 lb.
Flour	6 lb.
Bran	½ lb.
Water	8 gals.

The hops are boiled in all the water until the pods sink. In the meantime the potatoes are cleaned and properly boiled, then mashed, and the hop liquor poured on to them. They are then strained to remove the skins and the hop pods. These ingredients are thoroughly well mixed before straining. The sugar is added to the clear liquor, then the flour, previously baked but not browned, is stirred in, and last of all the bran when the mixture has cooled to about 80° F. The barm is kept until it starts fermenting spontaneously, which it does very quickly, as, even without stock, it may in some climates be used for breadmaking by itself about thirty-six hours after it is made. It is usual, however, to add about 1 quart of old barm as " stock," for the quantity given above, and when it is stocked in this way it " drops " in about twelve hours, and is ready for use in from two to three hours more. This barm may be used for sponges in the same way as " Patent barm," but the general practice is to make straight dough, standing in the trough for almost eight hours. For the first two or three hours after the dough is made it seems quite clay-like and dead, but it afterwards ferments with vigour, and the ultimate loaf is of full volume and good flavour. The dough should be well kneaded before being thrown out for scaling. In all other respects this barm is handled like " Patent." For one sack of flour about $1\frac{1}{4}$ gallons of barm are required. It may be noted that while about thirty-six hours is a sufficient time for barm of this sort to mature spontaneously and to be ready for use in sub-tropical countries, the same mixture will not mature sufficiently for use in temperate zones in less than fifty to sixty hours.

Barm from Hops and Potatoes

2. The following method has been used with success in a hot climate :—

Required .. Two soyer stoves, one potato strainer, two beer barrels (36 gallons), one hair sieve.

Ingredients .. $\frac{1}{2}$ lb. hops, 20 lb. potatoes, 15 lb. flour.

Method .. Half fill both soyer stoves with water and bring to the boil. Put $\frac{1}{2}$ lb. hops in one and 20 lb. potatoes (well cleaned and washed) in the other.

Boil till the hop pods have sunk to the bottom. Next strain the potatoes and liquor into the hop liquor, smashing the potatoes through the strainer with a wooden pestle. When this is completed the liquor will almost fill the boiler.

Boil for half an hour.

At the end of this period have ready a barrel previously scalded and cleaned.

Mix in the bottom the 15 lb. flour with cold water to a smooth paste. Pour in the whole of the liquor, stir well and let stand till the following day (24 hours).

Stock with 4 half-pint bottles of stout. This can be used from twelve to fifteen hours later.

55. *Old dough process*

In circumstances in which no sort of yeast can be obtained, the most satisfactory process is to make each batch with part of the dough remaining from a previous one. For this purpose 10 lb. of dough may be made into a sponge with 6 gallons of water and 50 lb. of flour. This sponge, after fermenting in a tub for twelve hours, will be in a condition very similar to that of a sponge made with yeast, and can then be handled in the same way. But consecutive doughs, after the first on each day, may be made by using a larger quantity, say 50 lb. of dough from one batch, mixing it with the water for a sack of flour (about 14 gallons), and making into dough in the usual way, with of course the necessary salt. This dough, kneaded once or twice, will be ready for scaling in about four hours. As a safeguard when using old dough for sponging, 1 quart, or in summer 2 quarts, of clear lime water may be used at the doughing stage. This method of making bread should only be used in emergency, when yeast cannot be obtained.

56. *Water*

It is essential that the water used in a bakery be clean and pure, and when inspecting a contractor's premises it is always desirable carefully to observe and inquire into the source of the water supply (*see also* Sec. 68, 17).

57. *Salt*

1. Salt is employed in breadmaking to give a flavour, without which bread would be insipid and flavourless. Salt not only imparts its own saline flavour but brings out the flavour of other substances in the bread.

2. Apart from the question of flavour in the bread, salt has a beneficial effect on the gluten, since it controls the fermentation to some extent and tends to inhibit injurious types of fermentation.

3. The usual amount employed is $3\frac{1}{2}$ lb. to each sack of flour ; during hot weather a little more may be employed. Salt should be white, fine, dry, crystalline and totally soluble in water.

58. *Rice cones*

These are employed in the bakery for dusting over dough boards to prevent dough from adhering to the wood. Good cones are coarse, sharp and reasonably white in colour; poorer qualities are brownish, contain numerous black specks and may feel soft and smooth.

59. *Breadmaking*

1. Bread is usually made at the present time by the straight dough process, the sponge process being seldom used.

Straight Doughs and Sponges

2. A straight dough is made by mixing all the ingredients, flour, water, yeast and salt in one operation. The sponge process consists of making a preliminary dough with a portion of the flour and water, all the yeast and a little salt. This preliminary dough is termed the " sponge " and it is usually allowed to ferment a long time. At the end of this period the rest of the flour, water and salt is worked in to give the full dough and a relatively short period allowed for the final fermentation.

Note.—The sponge may be made without salt, although a little is desirable in hot weather or where the yeast is of poor quality.

Breadmaking using a Straight Dough

3. The amount of flour taken depends upon the amount of bread required and the size of the plant, troughs, ovens, etc. In army bakeries it is usual to make two-sack doughs. Sometimes one-sack doughs are made.

A sack of flour is 280 lb. Owing to the cumbersome nature of such a sack, flour is supplied in half sacks (or bags) of 140 lb. each.

Ingredients

4. The ingredients for a two-sack dough are therefore :—

Flour	560 lb. (four bags of flour).	
Water (approximately)	29 gals.	This cannot be given with more exactitude. *See* Sec. **44**, 3.
Yeast	$2\frac{1}{4}$ lb.	Variation of this may sometimes be desirable. *See* Sec. **63**, 3.
Salt	7 lb.	

In established bakeries, machinery is available to carry out many of the operations. Where machinery is not available the one-sack doughs are easier to handle.

Temperature of Water

5. The temperature of the water is usually raised to between 90° and 100° F., so that the dough when made will have a temperature of 80° F.

The required water temperature is given by subtracting the temperature of the air in the flour store (i.e. that of the flour) from 160°, e.g. if the flour temperature is 60°, the water should be 160° — 60° = 100°.

A hard-and-fast rule as to the temperature of dough when made cannot be laid down to cover all circumstances. It must be varied according to the prevailing temperature in the dough room. In hot weather, doughs are made at a lower temperature, in cold weather at a higher temperature. The best temperature to employ under any set of prevailing conditions is a matter of experience and rests with the master baker.

Preparation of Yeast

6. First the yeast is broken down in a pail with some of the warm water. The temperature of the water for this should not be above 100° F. Some flour may be stirred into the pail and sometimes a little sugar may be added; this gives the yeast a chance to start working.

Preparation of the Dough

7. The flour is shot into the mixer and a measured amount of warm water is run in. The salt, having been dissolved separately in a pail of water, is then added. The knives are given a few turns and the yeast liquor is added. The knives are set in motion and the ingredients thoroughly mixed for about 10 minutes.

The dough is then made, turned out into a trough and wheeled away to prove.

Proving or Working

8. In the proving the yeast is fermenting the flour and raises the dough. After three to four hours the dough is getting up to the top of the trough, and it is then cut or knocked back and worked by hand so that a good deal of the gas is squeezed out. The yeast is working vigorously at this stage and after about two hours it is knocked down again; it rises again in about one hour and is again knocked down.

After a further proof of half an hour the dough is taken to the *dividing* machine.

Dividing

9. The dividing machine measures and cuts off pieces of dough of uniform weight; usually it is set to divide off at 2 lb. $3\frac{1}{2}$ oz. as this weight of dough gives a loaf weighing 2 lb., the loss being due to evaporation of moisture in the oven and in the bread store.

In hot, dry weather it may be necessary to scale off at 2 lb. 4 oz. as more weight is lost in the bread store before issue. The pieces of dough from the divider should be scaled periodically and adjustment made if necessary. The pieces on leaving the divider are more or less cylindrical, and they are roughly shaped in the *handing-up* machine. From this they pass to the *prover*, where the yeast, still working in the pieces of dough, expands them to approximately the right size for the moulder.

Moulding

10. After the prover the pieces of dough go to the *moulding* machine where they are given their final shape. After moulding they are placed on setter boards, and allowed to prove to recover from the effects of moulding. The gas produced at this stage gives the loaf its final aeration; if left too long the cavities in the loaf will be too large, or if too short a time the loaf will be small.

Baking

11. The moulded lumps of dough, having been allowed to "prove" for a sufficient time, are then put into the oven. Most large modern ovens are fitted with a movable bottom which slides out to receive the bread, but in old-fashioned and field ovens a peel has to be used. A peel is a kind of flat, long-handled spade, on which the loaves are placed and thrust into the oven. In doing this a certain amount of gas is pressed out, and for this reason "tinned" bread is usually much lighter than that which has been handled after being moulded. On being placed in the oven, the fermentation and swelling of the loaf is at first increased by the heat, but when the temperature of the dough reaches about 130° F. the yeast plant is killed and the fermentation is arrested. The oven should not be opened until the bread is judged to be baked. Batch bread is inferior to coburg, tinned or cottage bread, as the crust in the former often forms before the centres of the loaves have fully expanded.

The time taken in baking varies according to the heat and description of the oven, the size and description of loaves, and the size of the batch. The following table is an

approximate guide to the time required for baking in the circumstances stated :—

	In tins or separate loaves	In batch bread
$2\frac{1}{2}$-lb. loaf requires	50 mins. to 1 hr.	$1\frac{1}{2}$ hrs.
2 „ „ „	40 „ „ 1 „	$1\frac{1}{4}$ „

The proper heat for the ovens depends upon the kind of oven used ; it varies between 400° and 500° F., and the baker must know his oven.

Hardness on the one hand, and pastiness on the other, must be avoided. When the bread is sufficiently baked, that is, when the crumb, being lightly pressed by the hand, will spring back to its original shape—it is drawn out of the oven with a drawing peel or on the sliding bottom. It should be taken at once to the bread store to cool.

60. *Hand working*

Where machinery is not available the mixing, dividing and moulding are done by hand. In this case dividing is usually termed scaling, as each piece of dough should be scaled to the proper weight. The art of moulding is to produce the proper shape without breaking the skin and to leave a neat joint at the bottom of the loaf.

In making tinned bread more water may be added to the flour and, after dividing or scaling, the pieces of dough are placed in tins, allowed to prove the requisite time and baked.

61. *Yield of bread*

1. In the Service, bread is weighed and issued twenty-four hours after baking, and the yield is usually about 133 to 135 per cent. of the weight of the flour taken. Although about 50 per cent. of water is added to the flour, considerable loss occurs in the baking, and, owing to gas and volatile constituents, in the proving or fermentation. For specification yield, *see* Sec. **50.**

2. It must be remembered that the yield of bread depends largely on the type of flour and a high yield cannot be obtained from weak flour. Flour supplied by port millers is usually stronger than that supplied by smaller inland millers and a better yield should be obtained.

62. *Breadmaking, using a sponge*

Origin of Sponges

1. Sponge processes of breadmaking originated before compressed yeast was manufactured, the baker having to depend on barm of his own manufacture or brewery yeast. These were slow working, and the object of making a sponge with a portion of the flour was to get the yeast well established and working in the sponge, so that less barm was required for the overall dough than if a straight dough had been used. The process still is of great value when a proportion of the flour to be used is soft, weak flour, such as English. The subject is mentioned in Sec. **36**, 12, and Sec. **44**, 5 and 6. There is no doubt that the practice of making a sponge with a strong flour and adding the weak flour to make the dough gives good results. Under active service conditions, when compressed yeast may be unobtainable, the sponge process will have to be employed. A knowledge of this process is therefore essential for army bakers.

Comparison with Straight Dough

2. By comparison, the straight dough process is simpler and more straightforward, and the bread is produced in less time, whilst the sponge process is specially suitable where compressed yeast is not available, where some weak flour has to be used, and when it is convenient to set a sponge and leave it working overnight.

Setting the Sponge

3. The sponge may consist of quarter, half or three-quarters of the flour to be converted into bread, and is made by mixing the desired proportion of the flour with rather more than its due proportion of water, all the yeast or barm and a small amount of salt, about ½-lb. a bag.

The reason a little more water is used is that the yeast plant works faster in a slack dough and also the slack dough can be left to rise and fall in the trough, whereas a stiff dough would come over the top.

The amount of flour to use in the sponge largely depends on what the baker has been accustomed to. The conditions in the bakery, the quality of the yeast or barm available and the type of flour affect the decision, which is better left to the experienced baker on the spot.

Sponges may be set for varying lengths of time, from eight to twelve hours being usual.

Example of a Half Sponge

4. When using a half sponge and compressed yeast, the sponge will consist of :—

280 lb. flour.
About 20 oz. yeast.
,, 15 gals. water.
1 lb. salt.

The yeast should be broken down by itself in a portion of the water, before adding to the dough.

If patent yeast is employed and a quarter sponge made, this will consist of (for a two-sack dough) :—

140 lb. flour.
16 pts. patent yeast.
6 gals. water.
½ lb. salt.

The data above relate to an eight-hour sponge. Where a longer sponge is to be employed, less yeast may be used and the temperature need not be so high at the start.

The sponge is covered and allowed to ferment ; normally it rises and falls twice, but usually the sponge is set for a definite time, from eight to twelve hours, and at the end of this time the remainder of the flour, water and salt is worked in.

Making the Dough

5. For a two-sack dough, using a half sponge, the ingredients to be added to the sponge are :—

280 lb. flour.
About 14 gals. water.
,, 6 lb. salt (3½ lb. for each sack).

Using a quarter sponge :—

420 lb. flour.
About 21 gals. water.
,, 6½ lb. salt (3½ lb. for each sack).

The dough is carried out as follows :—

The salt is dissolved in the water at about 80° F. and the water is poured on the sponge, which is broken up until a thin batter results ; the remainder of the flour is gradually mixed in and the whole well kneaded to give a dough of the proper consistency. The kneading process is most important, as upon it depends the uniform fermentation of the dough. The dough is usually allowed to work for one to two hours, when it should be ready for scaling, moulding, final proving and baking.

63. *Factors affecting bread quality and bread production*

1. The art of breadmaking consists of so making and handling a dough that it goes to the oven at the right moment to give the best bread it is possible to obtain from the flour available.

Over- and Under-Fermentation

2. Dough that goes to the oven too soon is under-ripened and the bread is deficient in flavour. Dough that is allowed to ferment or prove too long gives undersized loaves and darker bread, which may have a sour flavour; i.e. the dough is worked out. Loaves that are underproved after moulding have small volume, there being little oven rise.

There are certain other factors the effect of which should be known, as in case the bread supply is not altogether satisfactory alteration in some particular may bring about improvement.

Variation in the Amount of Yeast

3. The greater the amount of yeast the shorter the time required in proving.

The relationship between the time of proving and the amount of yeast is approximately as follows, for a sack of 280 lb. :—

Dough (in trough)	*Yeast*
4 hours	1¾ lb.
5 ,,	1¼ lb.
6 ,,	1 lb. 2 oz.
7 ,,	1 lb.
8 ,,	14 oz.

There is no danger of imparting a yeasty flavour if a great deal more yeast is employed than is usual. Commercial practice favours more yeast and a shorter time of fermentation than is followed in the army bakeries; four- to five-hour doughs, or less, are often employed. Bread produced by short processes becomes stale more quickly than that produced by longer fermentation.

With small batches of bread below one sack, the proportion of yeast should be increased.

Variation of Flour

As soft flours ferment more rapidly and do not withstand a long fermentation as well as strong flours, a shorter process is desirable in this case.

Yeast Foods

4. Sugar, malt extract and yeast foods provide material ready to hand for fermentation or to stimulate yeast, and so speed up fermentation.

Water

Slack doughs ferment more rapidly than tight doughs.

Kneading

The more work put into a dough the better it is.

Temperature

7. This is important, as yeast works slowly at low temperatures and very rapidly at high temperatures. The best temperature for breadmaking is 80° F., and the maximum desirable is 85° F.

Salt

8. Salt has a retarding effect and additional salt is useful to counterbalance the increased temperature during hot weather.

The impossibility of applying hard-and-fast rules to a process can be understood where variation is possible in the quality of the flour and in the activity of the fermentative organism yeast; for this reason discretion is left to the bakery as to :—

i. the amount of water to be used in making the dough ;
ii. the length of time the dough is proving ;
iii. the time of the final proof ;
iv. the employment of a little more yeast and a shorter time of fermentation with some types of flour.

Bacteria

9. One change which may occur in dough has not been mentioned ; this is due to bacteria.

With low-grade flour, over-fermentation, long processes or weak yeast, bacteriological changes may occur and poor quality or sour bread may result. The organism producing "rope" is described in Sec. **64.**

Good active yeast in sufficient quantity, and careful control of the temperature so that it never exceeds 85° F., tend towards eliminating trouble from this cause.

64. *Rope disease in bread*

1. Bread is liable during hot weather to be attacked by a disease called "rope." The disease becomes manifest twenty-four to forty-eight hours after baking. The bread acquires a faint sickly odour, the crumb later becomes infected with brownish spots which increase in size and become moist and sticky. If at this stage a portion of the crumb is pulled out of the centre of the loaf, a number of fine threads resembling

those of a spider's web will be seen; these threads give the name "rope" to the disease.

2. "Rope" is produced by the organism *bacillus mesentericus*, introduced into the dough through the flour. The bacillus is often present in flour, but the disease only develops in hot weather and responsibility can scarcely be placed on the miller.

3. Practical steps to prevent trouble from this cause are :—

i. Packing the bread loosely in the store, so that a current of air can circulate all round the loaves and cool the bread quickly.

ii. Thorough cleaning and scalding of all baking utensils.

iii. When bread is found to be ropy, the flour employed should be put on one side, and where possible flour from a different source used.

The flour giving the ropy bread can be used when cooler weather sets in.

iv. Where iii. is not possible, the addition of acid calcium phosphate to the flour ($1\frac{1}{2}$ lb. for each sack), failing which, acetic acid (one quarter of a pint to the water used for a one-sack dough) is recommended.

The most favourable temperature for the production of rope is 100° F. The disease does not arise below 65° F.

65. *Inspection of bread*

When inspecting bread the external appearance of the loaves should be observed, and a loaf then cut with a sharp knife and the crumb examined and tasted.

The points to note are :—

(1)	Good quality (2)	Poor quality (3)	Reasons for poor quality (4)
I. Volume of loaf	Loaf bold and well risen.	Loaves of small height or little volume.	Flour of poor baking quality, underproving, over-fermentation, inactive yeast, old flour out of condition.
II. Crust ..	Rich brownish-yellow tint, neither burnt nor too light. As thin as possible consistent with adequate baking.	Thick burnt crusts.	Too fierce an oven or over baking.

(1)	Good quality (2)	Poor quality (3)	Reasons for poor quality (4)
III. Crumb ..	Colour depends on the grade of the flour. The best grades give a loaf with a pale yellow tint. Bleached flour gives a white loaf, lower grade flour a darker and duller loaf.	Dark colour.	Low-grade flour or over-fermentation of the dough.
	Texture—Fine.	Coarse.	do.
	Vesiculation — Even, large holes and doughy particles absent.	Large holes.	Overproving, inefficient moulding.
	Spring — The bread should spring back after gentle pressure has been applied, should be firm but not crumbly.	Sodden and heavy.	Too slack dough, underbaking, piling hot loaves one on the other.
IV. Odour and flavour.	The bread should possess a sound sweet odour and have a pleasant flavour free from any suggestion of sourness.	Sour bread.	Over-fermentation, poor yeast, low-grade flour with high temperatures in the dough. If sour bread is being produced, the yeast should be tested to see it has normal activity, and the utensils cleaned thoroughly. It is an advantage to use more yeast and a shorter working time. Sec. **63**, 3. The salt may be increased and the temperature kept at 80° F.

Army bakeries turn out bread as a rule in 2-lb. coburg loaves. This loaf is popular with the troops, keeps well and stands a fair amount of knocking about.

The bread inspection is made the day after the bread is baked, and before issue a number of loaves are examined as to general quality, and individual loaves are scaled to check the weight.

66. *Contract bread*

1. When weighing, it is best to select several loaves from different parts of the consignment and weigh each singly. Contractors as a rule do not scale the bread with the same care as military bakers, and therefore like to weigh a number of loaves at a time.

2. In addition to the defects liable to occur in military bakeries, there are certain devices which may be resorted to by dishonest contractors for the purpose of fraud. One of the commonest of these is " under-baking," which consists of retaining in the loaf the excess of water which should escape during baking. It is done by putting the dough into too hot an oven, thus causing a thick crust to be formed before the bread is baked inside. Putting the bread into too slack an oven also causes the bread to be under-baked and heavy. Not leaving it sufficiently long in the oven has a similar effect.

3. Batch bread is made with the sides of the loaves touching each other, and there is a crust on the top and bottom only. This bread loses less moisture in the oven but more afterwards, and if it is delivered whilst new an appreciable loss will occur before issue.

67. *Storage of bread*

1. The bread store should be dry, cool and well ventilated. The racks should be placed in the centre so as to admit air freely to the whole of the bread. Not more than 2 layers of loaves should be placed on each shelf in the rack, but if the bread is thoroughly dry and cold there is no objection to storing it several tiers high.

2. If warm bread is piled in a heap the loaves, especially those in the centre and at the bottom, will most likely become sodden.

3. Where the ventilation is poor, evaporation of moisture from the bread is reduced and this is apt to make it heavy, and in hot weather is conducive to rope disease.

4. An N.C.O. is detailed to take charge of the bread; his duties are as follows :—

i. To receive and keep a correct record of the bread produced in the bakery.
ii. To keep the batches of bread separate, so that the origin of poor quality bread can be traced.
iii. To inform the master baker when bread of inferior quality is being delivered into store.
iv. To make all issues to the troops, and to obtain receipts.
v. To make no issues except those shown in his Issue Book.
vi. After the master baker's inspection, to put on one side all damaged bread. This will be issued to the contractor in the presence of the master baker.
vii. To see that the store and the inside of the bread vehicles are kept clean.

5. The issue of bread loose in vehicles is not desirable, as men have to walk on the floor of the vehicle to remove the loaves. Tea chests, which hold about thirty loaves, are convenient receptacles and may be stacked in the vehicle.

68. *Description of a standard army bakery plant in general use in army bakeries*

Types of Buildings

1. A good roomy building fitted with electric power is desirable for a machine bakery.

The building should preferably be of three floors, the second floor being allotted for flour storage, the first floor as a dough room, and the ground floor for bakehouse, bread store and offices.

All baking materials should on arrival be taken up to the second floor by electric elevators, power rollers or other mechanical means, and thence allowed to move down, during the various processes, by gravity with the minimum of labour.

If the building is of only two stories, the flour, etc., may be stored on the ground floor and only taken up to the first floor as and when needed. This arrangement necessitates a greater ground area, but has the advantage that the building need not be so strong as when flour is stored on the top floor.

It is an advantage if a railway can be run alongside the building, and also if a loading platform for road vehicles is provided.

The building should be sited so that the entrances and exits face away from the prevailing wind, and double doors forming an air lock should be provided, so as to keep the interior of the building at an even temperature and prevent draughts when the outside doors are opened.

Bread Store

2. Sufficient well-ventilated storage should be provided for two days' supply of bread, to allow of receipts and issues to the troops while one day's bread is conditioning.

Space should be estimated at 2,000 cubic feet for each 10,000 lb. of bread, in order to allow for passages.

The door should be wide enough to admit light hand vehicles.

For method of storing bread, *see* Sec. **67.**

Machines

3. The machines in use in the standard army bakery are :—

1 Sifting machine.
1 Water gauging and conditioning tank.
1 Four-box divider and handing-up machine.
1 Automatic prover.
1 Moulding machine.

Ovens

4. The types used in the army bakeries are either the Collins or Perkins double-deck ovens, or ovens of a similar type. Owing to their bulk they are suitable for permanent bakeries only.

Details of ovens are given in Secs. **70** *et seq.*

Method of Using Machines

5. The flour is tipped, in the flour loft, into the sifting machine which sieves out all foreign matter, such as string, nails, etc., and passes the flour down to the first floor into

6. *The mixing machine*—a metal box with a hinged lid ; the box also being hinged at its lower front edge, so that it can be tilted forward. Inside the box are two blades of zig-zag shape, which revolve in opposite directions.

When the flour has been passed into the mixing machine, approximately 29 gallons of water, about 2¼ lb. of yeast and 7 to 7½ lb. of salt are added to the flour, the lid is closed and the knives are set revolving until all the ingredients are thoroughly well mixed (this takes about ten minutes).

The lid of the box is then lifted, the box itself tilted forward, and the blades revolved slowly so that dough is ejected into troughs on wheels, which have been placed to receive it.

The water supplied to the dough has been taken from the water gauging and tempering tank at such a temperature as to give to the dough a heat of about 80° F. The dough, after

being allowed to ferment for the necessary time in the trough, is transferred to

7. *The four-box dividing machine*, which divides the dough into pieces (four pieces at a time). (*See* Sec. **59**, 9.)

The pieces are then discharged into

8. *The handing-up machine*, which does the preliminary moulding and handing-up, and delivers the pieces in a roughly cylindrical shape, to

9. *The proving machine*, which is a slowly moving platform fixed to the ceiling of the ground floor.

The prover carries the pieces of dough slowly forward and at the end of ten minutes, during which time the yeast has given proof of its activity by raising the lumps of dough, it delivers them in regular succession at the rate of about 40 a minute to

10. *The moulding machine*, which completes the process by moulding the dough into the right coburg shape, ready for baking.

The doughs are then placed by hand on setter boards, and a number of the boards are conveyed on a dough carrier to the oven. Each dough carrier has the same capacity as an oven plate.

Baking Utensils

11. *Knives, bread or dough.*

Lamp, oven.—For seeing into ovens when there is no gas.

Peels, drawing and setting.—For placing bread in the ovens and withdrawing it—only necessary when a drawplate oven is not used.

Pokers, bakers.—For raking out cinders between the pipes in the furnace of steam ovens.

Rakes, bakers.—For raking out the furnaces.

Rasps, bread.—For rasping the burnt crusts of loaves that have been " topped " before issuing to troops.

Scrapers for troughs.

Saws, bakers, zinc.—For cutting blocks of salt; made of zinc because salt would corrode iron.

Scales, dough pan.—For scaling the dough when this is not done automatically.

Scoops, flour.

Troughs, dough, two-sack.—For setting the sponges and mixing the dough.

Pails.—For mixing yeast and salt.

Thermometer.—For temperature reading.

Brewing Utensils

12. *Cauldrons.*—Holding 45 gallons each with wooden covers and taps. The taps should be of gun-metal, not less

than 1½-inch bore. The cauldrons should be built over fireplaces.

Brewer's thermometer.—For ascertaining the temperature of the brewhouse, and of the water in the various operations.

Potato strainer.—A tin colander for straining the potatoes in making a ferment.

Potato smasher.—For mashing potatoes.

Wooden oar.—For stirring the malt liquor and mixing.

Yeast tubs.

Hair sieve.

Cloths.—For covering the yeast tubs.

Bowls, iron, galvanized (or preferably copper).

The brewhouse should be well ventilated and have a stove in order that an even temperature may be kept. The floor should be of concrete, stone or brick; there should be no drains or cesspools near.

Personnel Employed

13. Nightshifts—1 Serjeant controlling liquors and dough-making, yeast, weight of salt, correct amount and temperature of water and general supervision.

Nightshifts—	1	Serjeant controlling liquors and dough-making, yeast, weight of salt, correct amount and temperature of water and general supervision.
	1	Baker—on mixing machine.
	1	,, —in flour loft.
	1	,, —on liquors and ferments.
	1	,, —stoker.
Total	5	
Dayshift—	1	Staff-serjeant or serjeant, working foreman assisting master baker.
	1	Serjeant—in charge of dough room.
	2	Bakers—bringing doughs to the dividing machine.
	1	Baker—on dividing machine.
	3	Bakers—taking doughs from the moulding machine and placing on setter boards and taking to ovens.
	2	,, —placing loaves in ovens.
	4	,, —carrying bread from ovens to bread store.
	1	Baker—stoker.
Total	15	
Grand Total	20	

Additional tradesmen as supernumeraries, reliefs, etc., and non-tradesmen for fatigue duties will be required. As conditions will vary in each bakery, no definite figures can be laid down which will apply in all cases.

Normal Output of a Standard Army Bakery

14. Each piece in the plant is timed to turn out 2,400 pieces (about 2 lb.) an hour, and care is required to ensure that all parts of the process synchronize with the availability of the plant and that the work is continuous during each tour of duty.

Meal times should be arranged so that they do not interfere with the regular timing of the various processes.

The actual time taken to produce 48,000 lb. of bread would be from 1700 hours one day to 1415 hours next day, a total of $21\frac{1}{4}$ hours, as shown in detail in the following programme of working.

In order to obtain an efficient output it is necessary to ensure that all the apparatus is working efficiently and that all the machine out-turn is synchronized properly, and that everything is to hand and the machines conveniently placed in relation to each other.

If the ovens are not drawplate ovens, but have to be worked with peels, the out-turn for each man would drop by about 25 per cent. and the whole series of operations would have to be slowed up accordingly. Any hitches in the working of one machine would in the same way reduce the speed of the whole plant.

The provision of an ample number of fatigue men (non-tradesmen) is essential to ensure that the tradesmen are fully employed on technical work.

Hours of Working and Programmes

15. *Detailed programme for the working of an army standard bakery plant.*

1 Master baker.	
1 Stoker	Parade at 1700 hours, light boilers and get them heated up for dough-making. Light oven fires at detailed time and have ovens ready for baking by 0400 hours.
4 Dough-makers .. (1 Serjeant, 3 bakers)	Parade at 1930 hours. First dough made by 2000 hours. Approximately 51 doughs are required for 38,000 rations. Dough-makers work straight through eight hours, doughs being made at the rate of about 6 an hour, the mixer being cleaned by a fatigue man.

Remainder of bakers..	Parade at 0345 hours. Divider is started at 0400 hours, assuming first dough is ready and all men at their respective posts.
	Moulder started at 0410 hours.
	First batch of dough set at 0445 hours and drawn by 0535 hours, and then a continuous process until all bread is out of oven.
	The men are relieved for breakfast 5 at a time by the supernumeraries, and again at 1015 hours for a fifteen minutes' break, or as required during the morning.
	Flour for the next night's work to to be got ready by the supernumeraries before relieving others for breakfast.
	On the last dough going into the ovens, the bakehouse and all machinery to be thoroughly cleaned up, and the men return to barracks about 1415 hours.

Fuels Used in Baking

16. The fuel used in drawplate ovens is usually coke. This is a good fuel owing to the absence of smoke and flame, and the regular heat produced.

These ovens may also be fired with heavy oil fuel, provided the furnaces have been specially fitted for it. Oil gives a good even smokeless heat, and although slightly more costly, has the advantage that it is cleaner and easier to handle.

It has been found that from 12 to 15 lb. of coke are required for each 100 lb. of bread produced, varying according to the condition of the ovens.

Coal is uneconomical, dusty and smoky; the slack falls between the furnace tubes and is wasted. The consumption is 15 to 20 per cent. of the bread produced as against 12 to 15 per cent. in the case of coke.

Wood is unsatisfactory on account of labour for splitting, whilst the acrid smoke is painful and injurious to the eyes.

The consumption is 40 to 50 per cent. of the bread baked.

Water

17. Soft water is best for bakehouse purposes. It is essential that it be clean and pure.

To allow for all services approximately 450 gallons are required for each 10,000 lb. of bread.

Hot-water apparatus is necessary for at least 40 per cent. of this amount in cold weather.

69. *Outline of the conversion of two sacks of flour into bread*

i. *Using a straight dough* (*as used in a standard army bakery*) *:*
Ingredients :—

560 lb. flour
7 lb. salt
2¼ lb. yeast
29 gals. water (approximately).

Also about 5 lb. of rice cones for dusting.

2100 hours,	January	1st	—Dough made using all ingredients.
0100	,,	2nd	—Dough knocked down and turned over.
0300	,,	2nd	—Dough knocked down second time and turned over.
0500	,,	2nd	—Dough brought to dividing machine and passed through divider, handing-up machine and prover.
0510	,,	2nd	—Dough passed through moulding machine and placed on setter boards.
0535	,,	2nd	—Dough set in ovens.
0630	,,	2nd	—Bread drawn from ovens and packed in bread boxes.
0640	,,	2nd	—All bread in store.
0640	,,	3rd	—Bread fit for issue for consumption next day.

The labour required would be one section of bakers, consisting of :

1 Class I.
4 Class II or III.

ii. *Using a long half-sponge.*

Ingredients :—

560 lb. flour.
12 pts. patent or compound yeast.
29 gals. water (approximately).
7 lb. salt.

Also a small quantity of rice cones for dusting.

Labour required :

1 section of bakers, consisting of :—

1 Class I.
1 Scaler.
3 Class II or III.

There are usually :

5 men in the day section.
2 men in the night section.

The hours for the day section are as the work demands, and commence at 0600 hours ; those for the night section are 1800 hours to 0600 hours.

1800 *hours, January* 1*st*, operations commence, half-sponge set using :

280 lb. flour.
12 pts. patent yeast.
14 gals. water.
1 lb. salt.

Sponge takes twelve hours to rise and fall twice.

0600 *hours, January* 2*nd*, sponge broken and dough made, adding to the sponge :

280 lb. flour.
15 gals. water.
7 lb. salt.

0830 *hours, January* 2*nd*, dough ready for scaling, etc., having allowed half an hour for breaking the sponge and 2 hours for proving.

0900 hours,	January	2nd—	Dough scaled and moulded.
0915 ,,	,,	2nd—	All dough in oven.
1015 ,,	,,	2nd—	Bread drawn from oven.
1030 ,,	,,	2nd—	All bread in bread store 728 1-lb. or 364 2-lb. loaves.
1030 ,,	,,	3rd —	Bread fit for issue for consumption next day.

It is assumed that the patent yeast was ready at the beginning of operations.

The above programme is based on 2 ovens being available, capable of baking 190 loaves in each batch.

If D.C.L. yeast is employed, the sponge would rise and fall twice in about eight hours instead of twelve hours.

70. *Oil-burning Baker-Perkins' ovens*

Description

1. Oil, as a medium for heating ovens, is now substituted for coke in many bakeries.

The furnaces are heated by means of oil fuel, which is pro-

jected on to the bricks of the furnace by means of a burner, in which are two feed pipes, one supplying air and the other oil, both being under pressure from an electrically driven air blast.

The air mixes with and volatilizes the oil in the burner, and a fine spray of highly inflammable mixture is projected from the nozzle. When ignited the stream of burning oil is directed on to the bricks of the furnace at a very high temperature.

2. *Storage, main tank.*—A tank of suitable capacity is erected outside the bakery at a height from the ground governed by local circumstances.

The quantity of oil in the tank is shown by means of an indicator board. The rising and falling of a float in the tank operates the pointer which travels up and down the indicator board. The oil may also be measured by a depth rod suitably calibrated.

Another tank of smaller capacity is situated close to the stokehole and oil is conveyed to this from the main tank by a 4-inch pipe. Situated thus, this has the advantage in cold weather of allowing the oil to get warm and thin, so that it may run freely to the burners.

Below this tank is a smaller tank. An indicator over this tank shows the amount of oil contained in it, and the oven foreman is therefore able to calculate the amount of oil used during the day. The oil in this tank is kept under pressure from an air blast, and the pressure is indicated on a board for the purpose.

3. *Air blast.*—This is generated by an electrically driven centrifugal fan. A spare air blast can be driven by a small petrol motor should the current fail.

4. *Feed.*—Oil is fed to the six burners from the smallest tank by a main feed pipe 2 inches in diameter. This branches off to the burners, one for each oven.

Air is supplied to these burners from the air blast, and mixture is arranged by the operation of two small hand wheels.

5. *Furnace.*—This is similar to the usual type of army ovens, with the exception of diagonal bricks in the centre of the furnace, which divert the flame from the jet to both sides of the furnace.

6. *Method of lighting.*—The air blast is first switched on, and the dampers above the furnaces opened. A small amount of cotton waste, soaked in oil, is placed in the furnace and ignited.

The burner is turned round into the furnace and the oil and air wheels manipulated until a bright flame is obtained.

To Work the Equipment for Baking

7. Adequate time should always be provided for raising ovens to baking heat, 60° F. an hour being the normal rate for raising temperature.

For baking bread continuously on drawplate ovens, it is usual to keep the burners firing all the time at their normal rate, adjusting the flame when necessary in order to maintain the proper temperature. Instructions for this adjustment will be found on the standard instruction sheet.

8. The operation of the burner to give a correct flame should be studied carefully until proficiency is gained.

A correct flame should appear bright and incandescent when burning the maximum quantity of oil. The flame should then reach well across the furnace and should practically fill the back portion of the furnace beneath the corbel course, being spread equally from side to side of the furnace in order to give even heating, the tip of the flame just coming up past the corbel. No flame should reach higher than this, and no smoke should be formed.

It is important, in order to obtain good combustion, that the angle of projection of flame be kept well down in the furnace towards the hearth, so that proper spreading of the heat results, and the flame will not then burn directly upon the bottom tubes. The burner doors should be kept closed when firing, and the secondary air opening, or ash-pit door, should be so adjusted by means of the adjusting screws that sufficient air is admitted to complete the combustion at the rear of the furnace. It is important not to have the secondary air door too wide open, especially when the draught is sharp. In that case too much air would be drawn through with the effect of cooling the furnace, lowering the efficiency, and rendering adjustment of the flame more difficult, especially at low pressure.

9. On completion of baking for the day, or when turning off the burners, the dampers and the burner doors should be closed in order to retain the heat in the furnace, and the apparatus should be left all clean ready for the next firing.

10. In turning off the burner, it is important to close the oil cock below the swivel first; then let the air blow the burner clear of oil in order to avoid drips; next shut off the burner valves and withdraw the burner right out of the furnace, which shuts off oil and air at the swivel and prevents combustion of oil in the burner.

11. The screw down oil valve between storage tanks and measuring tank should be kept closed tight except when filling up with oil.

Care of Apparatus

12. The following points should be kept under close observation in order to ensure efficient working combined with safety :—

Furnaces.—It is important that furnace brickwork should be in good condition. The corbel course beneath the bottom tubes protecting them from direct incidence of the flame should be periodically inspected to see that it is in good order.

The bricks forming the hearth of the furnace should not be allowed to become deranged, and the secondary air ports in the hearth should not be allowed to become clogged. In lighting up do not use more waste or rags than is necessary, since the ash formed will, in time, clog up the passages. When the furnaces are seasoned to use, and the operator is experienced, a piece of paper is usually sufficient to light the fire.

Given proper adjustment and a correct grade of fuel oil suitably warm, carbon should not be formed in any considerable quantity. If formed it will possibly take place at the point where the flame impinges on the back wall of the furnace, and care should be taken in removing it not to displace the firebricks and no violent poking should be permitted. The removal of carbon is best done immediately after turning off the flame, when the deposit is hot, it being much softer in that condition and easily dislodged. When dislodged, it usually burns away of its own accord. To ensure that due attention is given to the furnace brickwork when necessary, it is advisable to utilize the annual inspection service provided by the manufacturers.

Maintenance of Burners, Equipment, etc.

13. The first essential to get the best results is to keep the apparatus clean. This is conducive to general good working and any faults are more readily evidenced before they become serious.

14. The fan should be kept lubricated and running up to speed. If it is run in a dust-laden atmosphere, the vanes of the impeller may require periodical cleaning.

15. The burner itself should be cleaned daily, to effect which the nozzle should be removed and scraped, and the internal atomizer tube should be wiped and the slots in it cleaned out with a knife.

16. Should the glands in course of time show leakage, they should be re-packed, preferably with palmetto impregnated

packing, $\frac{1}{8}$-inch square, woven section. This applies to the swivel and to the oil valve gland on the burner itself, and also to any oilcocks having gland packings.

17. Oil tanks should be thoroughly drained and, if necessary, cleaned at least once annually. Failure to do this may result in a sediment or emulsion of oil and water collecting in the bottom of the tanks and causing trouble.

18. The air pressure gauge should be kept in good order.

Comparison of Fuels

19. The following are points of comparison in the use of oil fuel as compared with coke in Perkins drawplate ovens :—

Coke gives a good even fire, an average of 15 lb. of coke being required to bake 100 lb. of bread. Taking the coke at 27*s.* a ton, the cost of fuel for 100 lb. of bread = 1·75*d.*

Oil fuel.—1 gallon is required to bake 180 lb. of bread, or $\frac{5}{9}$ gallon for 100 lb. of bread. Taking a gallon of fuel oil at 4*d.* a gallon, the cost of fuel for 100 lb. of bread = 2·2*d.*

There is therefore a difference of 0·47*d.* for each 100 lb. of bread in favour of coke.

Coke has the further advantage that a cold oven can be heated in twelve hours, whereas thirty hours are required if oil fuel is used. This is not a serious disadvantage, however, as an oven is only allowed to go cold when in need of repair, or on re-starting a bakery after a period of disuse.

Oil fuel has the following advantages :—

i. Oil-fired ovens are much easier to keep clean.
ii. The fuel is more easily transported.
iii. The number of men required to keep a number of ovens going is reduced. One man can regulate the temperature of ten or twelve ovens during the actual baking, whereas four men would be required to stoke a similar number of coke furnaces. Two men would be required to each six oil-burning ovens for the purpose of care of the apparatus, maintenance of burners, cleaning, etc. With very little training unskilled labour can be usefully employed to keep oil furnaces going.

71. *Perkins drawplate ovens*

(*See* Plates 29 to 32)

1. The "Perkins" drawplate ovens are of brick construction, but heated by means of "Perkins" steam pipes, similar to those in the Oven, steam, field, Mk. II. They are made with one or two decks, the latter having separate furnaces to

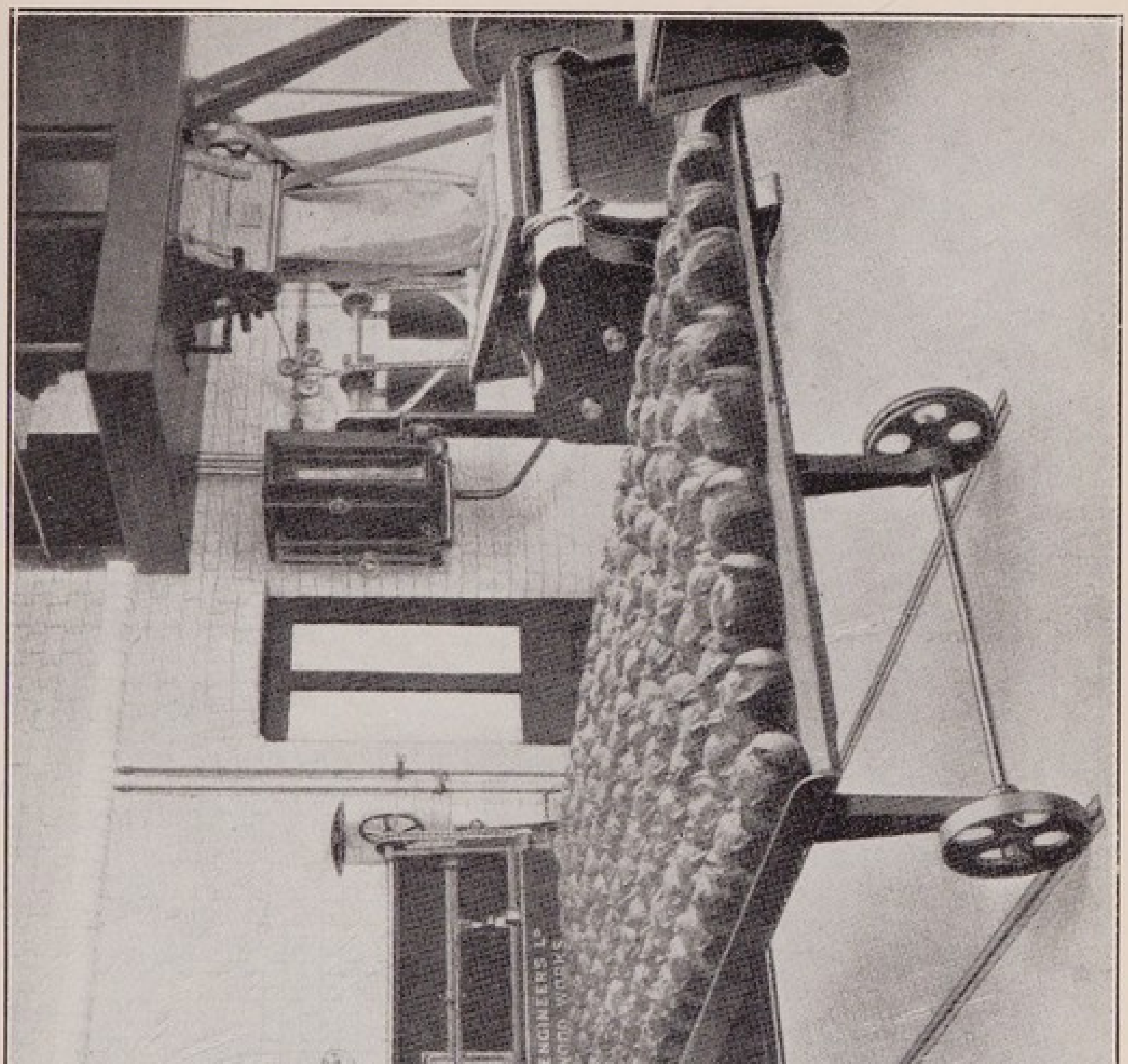


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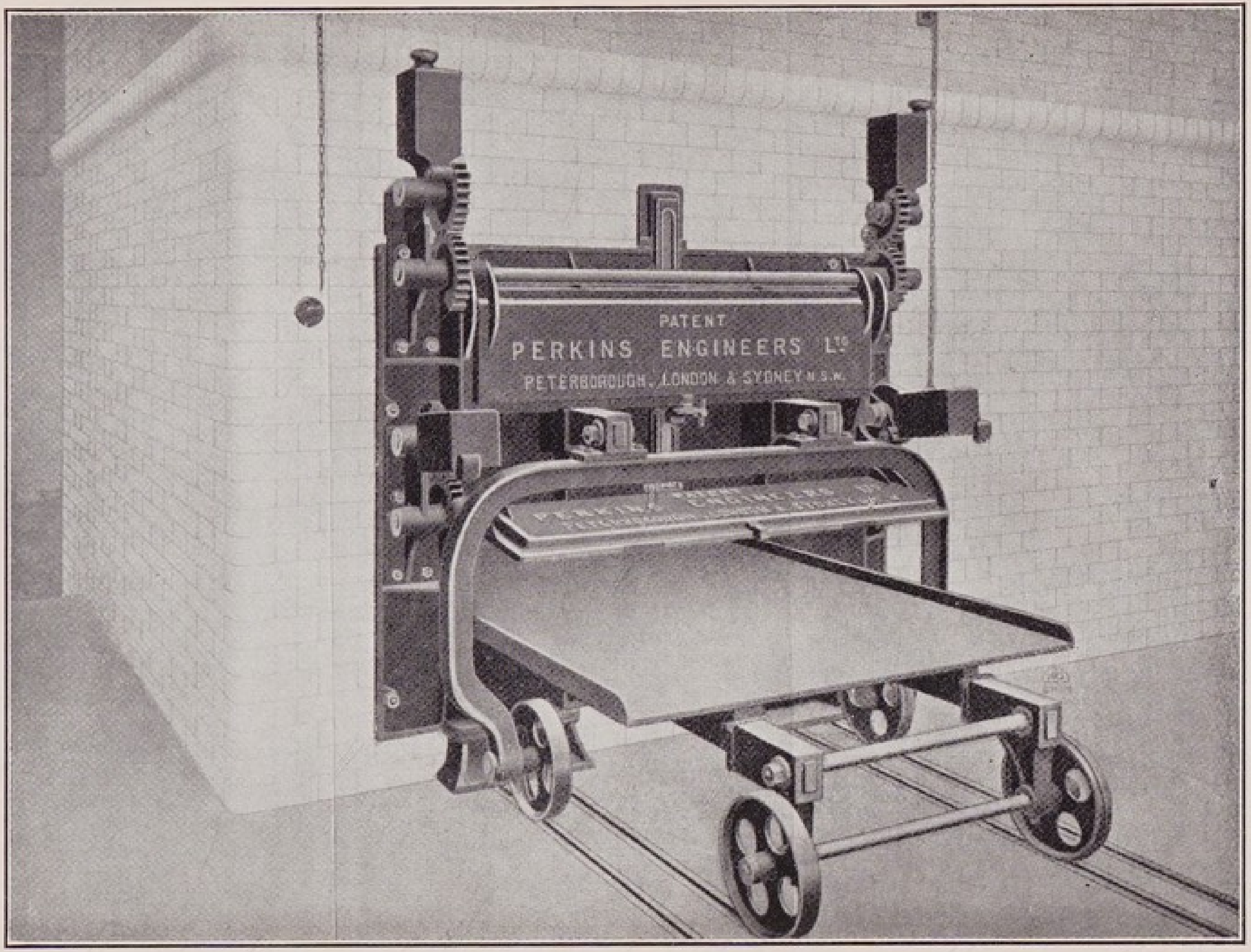
PLATE 30.—PERKINS STEAMPIPE DRAWPLATE OVEN—DOUBLE-DECK



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(Plan and Elevation)

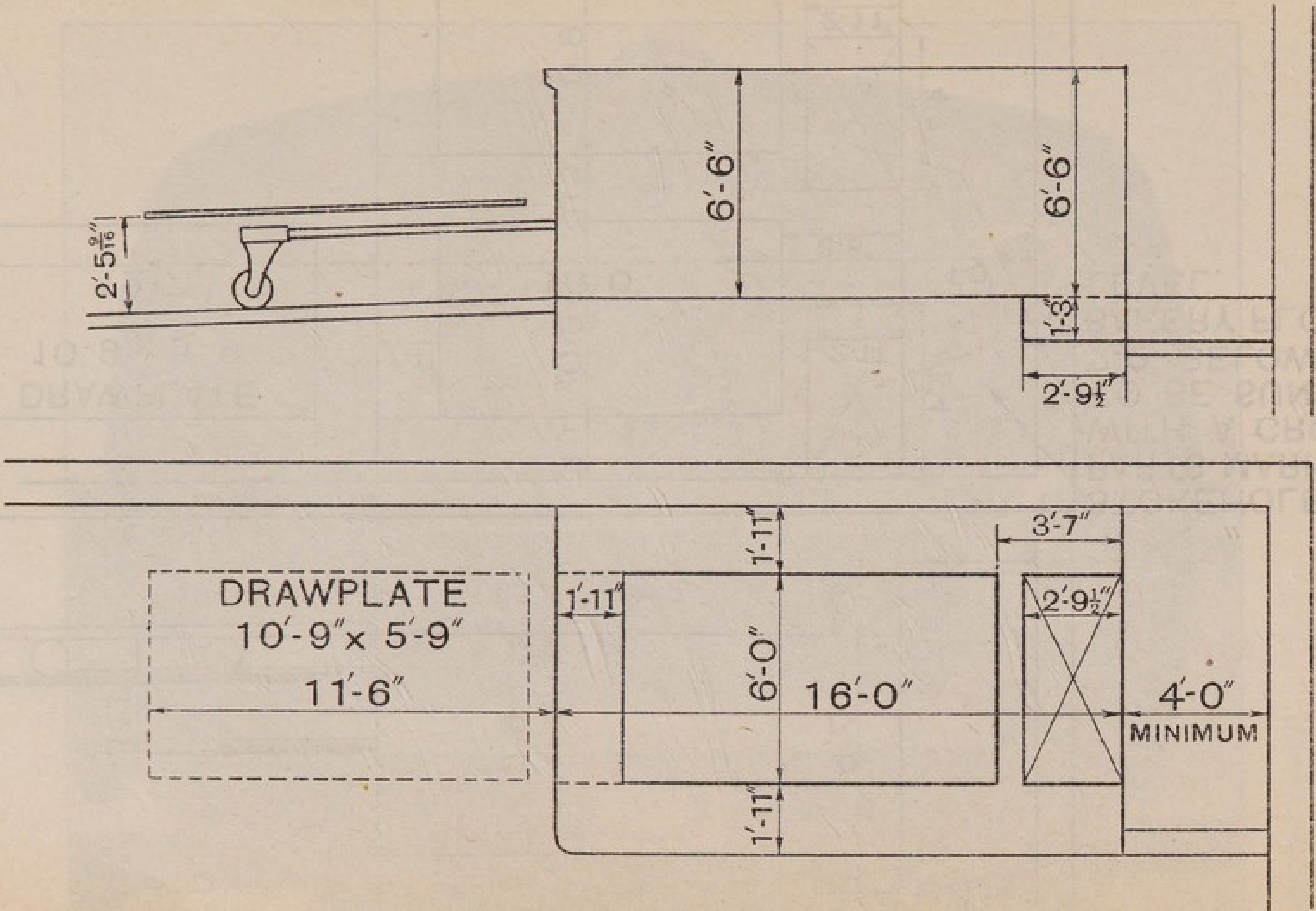

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Plate 32.—Perkins Steampipe Drawplate Oven—Double-deck

(Plan and Elevation)

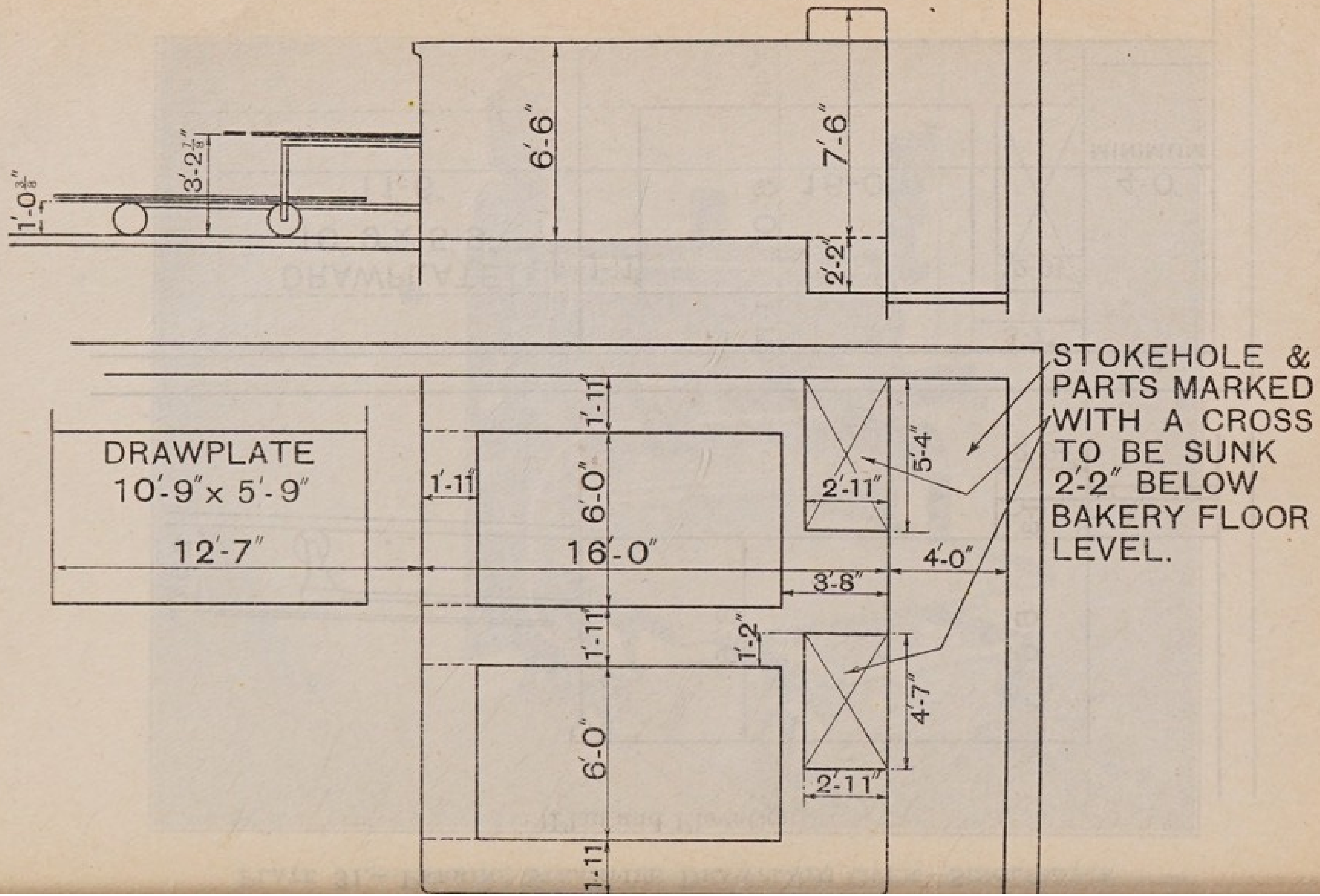

PLATE 33.—OVEN, STEAM, FIELD, DOUBLE-DECK, MK. II (FRONT)

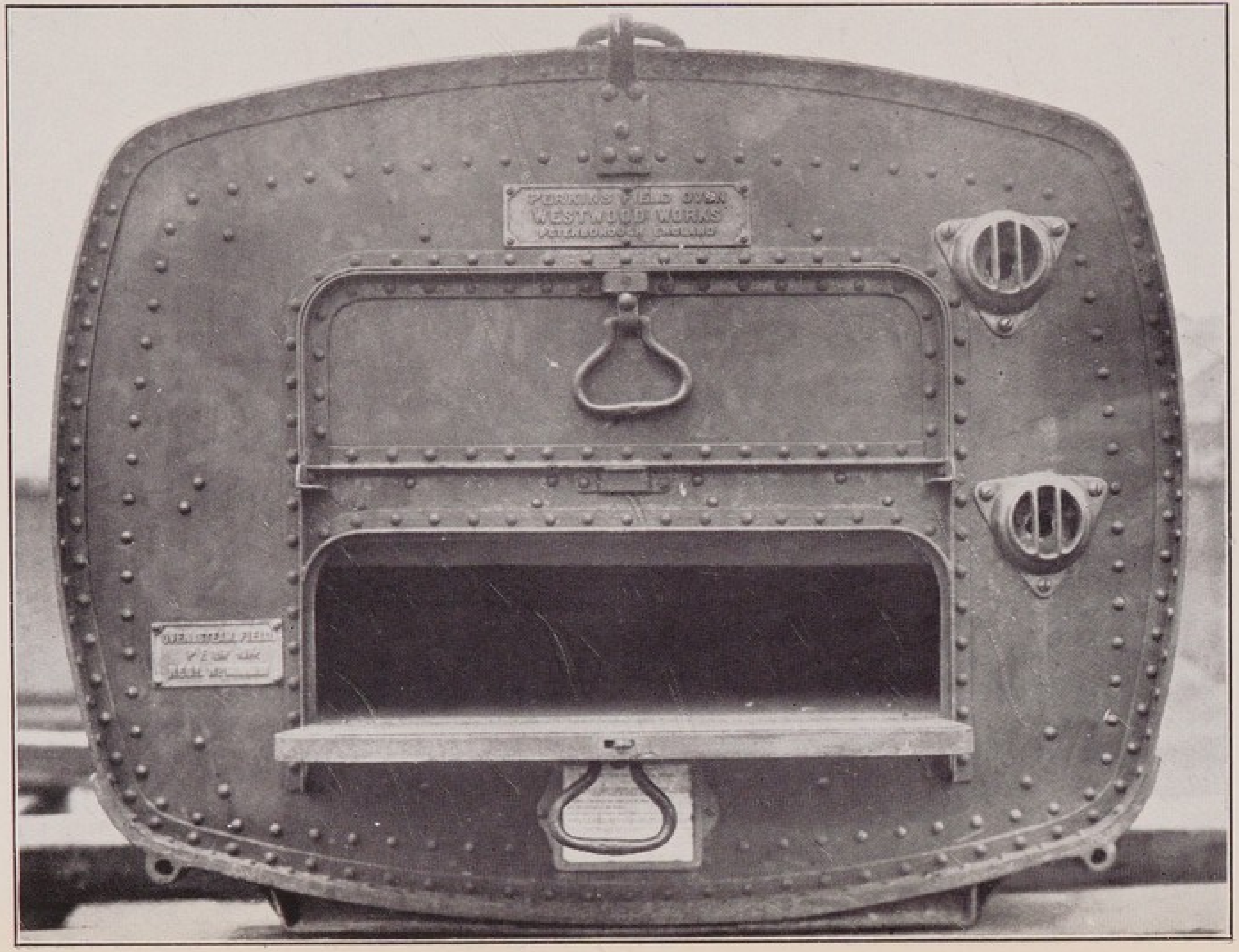

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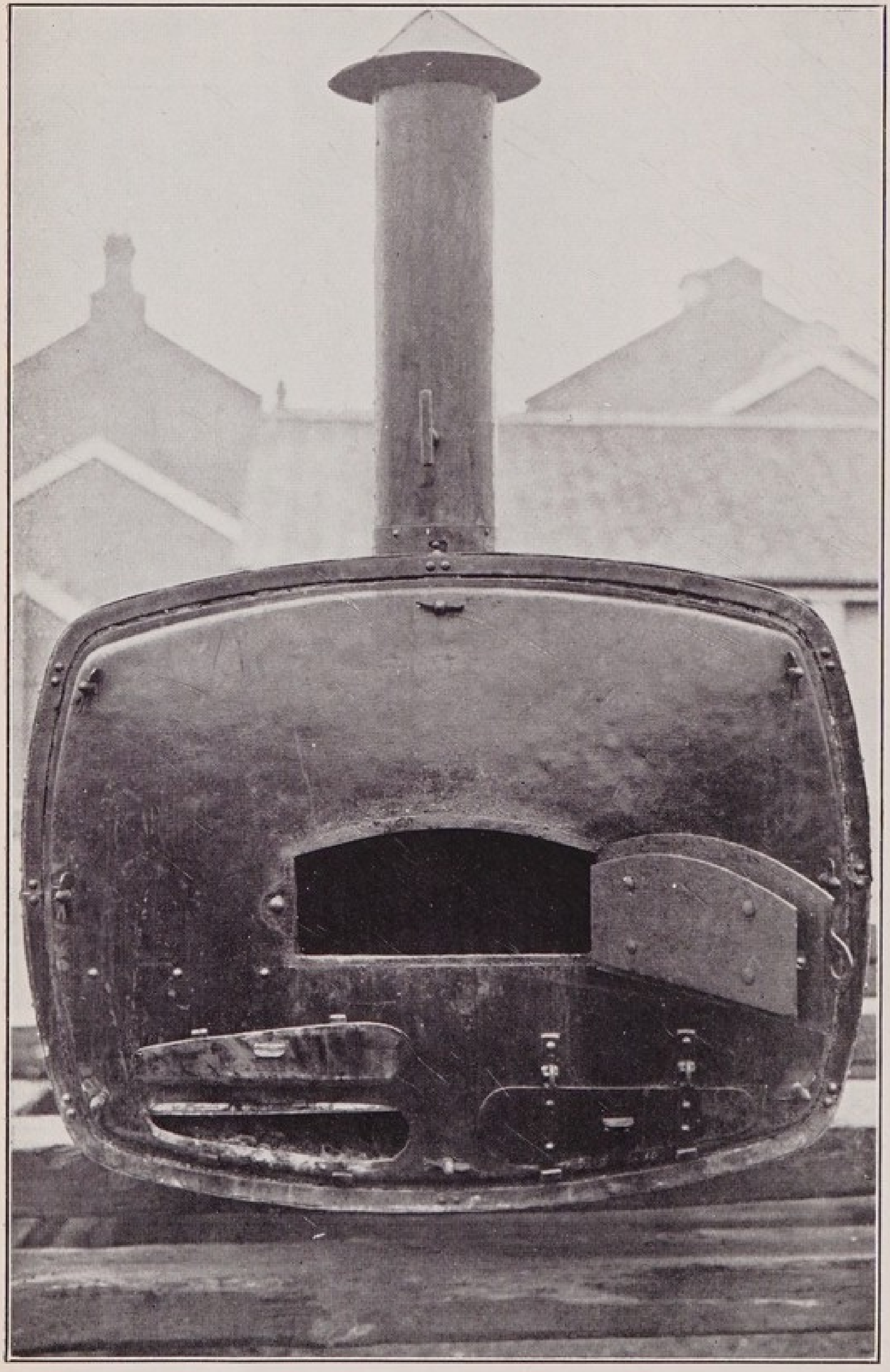
Plate 34.—Oven, Steam, Field, Double-deck, Mk. II (Back)



each deck, so that there are practically two ovens, one over the other.

2. The drawplate is 10 feet 9 inches long by 5 feet 9 inches wide, and travels in and out of the oven on a carriage, with the front end on wheels running on rails laid in the floor of the bakehouse, and the back end on an anti-friction roller which runs on rails inside the oven. The drawplate " telescopes " over this carriage on balls which run in races attached to the carriage. The moving parts inside the oven are thus " anti-frictional," and do not require lubrication.

Each drawplate can deal with 180 or 190 two-ration loaves a batch, and the batch can be baked in from forty to fifty minutes. One batch an hour, including setting and drawing, is a fair allowance.

3. These ovens should be built on good foundations resting on a solid substratum, and if water rises near the surface a solid block of concrete should be laid over the whole site, to prevent cracking due to abstraction of moisture by the heat of the oven.

4. A chimney 20 to 25 feet high is required, and it should be carried above anything likely to cause down draught by baffling the wind.

5. When using coke fuel a thin regular fire should be aimed at, not higher than say 2 inches below the bottom tubes, and the firebars should be kept clean so that the fire burns brightly, but not fiercely, low down in the furnace. Fuel should not be piled up in the furnace doors as this tends to waste, too much top heat, and unnecessary heating up and destruction of the outer wall of the furnaces.

6. Banking should not be resorted to for periods of more than three hours, but the firebox should be cleaned out daily and the fire re-started.

72. *Ovens, steam, field, double-decked, Mk. II*

DESCRIPTION

(*See* Plates 33 and 34)

1. The casing of the oven consists of an inner and outer shell with the intervening space filled with insulating material. This should not be interfered with or the efficient heating of the oven will be impaired.

2. The small plates screwed to the outer casing at various points are simply cover holes through which insulating material is packed ; they should not be removed.

3. The firebox, which has no connection with the oven chamber, is constructed for burning wood, but if necessary other fuel may be used.

4. The furnace casing being of steel will, however, need much more frequent renewal when coal, coke or liquid fuel is used.

5. The draught is controlled by means of the ashpit doors and the damper in the funnel.

6. The top of the firebox is formed into a collecting flue (provided with cleaning doors at the sides of the firebox) into which the smoke and products of combustion pass, by way of a narrow slot, to the funnel, which is over the centre of the firebox.

7. The collecting flue and the upper tubes, and also the flue pipe, should be cleaned regularly, the frequency depending on the amount of soot deposited in regular work. These are the only parts that require sweeping.

8. The heat is conveyed into the ovens by means of "Perkins tubes," which are arranged in parallel rows under the bread-plates and crown of the ovens.

9. These tubes are quite independent of each other and each has its working charge welded into it, and therefore no further charging is needed.

10. In use, the oven should be so inclined that these tubes fall towards the firebox, the firebox end of the casing being about 6 inches lower than the other end (*see* Plate 40).

11. The temperature is indicated on the mercurial thermometers against the oven doors, the bulbs being inside the oven chamber.

12. Baking temperature varies from 420° to 450° F.

13. To ensure regular heating of the oven it is only necessary (as in any other furnace) that the fire should be spread easily over the surface of the firegrate. The fuel must not be packed too closely into the furnace, but so that air for combustion may get through. The ashpit should be kept clean of ashes.

14. The number of loaves in a batch is generally 80 on each plate, and in continuous work the output is 18 batches in twenty-four hours.

Fuels

15. The firebox is constructed primarily for burning wood. The wood should be sawn into lengths of 12 to 16 inches, and must not be laid too close; thick and thin pieces should

PLATE 35.—FURNACE DOOR FITTED FOR OIL FIRING AND COMPRESSOR

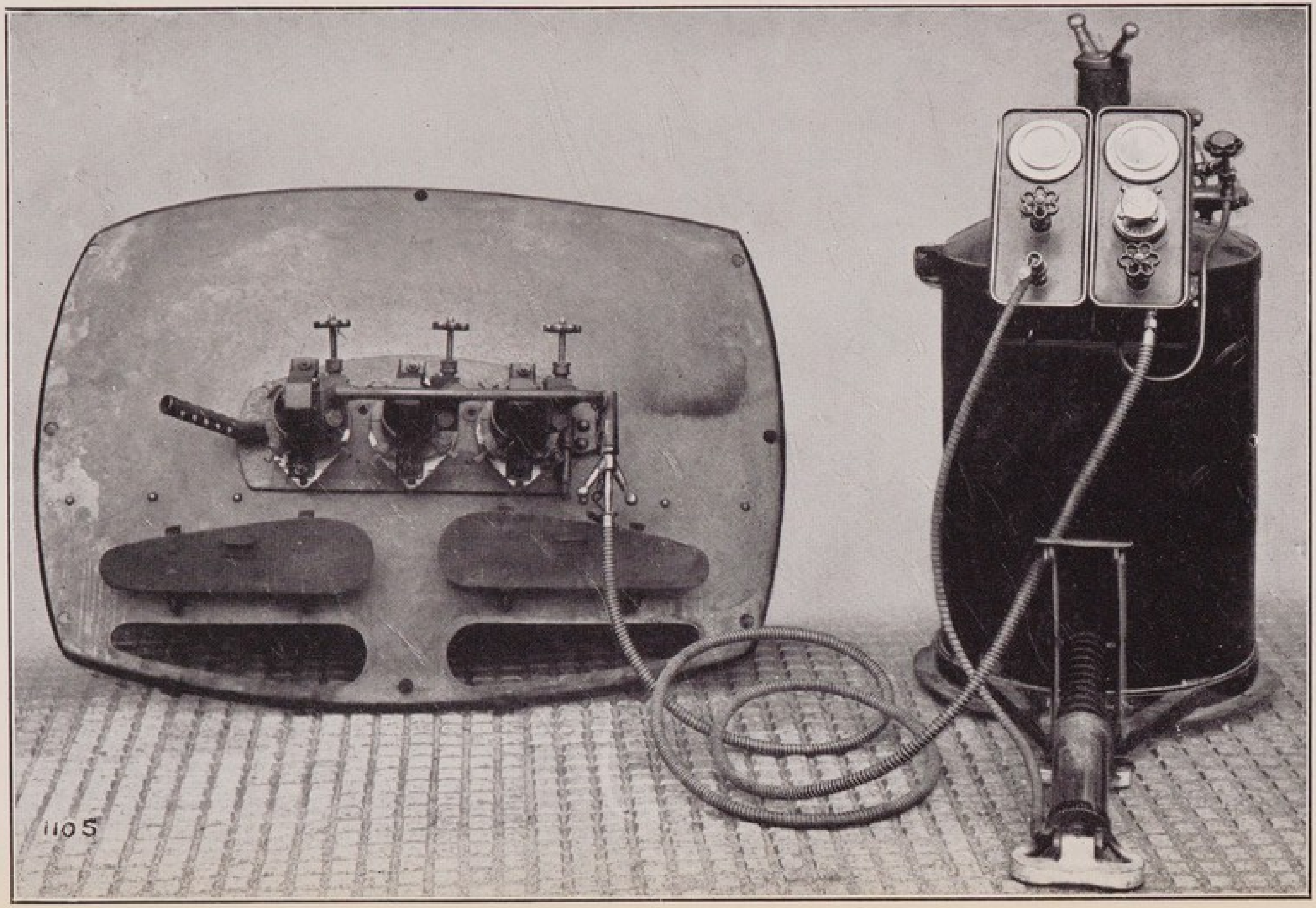


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PLATE 36.—OVEN, STEAM, FIELD, DOUBLE-DECK, MK. II

Holdfast for tackle for use in transportation

Plate 37.—Oven, Steam, Field, Double-deck, Mk. II

First position of spars in removal of oven from lorry on to sleeper ramp

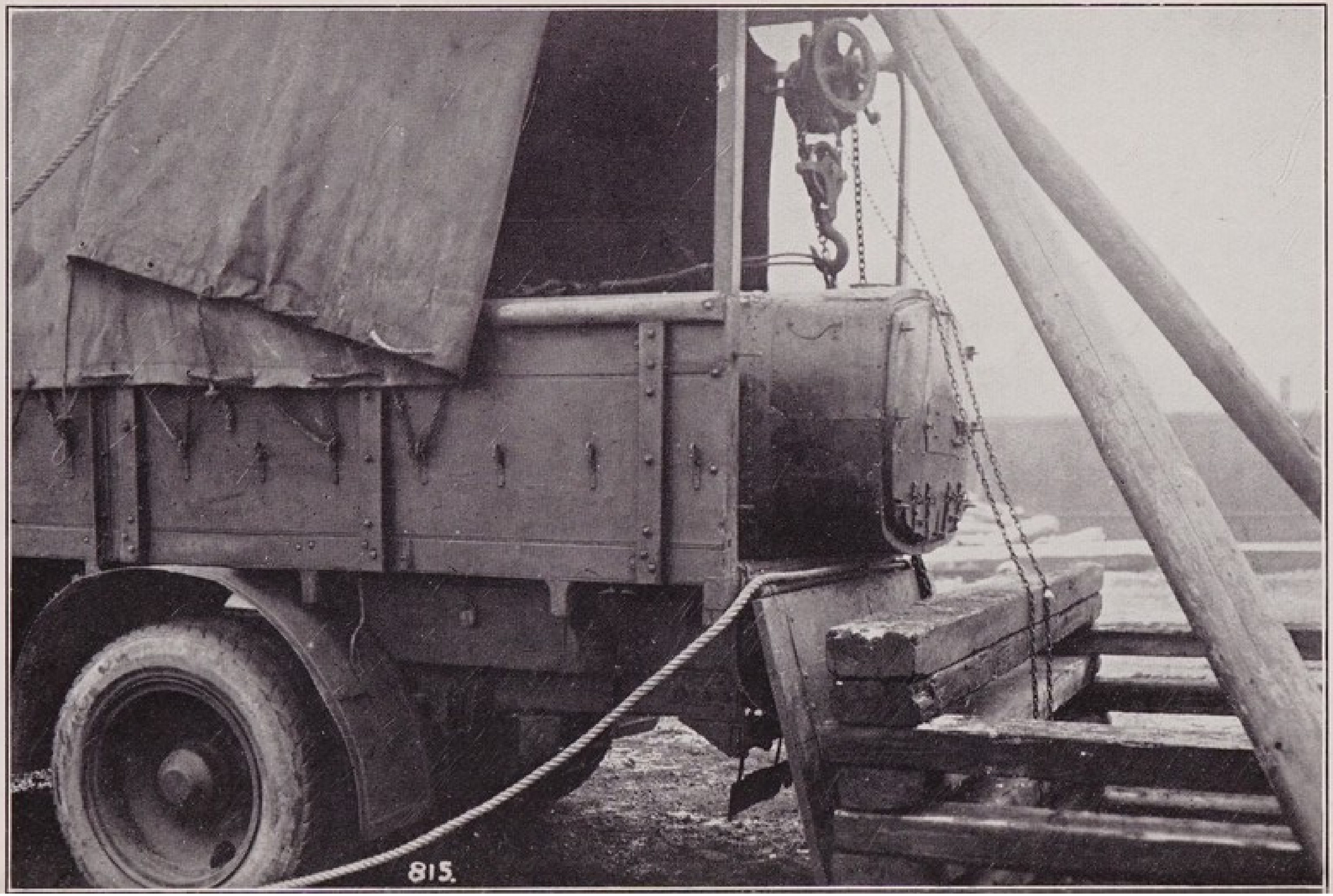


Plate 38.—Oven, Steam, Field, Double-deck, Mk. II

Second position of spars in removal of oven from lorry on to sleeper ramp

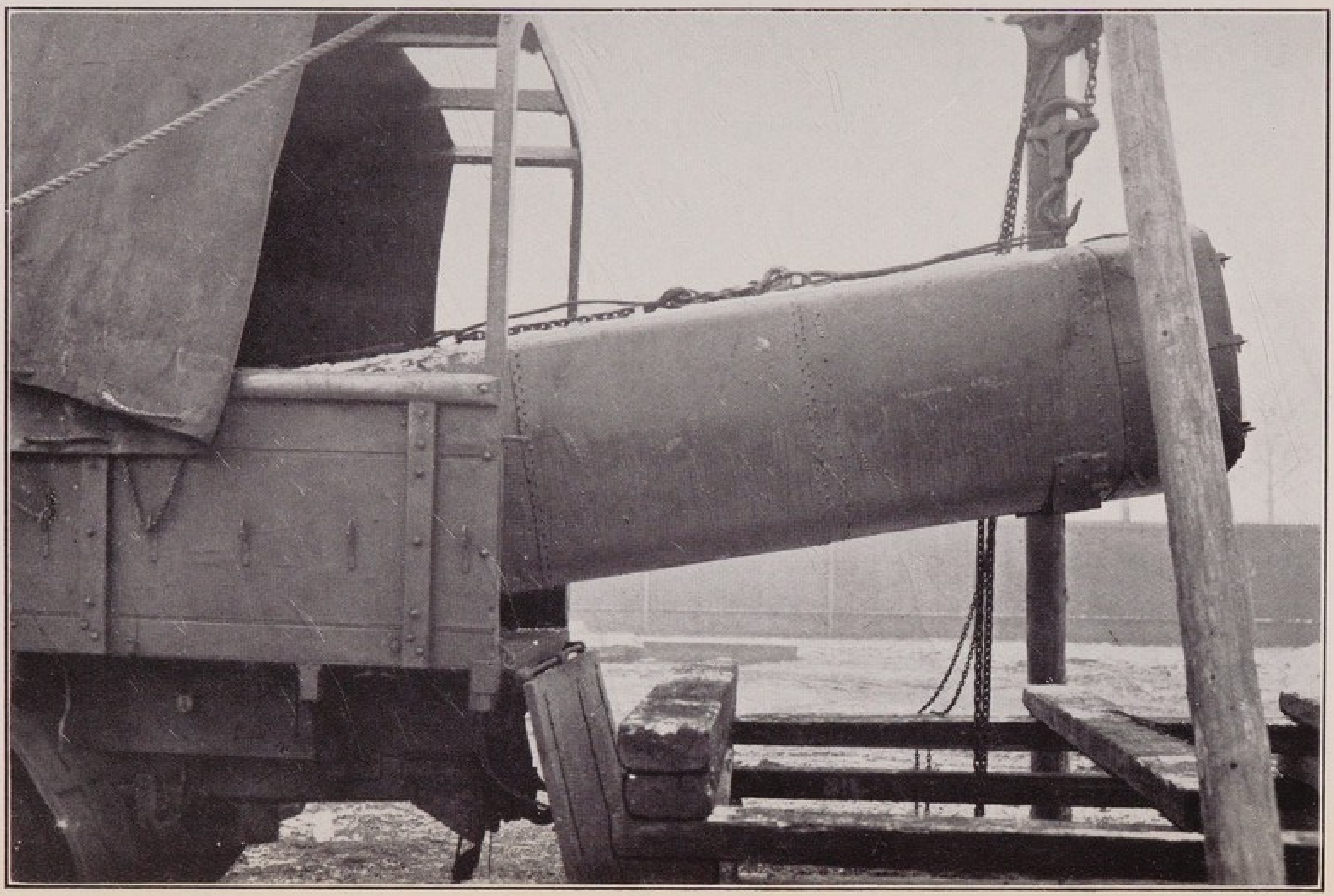


Plate 39.—Oven, Steam, Field, Double-deck, Mk. II

Third position of spars. Note method of slinging used to obviate crushing the oven casing

Plate 40.—Oven, Steam, Field, Double-deck, Mk. II

Mounted on ramp ready for use

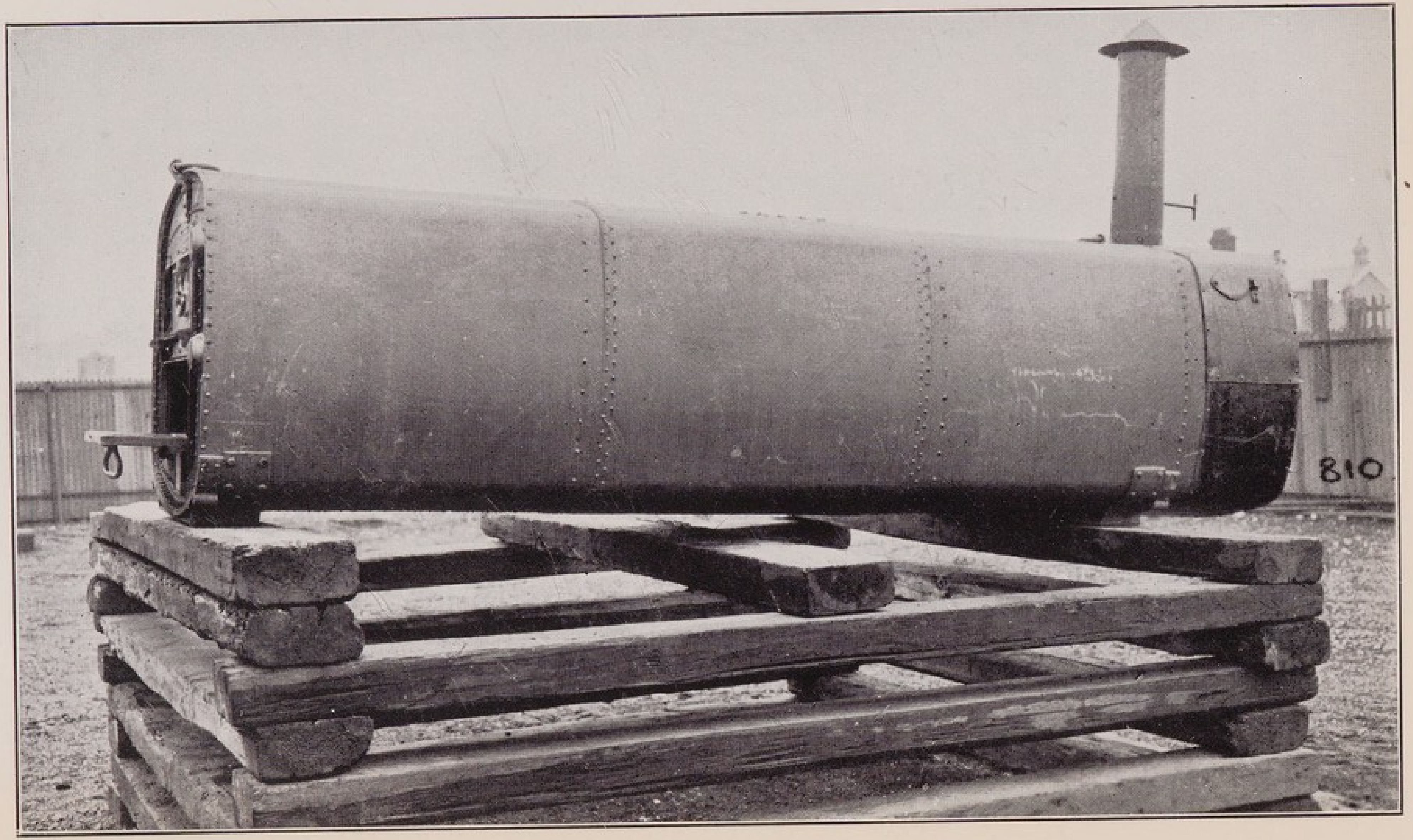
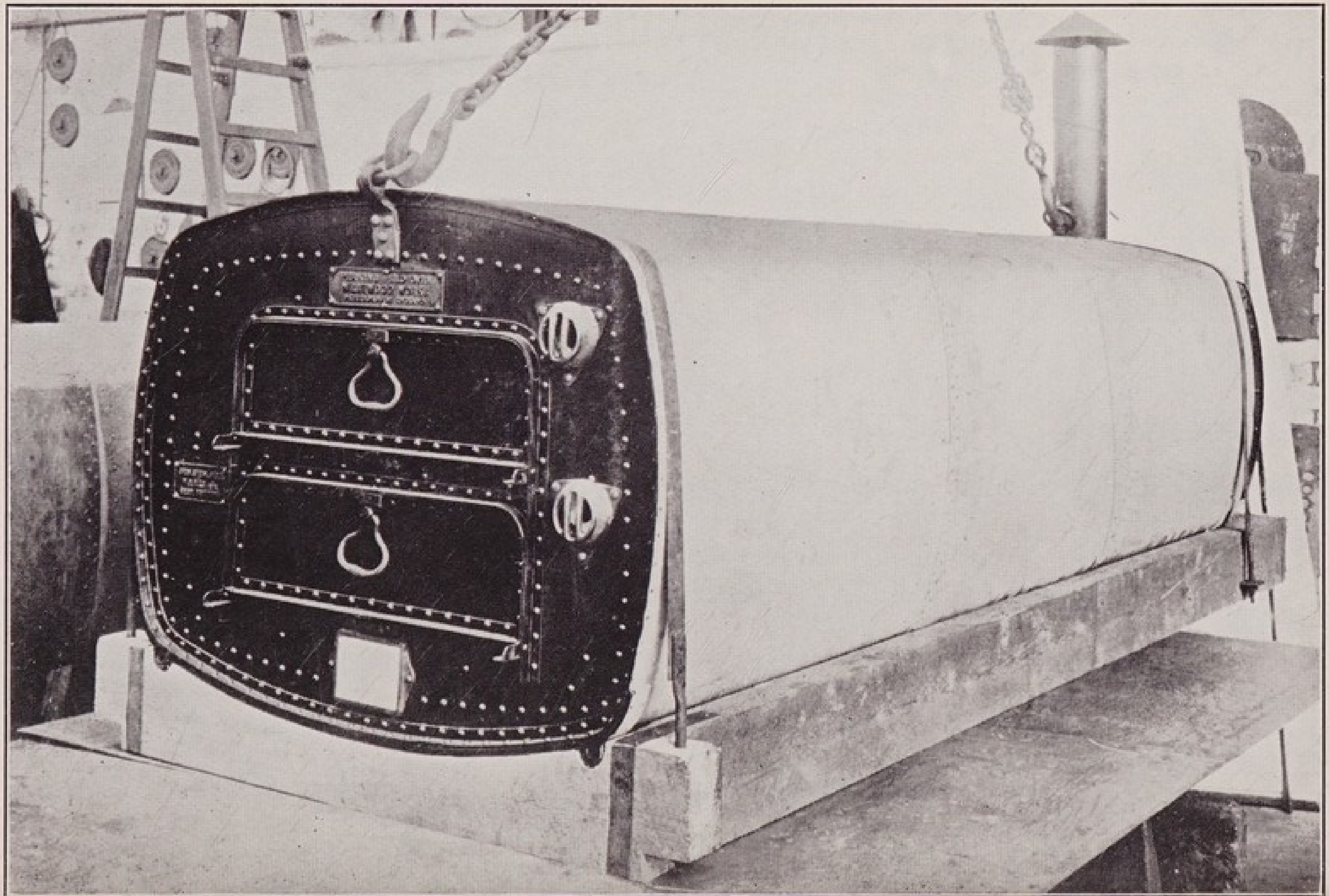


Plate 41.—Oven, Steam, Field, Double-deck, Mk. II

Cradle for use when transporting



be used together and some dried wood kept handy for rapid burning if required. About ⅕ lb. of wood is required for each 1 lb. of bread produced. Ovens fitted with all steel furnaces for burning wood can be adapted for coal and coke burning by removing the furnace and fitting an adapter lined with firebrick. Where it is likely that coal or coke will be used the firebrick lined furnace lasts longer, reduces fuel consumption and the amount of repairs.

Liquid Fuels

16. Liquid fuels which can be used are heavy oils, paraffin and petrol.

Steam ovens can be adapted for the use of liquid fuels by fitting the furnace door with spray nozzles (fed from a separate compressor) and lining the furnace with a series of baffle plates to distribute the flame evenly over the oven plates.

Plate 35 (page 136) shows a furnace door fitted for oil-firing together with the separate compressor.

The comparative costs of coke and heavy oil would be in about the same proportion as in the case of the Perkins coke and oil-burning ovens already described.

In the case of petrol and paraffin it has been found that to bake 576 lb. of bread it required :—

Petrol, 18 gallons at 10½*d.* a gallon = 31·6*d.* for 100 lb. of bread.

Coke, 168 lb. at 27*s.* a ton = 4·2*d.* for 100 lb. of bread.

The amount of paraffin required would be slightly less.

Transportation

(*See* Plates 36 to 41)

17. The weight of the oven by itself is 28 cwt.

The Mk. II, steam field oven is transported on an ordinary flat platform lorry.

The well-shaped body of a 6-wheeled lorry is not suitable.

On arrival at the bakery site these ovens must be removed from the lorry and mounted on some form of ramp.

Mounting for Use

18. The best form of ramp is two brick walls, one under each end of the oven, and the rear wall 6 inches lower than the front. But as the building of these walls would take some time, it will usually be preferable to use a ramp constructed of sleepers or baulks of timber (*see* Plate 40).

Sandbags do not make suitable ramps, owing to the difficulty of sliding the oven into position, and their tendency to sag under its weight.

The ramps should be of sufficient height for convenient access to the ovens and for the stoking of the furnace ; about $2\frac{1}{2}$ feet to 3 feet is suitable.

19. The ovens are difficult to handle owing to their weight and construction, and in order to get them out of the lorry and on to the ramp, the following tackle will be found useful :—

i. Two strong spars about 15 feet × 7 inches lashed or joined by a metal ring at the head (*see* Plates 37 to 39).
ii. Two sets of block and tackle, with a mechanical advantage of 4 : 1. One set to raise the oven and the other set to pull back the spars from which the first block and tackle are suspended.
iii. A suitable form of holdfast or anchor (*see* Plate 36).
iv. Two lorry tow ropes and oval iron rings.
v. Sufficient strong cordage to work the block and tackle and for guy ropes.
vi. Two spades.
vii. Four iron crowbars for lowering the oven into position.

20. With a gang of one superintendent and ten men, the approximate time to mount one oven is :—

Building ramp of 16 sleepers	..	About 20 minutes
Erection of tackle	..	20 ,,
After backing lorry up to ramp, removing oven from lorry to ramp		About 30 ,,
Total	..	1 hour 10 minutes.

About the same time is required to dismount the oven and replace it on the lorry.

21. Owing to the thin nature of the oven casing and the ease with which it would buckle, it is inadvisable when moving the oven to lift it by means of ropes round the body of the oven.

The lifting rings at either end of the oven should be used by means of a rope or chain sling between them.

22. A type of cradle which is suitable for use when transporting these ovens is shown in Plate 41.

With this type of cradle it is possible to move an oven from a lorry on to a ramp by means of rollers or crowbars without the use of overhead tackle, and with no risk of damaging the casing of the oven.

Men Required to Work the Oven

23. Two men for placing the bread in the oven or withdrawing it and one stoker are required to work this oven.

SYSTEM OF BAKING

24. The system of baking is that adopted in ordinary bakehouse procedure; there are no special matters for attention in the use of these ovens, except that it is found convenient, in putting the bread into the oven, to make use of the dishes used in the Aldershot oven and to place six loaves on a dish.

73. *Ground ovens*

1. The difference between all classes of ground ovens and other ovens is that in ground ovens the fire burns in the oven itself and has to be raked out before the bread is put in, the bread being baked by the heat retained in the walls of the oven; whereas in ordinary ovens the heat is applied by a fire burning outside the oven while the bread is actually in the process of baking.

THE ALDERSHOT OVEN

(*See* Plate 42)

2. The portable class of ground oven is represented by the "Aldershot oven." This consists of :—

2 sections, weighing	186 lb.
2 ends ,, ...	52 ,,
1 bottom ,, ...	66 ,,
4 bars ,, ...	28 ,,
9 tins ,, ...	36 ,,
1 peel ,, ...	6 ,,
Total ..	374 lb.

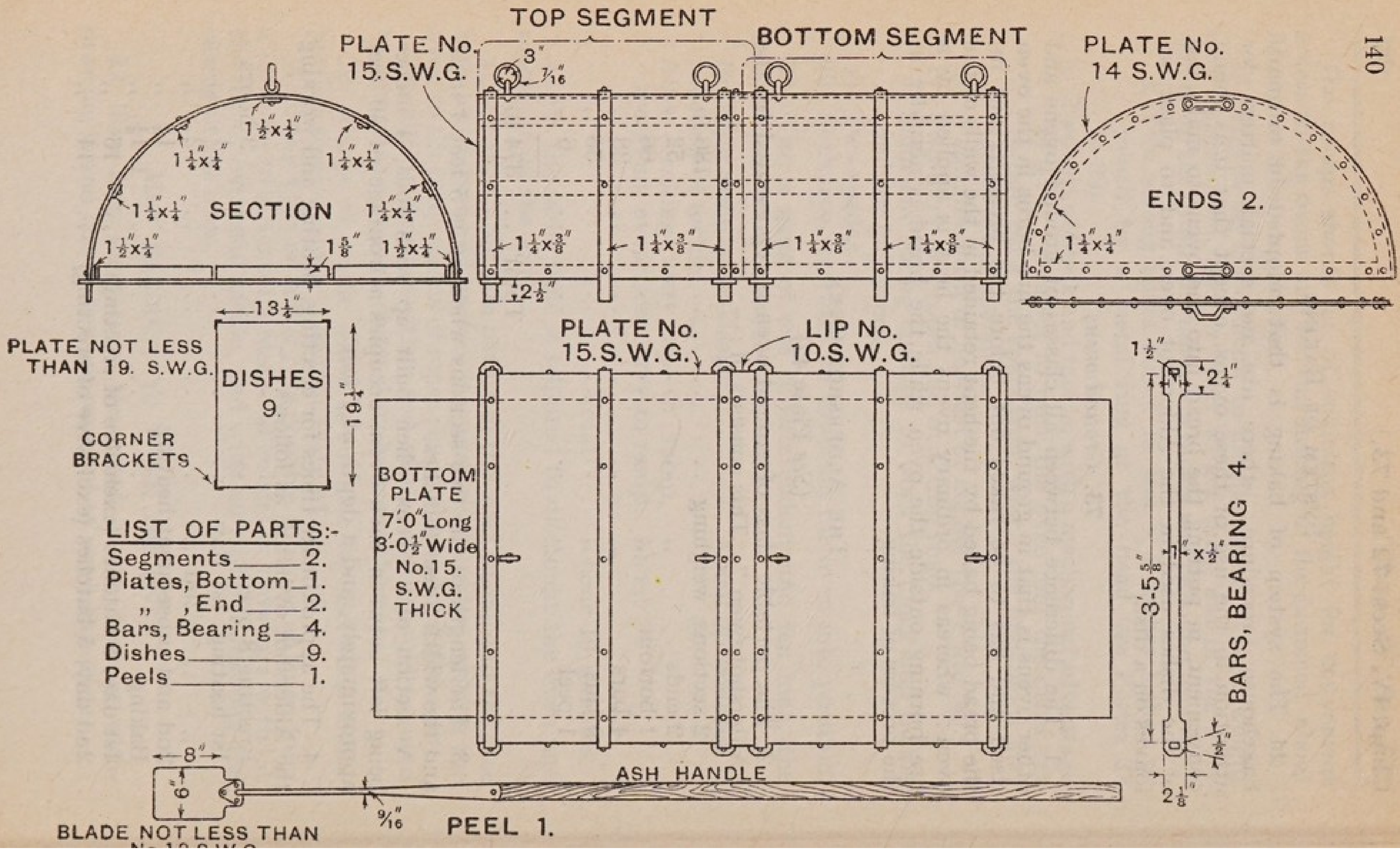
3. The length of the two sections when up is 5 feet 1 inch, and the width 3 feet 6 inches.

A section of 8 ovens when built up with sods, 4 inches being left between each oven, occupies a frontage of 40 feet approximately, and a depth of 7 feet.

4. The approximate times for erecting, heating and working the Aldershot oven are as follows :—

Erecting 8 ovens	3 hours
1st heating, 1st day	4 ,,
,, ,, 2nd ,, ...	2 ,,
2nd and subsequent heating	$1\frac{1}{2}$,,
Baking	$1–1\frac{1}{4}$,,
1st day, 5 batches (exclusive of erecting) ..	16 ,,
2nd day, 5 batches (exclusive of erecting) ..	14 ,,

PLATE 42.—THE ALDERSHOT OVEN, MK. II



5. *Capacity*.—Each oven holds 54/2 or 2½ lb. loaves, or 108 rations; 8 ovens hold in one batch 864 rations; 8 ovens can bake sufficient bread for an infantry brigade, in 5 batches.

6. *Fuel*.—The approximate amount of wood required for each oven is :—

1st heating, 1st day	300 lb.
,, ,, 2nd ,, ...	150 ,,
2nd and subsequent heatings	75 ,,
8 ovens, 1st day	5,250 ,,
,, 2nd ,, ...	3,750 ,,

7. A useful rule for calculating the amount of wood required with any kind of ground oven is to allow 1 lb. of wood for every pound of bread produced ; this gives an ample allowance.

8. *Bakers*.—On home manœuvres three bakers are required for every two ovens, but on service two are allowed for each.

9. *Erecting ovens*.—The ovens should be erected on a gentle slope, the mouths facing the prevailing wind, as the ovens heat more quickly and the smoke is blown away from the bakers. A "master" and nine men are required to pitch eight ovens. The master and five men mark out the baker's trench, build the walls, and level the roof ; four men cut turf sods, dig out the baker's and other trenches, throw earth over the ovens, split wood, and light fires. The tools required are four spades, four shovels, and two picks. The master baker should have a line 40 feet long, with ten knots where the centre of each oven will rest.

The first knot will be 2 feet 9 inches from the end of the line, and the others at intervals of 3 feet 10 inches from it. The ground to be occupied by the ovens, which will be a rectangle 40 feet long and 6 feet 1 inch wide, should be marked out, a stake being driven at each corner and one at each knot. The ground is then cleared and the sods removed, if on turf. The outer ribs of each section are inserted in the eyes of the cross-bars, and the two sections are laid on the ground with their ends overlapping about 1 inch. The ends of the ribs and cross-bars are sunk flush with the ground. The back ends of the ovens are then placed in position. Next mark out the baker's trench 1 foot from the front of the ovens, 2 feet wide and 1½ feet deep : 148 sods are required, each 1½ feet long, 1 foot wide, and 4 inches deep. The sod wall is now built round the ovens ; one man takes each end, three the back, and one the front. Each course should be completed before another is begun. The sods are laid grass downwards, and are built in the same manner as bricks, the joints being "broken."

Simultaneously the baker's trench is dug, and the earth thrown over the ovens. With this earth the sods are well bedded and backed. The joints between sections are covered with clay or sods, grass downward. The tops of the ovens are covered with earth beaten down to a height of 6 inches in front, sloping backwards till it just covers the back ends of the ovens ; this gives a fall to drain off rain-water. The roofs of the two outer ovens should be drained both outwards and backwards. A trench 1 foot wide and 9 inches deep should be dug round the ends and backs of the ovens about 3 inches from them to drain off rain-water. The baker's trench should also be drained.

10. *Directions for working.*—The following directions for working should be observed :—

i. Every night, wood should be laid in each oven ready for lighting in the morning. It is thus kept dry.

ii. When the oven is heated, the embers should be drawn out with a rake, and a small quantity of ashes left and raked even with the floor.

iii. The tins containing the dough should not be put in till twenty minutes or half an hour after the fire is drawn.

When the tops of the oven sinks to less than 14 inches from the bottom, which will happen sooner or later owing to the metal being softened by the heat, they should be taken to pieces and beaten into shape with mauls.

When the dough is placed in the oven (which is done by lifting the tins in with the peel) the door is placed in position and the crevices closed with clay.

74. *Improvised ovens*

Ground ovens, on the principle of the Aldershot oven, may be improvised of almost any material, the shape and method of working the Aldershot oven being taken as a pattern. For example, ovens may be made of brick, corrugated iron, half barrels covered with clay or biscuit tins beaten out into the shape of an arch, and supported by half tyres of wheels, etc.

75. *Steam field ovens, Mk. II, and Aldershot ovens—A comparison*

1. For the purpose of comparison a section of eight Aldershot ovens working side by side with four steam ovens for about ten hours a day is here considered.

Each steam oven can turn out six batches of 288 lb., using tins, in the ten hours, so that four ovens together will turn out 6,912 lb.

The section of Aldershot ovens will produce 3,456 lb. in the same time.

2. *Mobility.*—Each steam oven weighs 28 cwt. and is very awkward to handle even with the necessary tackle.

It is transported by a 3-ton lorry, the 30 cwt. type of lorry not being long enough in the body.

The section of Aldershot ovens weighs about 27 cwt. and can be packed either in a 30-cwt. lorry or with other equipment in a 3-ton lorry.

The four steam ovens therefore take up four times the amount of transport required for a section of Aldershot ovens.

3. *Fuel.*—The steam oven only requires $\frac{1}{5}$ lb. of wood for each pound of bread produced, whereas the Aldershot oven requires 1 lb.

The steam oven can also be adapted to use oil fuels, whereas in the Aldershot oven only wood can be used.

4. *Durability.*—If continuously worked Aldershot ovens become unserviceable as a rule far sooner than steam ovens, but they are much more easily repaired or replaced.

5. *Labour.*—The four steam ovens require 19 bakers and 5 issuers, while the Aldershot ovens require 16 bakers and 5 issuers.

6. *Bread produced.*—Though the bread produced by each class of oven should be of equal quality, considerably more care and experience is required in working Aldershot ovens.

7. It will be seen, therefore, that four steam ovens will produce twice as much bread as a section of Aldershot ovens with only three extra men, but require four times the transport to move them.

8. The time taken in erecting the steam ovens will depend on the material available for making ramps, but it is not likely to be much quicker than the erection of the Aldershot ovens.

76. *Miscellaneous breadstuffs*

Unfermented Bread

1. This bread is produced by the agency of baking powder or by the use of carbonic acid gas under high pressure (aerated bread).

Baking powder consists of a mixture of chemicals, one of which is invariably bi-carbonate of soda, whilst the other is an acid substance such as cream of tartar, acid calcium phosphate, tartaric acid, citric acid, etc. The ingredients are mixed with dry starch, which absorbs any traces of

moisture and prevents the components reacting on each other before use.

When mixed in a dough the acid component reacts on the sodium bi-carbonate causing an evolution of the gas carbon dioxide.

Cream of tartar is to be preferred to any other acid component as very little action takes place in the cold; most of the gas is produced when the dough is warmed in the oven and a better rise is thus obtained. Cream of tartar substitutes react immediately they are mixed in the dough and some gas is wasted. Acid calcium phosphate is the best substitute for cream of tartar.

The method of using baking powder is as follows :—

> Spread the flour evenly at the bottom of the trough, sift the baking powder over the flour, taking care to break up any small lumps which, if left, would cause a yellow stain in the bread. The dry powder and flour should then be thoroughly mixed and sifted at least twice.
>
> Dissolve salt in clean cold water, at the rate of $2\frac{1}{2}$ lb. to each sack of flour only, as a considerable quantity of saline matter is produced by all baking powders. Water which has been boiled and allowed to get cold is the best for the purpose.
>
> Mix the flour, baking powder and water thoroughly with a rotary motion, constantly stirring up from the bottom. The dough being properly mixed should be at once scaled, moulded and placed in a moderate oven. To make a good loaf with baking powder, the bread should be in the oven within thirty minutes of adding the water to the flour. No more salt than the above-mentioned proportion should be used, or the bread becomes heavy, dark and briny. If the dough is allowed to lie about, the effervescence is finished before it is put in the oven.

The substance sold under the name of "Self-raising flour" is a mixture of ordinary flour with chemicals which, when water is added, produce gas to raise the flour. It is not much used for breadmaking, but is largely employed in private houses for pastry, etc. For breadmaking the usual proportion of baking powder is 3 oz. for each 4 lb. of flour.

Wholemeal and Brown Breads

2. Genuine wholemeal is produced by grinding the wheat between stones and sieving out the coarse bran. A certain amount of such meal is produced in Great Britain in mills which run a pair of stones specially for this purpose. Such

meal contains comminuted germ which is absent from the meal produced by roller milling.

Generally speaking the terms wholemeal bread and brown bread are used synonomously and refer to the brown bread produced from wheatmeals of various types. The wheatmeals of the roller mills usually consist of a mixture of the lower-grade flours with fine offal, and are not so nutritious as the genuine product.

The brown colour of the bread is due to the branny matter contained in the meal.

The special meals such as Hovis, Daren, etc., are in a different category, consisting of good grades of flour with specially prepared germ meal, and contain less branny matter.

Rye Bread

3. Rye is much hardier than wheat and can be grown in climates which are too cold and severe for wheat. This fact contributes to rye being so largely grown in north-eastern Europe, and to rye bread being still the staple food of the poorer classes in these districts.

Rye is milled somewhat differently from wheat and even refined rye flour gives a dark coloured loaf.

Rye more nearly resembles wheat than do other cereals, but is deficient in gluten and therefore gives close, heavy and small loaves. The bread is not usually made with yeast but with sour dough or leaven, the flavour so produced being preferred by the consumers.

The addition of 20 to 30 per cent. of wheat flour gives a better loaf ; this is often made.

Wheaten bread is more digestible and is superior to rye bread, and the general tendency, as far as agricultural progress and economic reasons permit, is for wheat to supplant rye.

Unfermented Cakes

4. The " chuppaty " of India is simply made with flour, water and salt. It is agreeable to the taste and nutritious, when made by the native cook.

The mixture of flour and water and a little salt is made into a stiff dough, which is rolled out to a thickness of about ¼ inch on any round tin that may be available. It is then cooked over the cinders.

The Australian " damper " is made by digging a hole in the ground, filling it with a wood fire, and when the fire has thoroughly burnt up, removing it, laying the dough on a large stone, covering it with a tin plate, and heaping the hot ashes round and over it. In a campaign, every soldier, if he could

get flour, baking powder and wood, would soon learn to bake a cake for himself. The only point that requires practice is the prevention of excessive heat; if it be above 212° F., too much of the starch is turned into dextrine and the cake is tough. Exposed to greater heat and well dried, the unfermented cake becomes biscuit.

Should the chuppaty or damper be spoiled in the cooking, soak it in water—or milk, if available—and bake it again in any form of improvised oven. A fairly palatable form of biscuit may thus be obtained.

Breadstuffs from other Grain

5. In time of emergency bread of sorts can be made from other grain and from legumes.

Examples are :—

Barley bread, oat cakes, maize or Indian corn cakes, bean and pea bread, potato bread (mashed boiled potatoes).

None of the above can be fermented as wheat flour dough is fermented, and when they are used by themselves it is preferable to make unfermented cakes.

Where some wheat flour is available the best procedure is to make a sponge of wheat flour and yeast, allow it to ferment, then mix in the other meal to make the dough and allow the dough but a short fermentation before baking.

The reason for the above procedure is that wheat is the only grain containing the proteins which together constitute gluten, so that flour dough alone is able to retain the gas necessary for a well-aerated loaf. Secondly, the diastatic enzymes occurring in other grain and in legumes convert the starch into sugars at such a rate that dark treacly products result. The short fermentation in the dough stage avoids this excessive change.

CHAPTER V

GROCERIES

77. *General*

1. This chapter describes some of the chief items of groceries, etc., which are dealt with by the R.A.S.C. in peace at home and abroad.

2. As is the case with all supply commodities, a War Department specification is compiled for each item. These specifications are embodied in the Handbook of Specifications for Supplies. Each specification lays down conditions as regards quality, type of container, size and type of cases, period of warranty and method of marking the various packages.

3. Details of weight, measurement, etc., of the various patterns of packages in which R.A.S.C. supplies are packed are given in Appendix III.

78. *Biscuits*

1. Army biscuits are made from flour, meal, salt, sugar and water kneaded into a thick paste, cut into the proper shape, pricked with holes, and baked in the oven. They are made by machinery.

2. Biscuits are a convenient and compact form of food, especially as regards carriage and keeping, and are well adapted for use in the field. If properly packed in casks or tins, they will keep a long while, but if exposed to damp, they soon become musty and mouldy and are attacked by various insect pests. They contain more nutriment than the same weight of bread, ¾ lb. of biscuit being equal to 1 lb. of bread.

3. In the manufacture of biscuits there is a loss of about 10 per cent., whereas in the manufacture of bread there is a gain of about 32·85 per cent. The reason of this is that biscuits, being flat, compact, and highly dried in baking, lose not only the water used in making the dough, but also a portion of the moisture in the flour itself.

4. Biscuits should be a light yellow colour, well baked and crisp but not burnt.

They should have a just perceptible sweetness and a slight mealy flavour, and should be sufficiently friable and porous to soften in the mouth.

They should be neither tough nor pasty inside, nor solid and flinty, but should be hard enough to permit of their being carried without damage in the haversacks.

5. As service biscuits contain a high proportion of wheatmeal, they have a tendency to develop a slight rancid odour in the canister ; this is often perceptible when a canister is opened some months after packing.

The odour of rancidity soon disappears on exposure to air.

79. *Butter*

1. Fresh butter is prepared by churning cream, soured by the proper ferment, with or without the addition of salt, preservatives and colouring matter.

2. As the sale of liquid milk is generally more profitable to home farmers, butter is largely imported from Canada, Australia, New Zealand, the Irish Free State, and from Denmark, the Argentine, Russia, Finland, Sweden, the Netherlands, France and the U.S.A.

The composition of butter is roughly as follows :—

Milk fat	83 per cent.
Water	14 ,, ,,
Casein	0·8 ,, ,,
Milk sugar	0·3 ,, ,,
Lactic acid	A trace
Natural mineral matter	0·1 ,, ,,
Added common salt	1·5 ,, ,,

3. The Butter and Margarine Act, 1907, now embodied in the Food and Drugs (Adulteration) Act, 1928, lays down the maximum limit of 16 per cent. for the water present in butter.

4. Butter is the most readily digested of all fatty substances, and where the cows are well fed is a rich source of vitamin A.

5. *Adulteration*.—Butter may be adulterated by the addition of foreign fats, such as cocoanut oil and margarine, by casein and starch, or by the incorporation of excessive amounts of water, salt or preservatives (e.g. boric acid).

Butter-milk separates during churning and, if the subsequent washing of the butter is not properly carried out, more especially during the hot weather, water may remain in the butter to an extent greater than the legal limit of 16 per cent. This is an irregularity very easy to detect.

6. *Simple tests for quality*.—The texture, odour and flavour are the main guides. Butter that has been overworked to obtain a higher water content, or to blend butters from various

sources, has no grain. Stale butter is detected by the odour. The flavour and the feel of butter on the tongue can usually be distinguished from that of margarine, particularly if a little butter known to be genuine is available for comparison.

7. *Analysis.*—Butter is analysed for percentage of moisture content, curd and salt, and for the genuineness of the butter fat.

80. *Cheese*

1. Cheese is one of the most concentrated foodstuffs and at the same time has good keeping properties.

2. Milk is ripened by the use of a starter (the starter was formerly sour milk, nowadays a culture of lactic acid organisms is commonly used), and when sufficiently ripened a dilute solution of rennet is stirred in.

The rennet coagulates the milk and a separation into curd and whey takes place.

The curd is ripened in a manner appropriate to the variety of cheese being made, the whey drained off, the curd then milled and pressed into shape. The cheese is then usually wrapped and stored for a definite period for the ripening to take place.

3. The ripening of cheese and the production of the characteristic flavour depends on the presence of certain bacteria and moulds and, in order to prevent organisms of the wrong type developing, cleanliness of the milk and the factory is necessary.

4. Pasteurized milk is sometimes used where milk supplies are not reliable as regards bacterial content, but such milk does not give the best quality cheese.

5. The action of rennet in coagulating milk is due to an enzyme rennin. This is obtained by the careful maceration of the lining of the fourth stomach of the calf in dilute salt solution.

6. The colour of cheeses, such as cheddar, is produced by the addition of colouring matter just before the curdling takes place.

The colour of stilton is due to mould growths.

Some cheeses are coloured and flavoured with sage.

7. There are many varieties of cheese, the differences being due to the fat content and the method of ripening the milk, treating the curd and ripening the cheese.

Common types of cheese are :—

i. *Hard*.—Cheddar type. (Cheddar, Cheshire, Leicester, Gloucester.) Cheese of this type is made in Canada, New Zealand, and the U.S.A., as well as in Great Britain. Foreign hard cheeses include Gruyère and Parmesan.

ii. *Semi-hard*.—Stilton, Gorgonzola, Roquefort.

iii. *Soft*.—Cream Cheese, Cammembert, Limburger, Wensleydale.

8. Cheese contains most of the fat and protein present in the milk from which it is prepared, the whey containing the milk, sugar and the non-coagulable albumen. Cheese prepared from full-cream milk, therefore, has a high nutritive value, the composition being, approximately, Water 32, Fat 35, Protein 28 per cent. Cheese made from skimmed milk contains less fat and tends to be tough, dry and leathery, and to counteract these tendencies more water is usually incorporated in it. Some varieties are made from partly skimmed milk.

9. The passing off of skimmed milk cheese and of margarine cheese as full-cream cheese or genuine cheese is the form of adulteration most likely to occur. Margarine cheese is cheese the fat of which has not been derived from milk, but from cocoanut oil or similar sources.

Such cheese is required by law to be marked " Margarine cheese " ; there is at present no legal minimum limit of fat content.

10. Cheese is sampled by a cheese trier. As soon as the plug is removed it should be passed under the nose to detect the odour, and examined as to compactness and colour. A portion of the plug is used to close the hole made, and the remainder is tasted for flavour and rubbed between the fingers to ascertain the texture.

11. Cheddar cheese is the type usually purchased. When cut it should have a close, solid and uniformly coloured interior, a pleasant mild aroma, and a smooth texture free from hard particles.

12. Deficiency in fat content is the chief cause of rejection of cheese.

Shrinkage in Store

13. Loss of weight, either through the exudation or the evaporation of moisture, is inevitable with all varieties of cheese even after the actual process of manufacture is completed. The higher the moisture-content of the cheese, the greater the tendency to lose weight in store. Over a given storage period

the loss is therefore likely to be greater with the soft cheeses than with the hard varieties.

14. The rate of evaporation of moisture from cheese is determined mainly by the temperature and humidity of the atmosphere, and the texture and size of the cheese. A high storage temperature not only accelerates evaporation but also causes the running of butter-fat from the cheese, to the serious detriment of its quality. Evaporation is also accelerated by a dry atmosphere, excessive mould growth, and faulty ripening. Cheeses of open texture tend to lose weight in store to a greater extent than those of close texture. Thus, evaporation is greater with Cheshire cheese than with Cheddar. Shrinkage in store is generally greater in the smaller cheeses owing to their relatively greater surface area.

15. It is impossible to generalize as to the rate of shrinkage in different varieties, but the normal loss in weight of mature cheese in store is generally accepted as being 1 per cent. a month in the case of Cheddar, and up to 2 per cent. a month in the case of Cheshire. For freshly made cheese, the rate of shrinkage is much greater. Cheshire cheese, for example, may be expected to lose about 6 per cent., and white Stilton and Wensleydale 20 per cent., of weight in the first two months after making. September made cheeses of the hard varieties shrink less in storage than those made earlier in the year, a fact which is only partly due to the lower temperatures ruling when they are in store.

16. In tropical climates the percentage of loss will vary according to type of cheese, season and length of time between packing and issue.

Unwaxed cheese may lose 6 per cent. or more in weight in tropical climates.

Waxing Cheese

17. In order to reduce the loss by evaporation some cheeses are waxed; this is done by dipping the cheese in melted paraffin at a temperature of about 220° F. for six seconds.

The cloth is removed before a cheese is waxed.

18. The amount of wax used is small, about 2 oz. for 35 lb. of cheese; a thicker coating tends to crack and peel off.

81. *Eggs*

1. Eggs of all birds have the same structure.

Inside the shell, which is full of minute air-holes, is the membrane of skin. This is formed of delicately interlaced

fibres and appears single, but in reality is double. The two membranes separate at the larger end of the egg, forming an air chamber, the size of which can easily be seen on holding the egg up to the light, and is a very good criterion of its freshness or otherwise. When the egg is newly laid, this space is not much larger than a threepenny piece, and amounts to about one-twentieth of the total cubic contents of the egg; but as the egg is kept, the moisture evaporates through the pores of the shell, and as the fluids diminish the air chamber increases in size, so that in stale eggs it sometimes occupies a seventh part of the interior of the shell.

2. A fresh egg appears of a uniform rosy tint when held up to the light, a stale egg looks cloudy and opaque. Fresh eggs are more transparent in the centre, old eggs look more transparent at the top.

Another test is to dissolve 1 oz. of salt in 10 oz. of water and place the eggs in it. Good specimens sink, indifferent float half-way, whilst bad eggs float to the surface—even in pure water.

3. Eggs which are washed or preserved in liquid, or coated with a varnish, lose their polish. This may be noticed by simple comparison.

4. Eggs are frequently kept in fresh condition for periods up to six months at a temperature of about 30° F.

5. It is important to note that only *imported* or *preserved eggs* are required by law to be marked *on the shell.*

National Mark Eggs

6. Packers authorized by the Ministry of Agriculture may only apply the National Mark to produce which complies with the definitions of quality prescribed for the grade designations for hen eggs, namely :—

Special ..	$2\frac{1}{4}$ oz.	First quality condition, i.e. the eggs must not have been preserved by any process, the shell be clean and sound, the yolk translucent or faintly but not clearly visible, the white translucent and firm, and the air-space not more than $\frac{1}{4}$ inch in depth.
Standard ..	2 ,,	
Medium ..	$1\frac{3}{4}$,,	
Pullet ..	$1\frac{1}{2}$,,	

7. The National Mark is not applied to the eggs themselves, but to the box or carton by means of a label (*see* para. 5, above),

and eggs packed under these labels are guaranteed to have been *candled singly* before a strong artificial light within forty-eight hours prior to despatch from the packing station. Single candling is essential to guarantee high standard and to eliminate minor blemishes, e.g. small blood spots, as well as the more serious defects. For this purpose each egg is rotated sharply during candling and receives the undivided attention of the operator.

The technique of candling is explained in Marketing Leaflet No. 28, entitled " The Testing of Eggs for Quality," issued by the Ministry of Agriculture and Fisheries.

82. *Jam*

1. Jam is made by boiling fruit with sugar or with a concentrated solution of sugar in open steam jacketed pans.

The best jam is obtained from fresh fruit but, as the fruit season is short and the manufacture of jam requires the purchase of large amounts of sugar, it is usual to preserve a good deal of fruit in the form of pulp, which is converted into jam as required.

2. Fruit is pulped by placing it when quite fresh in barrels and covering with a dilute solution of bisulphite or sulphur dioxide. Fruit so preserved remains sound for long periods.

3. Jam prepared from pulped fruit does not set very well, and it is usual to add a certain amount of pectin, a sort of fruit jelly, to rectify this. There can be no objection to this so long as the addition is not made to cover up a deficiency of fruit.

4. The fruit is prepared by machinery, which removes stones from stoned fruit, tops, tails and hairs from gooseberries and stalks from currants.

5. The sugar used in manufacture amounts to about 60 to 65 per cent. of the weight of the finished jam. The proportion in Army jam is somewhat higher than is normally used, as this jam is required to have prolonged keeping properties; to ensure this the total soluble matter in the jam should be not less than 71·5 per cent., most of this being derived from the sugar.

6. *Adulterations.*—Jam from firms of repute is not adulterated, but others in order to produce cheap jams make a practice of adding apple pulp and juice, and using a correspondingly less amount of the required fruit. The adoption

of standards for first and second quality jams by the Jam Manufacturers Association should remove misrepresentation of this type.

7. *Simple tests for quality.*—The jam should be sufficiently gelatinous to retain its shape a short time after being removed from the tin. The flavour should be of a satisfactory nature and not merely one of sweetness.

8. *Analysis.*—Jam is analysed for sugar content, soluble matter, fruit fibre and extract, pectin, acid and certain other factors where necessary.

83. *Margarine*

1. Margarine is the name given to those substances prepared in imitation of, and as a substitute for, butter. It is defined legally as any substance which resembles butter, but is not milk-blended butter.

The aim of the margarine manufacturer is to produce a substance resembling butter in appearance, flavour and consistency.

2. Margarine is a nutritious food but contains little or none of the vitamins contained in butter fat, and therefore is not a complete substitute for the latter. Margarine specially vitaminized is prepared in Great Britain.

3. An outline of the manufacture is as follows :—

A suitable mixture of carefully refined oils and fats is blended warm and mixed with a trace of colouring matter, usually annatto. The composition of this blend varies with the state of the market ; but the better kinds of margarine contain a higher proportion of animal fats such as oleo oil, premier jus and neutral lard. Palm kernel oil, cocoanut oil, cotton seed oil and arachis oil are the chief vegetable oils used The melted coloured blend of oils is beaten into an emulsion with skimmed milk, soured to the exact acidity required by a carefully selected ferment. The still-melted emulsion is run in a fine stream upon rollers, kept very cold by brine circulating within, and the emulsion promptly solidifies, resembling a skin of fine chamois leather clinging to the cold roller. As the roller revolves the skin meets a knife by which it is scraped off and collected. The flaky mass of margarine is then ripened by warming slightly for the correct time, and worked in a blender to get rid of surplus water, to incorporate salt, and to obtain a butter texture. The margarine is then worked by machinery into a roll shape, cut into the required length and wrapped. The whole process

depends upon the most scrupulous cleanliness in order to secure the margarine against the access of micro-organisms which would spoil the flavour and keeping properties.

4. The Butter and Margarine Act, 1907, laid down the maximum limit of 16 per cent. for water in margarine, and made it illegal for margarine to be sold except when properly labelled as such.

5. *Storage*.—Margarine should preferably be kept in cold store.

6. *Simple tests for quality*.—Appearance, texture and flavour. The nearer these approach to butter the better the quality of the margarine.

7. *Analysis*.—Margarine is analysed for moisture, salt content and preservatives.

84. *Milk*

Fresh

1. The composition of milk is approximately as follows :—

Water	87 per cent.	
Fat	3·5 ,, ,,	Fat 3·5
Milk sugar (lactose) ..	4·5 ,, ,,	Non-fatty solids 8·75
Protein	3·5 ,, ,,	
Mineral matter (ash) ..	0·75 ,, ,,	

It also contains the vitamins necessary for growth.

The composition of milk from individual cows varies to a considerable extent according to the breed of the cow, the period of lactation, the climate, food and interval between milking.

For the purposes of the Food and Drug (Adulteration) Acts, 1928, the minimum standard for fresh milk is :

Fat	3·0 per cent.
Non-fatty solids	8·5 ,, ,,

Milk failing to reach these standards is presumed to be adulterated either by the abstraction of cream or the addition of water or skimmed milk.

2. Milk is an ideal medium for bacterial growth and, therefore, it is essential that the utmost attention be paid to cleanliness at every stage connected with its supply. Failure in this results in the rapid growth of organisms which sour the milk and may result in disease organisms gaining access to it.

Diseases which may arise or be spread through the milk supply include enteric and other intestinal diseases, diphtheria,

tuberculosis and scarlet fever. This has led to a certain measure of control being enforced as regards the suitability and cleanliness of dairying premises, and also to a spread of the practice of pasteurization.

3. In countries where there is no control, particularly in the East, the ordinary milk supply is dangerous.

4. *Adulteration.*—The chief forms are the removal of cream and the addition of water or skimmed milk.

An analysis is necessary to detect skilful adulteration, and in cases of doubt the cows may be milked before an inspector and the known genuine supply be analysed.

5. *Preservatives.*—Boric acid and formalin were formerly added to milk to delay the souring, but such additions are not now permitted in Great Britain, although not necessarily prohibited abroad.

6. *Skimmed milk* is milk from which has been removed only that amount of cream which rises to the surface after it has stood for some time; it still retains from 1 to $1\frac{1}{2}$ per cent. of fat.

Machine skimmed or separated milk is that from which almost the whole of the cream has been removed by machinery; it retains less than $\frac{1}{4}$ per cent. of fat.

Condensed Milk

7. Condensed milk is made by evaporating under a partial vacuum full-cream or machine-skimmed milk with or without the addition of sugar. Condensed machine-skimmed milk is not used in the Army.

An outline of the manufacturing process is as follows :—

On arrival at the condensery, the milk is rapidly examined and, if satisfactory, bulked in large tanks. A representative sample is then carefully tested, as, unless the acidity natural to milk is extremely low, curdling would ensue in the later stages of manufacture. It is then pasteurized and the hot milk (if sweetened condensed milk is required, together with the necessary sugar) is drawn into the vacuum pan. This is a large enclosed vessel, heated by steam, in which a partial vacuum is maintained by means of an exhaust pump. This vacuum causes the milk to boil at a comparatively low temperature, and evaporation is continued until it has been reduced to about one-third of its original volume. The exact point at which to stop condensation requires considerable skill and experience.

After the milk is condensed, it is cooled, filled into tins and sealed. In the case of the unsweetened product, the

condensed milk is homogenized before the cans have filled, in order to prevent fat separating, and the filled tins are sterilized in an autoclave to destroy organisms which are still present in the milk.

After cooking, the tins are cooled to about 90° F. and kept at that temperature for some days in order to detect any which have escaped sterilization. These tins become " blown " and are picked out and destroyed, together with any which are imperfectly sealed.

Sweetened condensed milk manufacture is similar in technique to that of unsweetened, but final sterilization is unnecessary, as the added sugar preserves the milk from fermentation.

The finished products contain all the solids of the original milk and only water is removed. With the exception of sugar to the sweetened variety, nothing is added.

8. The Condensed Milk Regulations, 1923, prescribe that full-cream sweetened or unsweetened condensed milk shall contain a minimum of 31 per cent. of total milk solids, of which not less than 9 per cent. shall be milk fat. These Regulations also require the label of the tin to state the equivalent of the contents in pints of milk, and for this purpose " milk " is stated to mean milk which contains 3·6 per cent. of milk fat and 12·4 per cent. total milk solids including the fat. The standard is thus higher than that adopted as the minimum for fresh milk.

9. *Adulteration.*—This product is not adulterated at the present time and the produce of well-known British firms can usually be relied upon as conforming to the legal standards of the country where it is sold.

10. *Simple tests for quality.*—The tins should not have a blown appearance. When the tin is shaken, the contents should appear to be liquid. The milk should be of a creamy colour, free from lumps and should pour smoothly from the tin. The odour and flavour should be satisfactory. Spring milk is slightly abnormal, and condensed milk prepared at this time of the year has a greater tendency to thicken. If such milk mixes satisfactorily with warm water and with tea, there is little real fault to be found with it.

11. *Analysis.*—Condensed milk is analysed for the amount of fat, total solids, equivalence of the contents in terms of milk, and the extent of metallic contamination. Samples are also incubated at 100° F. for a week to observe the keeping properties.

A typical analysis is :—

Net weight	12·5 ounces
Milk solids	31·5 per cent.
Fat	9·4 ,, ,,
Ash	1·93 ,, ,,
Equivalent	1·54 pints of milk.
Tin	0·3 grains per pound
Copper	3·9 parts per million
Lead	Nil.

Dried Milk

12. Dried milk is cow's milk which has been deprived of all but 2 to 3 per cent. of water, the result being a more or less dry powder containing all the solids of the milk.

Dried milk is preferable to an uncontrolled fresh milk supply.

13. The usual commercial preparations are :—

i. Dried machine separated milk containing about 1 per cent. fat.

ii. Dried half-cream milk containing about 15 per cent. fat.

iii. Dried full-cream milk made from fresh whole milk, containing from 27 to 30 per cent. fat.

14. In one drying process, the milk is condensed in a vacuum to a certain degree, and then, without cooling, is filtered and pumped through a fine nozzle into a chamber through which hot dry air circulates. The milk spray falls as a dry powder on the floor of the drying chamber and does not require any breaking up, grinding or sieving.

In another process, the milk is passed between two hot revolving cylinders, and the water of the milk is quickly evaporated, leaving a thin sheet of dried milk which is removed by knife blades adjusted to scrape off the deposited film. This is subsequently broken up and sieved to give a uniform granular powder.

15. The sale of dried milk is regulated by the Public Health (Dried Milk) Regulations, 1923, which fixes a minimum fat content for full-cream dried milk at 26 per cent., and which, in the case of partially skimmed milk, demands a declaration affixed to the packet to that effect.

16. Dried milk is reconstituted by dissolving the powder in warm water, the fluid thus obtained resembling fresh milk, and the most satisfactory results are obtained by following the instructions of the manufacturers in making the solution.

17. A more complicated, but better, method of reconstituting milk is with a machine known as an emulsifier. When an emulsifier is available, it is usual to employ skim-milk powder and fresh butter in the reconstituting process. The disadvantages are that electrical or steam power is required to work the emulsifier, and cold storage is necessary to keep butter in sound condition any length of time, especially in warm climates. Only fresh unsalted butter can be used.

18. *Storage.*—If kept long, especially if not stored in a very dry place, dried milk packed in paper or cardboard is inclined to acquire an unpleasant taste and tallowy odour, due to rancidity beginning in its fat contents, or possibly to oxidation changes in the fat globules.

19. *Simple tests for quality.*—The readiness with which the powder mixes with water to give reconstituted milk; the appearance and flavour of the product.

20. *Analysis.*—Milk powder is analysed for fat content and moisture.

85. *Rice*

1. Rice is the staple food of the Eastern races; it is grown largely in India, Burma, China, Japan, the Indies and the Southern States of America.

2. Rice is threshed in the manner of wheat, and after threshing is known as paddy. The seed is covered with a hard gritty husk and needs decorticating before it is fit for consumption.

3. Native milled rice usually contains the germ of the seed, but the rice shipped to Europe is whiter and has had the germ removed. Where rice is the main article of the diet, it is necessary to retain the germ, otherwise beri-beri will occur owing to vitamin deficiency.

4. Rice is inferior to other cereal grains in food value. It contains a high proportion of carbohydrate, but is low in protein and fat. Its composition is approximately :—

Starch	80 per cent.
Protein	7 ,, ,,
Fat	0·5 ,, ,,
Mineral matter	0·5 ,, ,,
Water	12 ,, ,,

5. There are many varieties of rice, the best being the large grained varieties. Patna, a long hard grain, has good keeping properties. Burma supplies a large amount of rice to the British market.

6. The quality of rice is judged by the size of the grain, the colour and the freedom from broken grains and from grains with husk adhering to them. Dust in rice indicates the presence of weevil.

7. Rice is ground into flour, in which form it is used for a variety of culinary purposes. Coarse ground rice is sold as "rice cones" for use as a dusting powder in bakeries.

8. Rice is sometimes polished by the use of a little oil. This renders the grain slightly more translucent and is thought to improve the appearance.

9. Rice should be unpolished, of good quality and colour, clean, sound and free from grit and impurities. The moisture should not exceed 13 per cent.

86. *Rum*

1. Rum is a spirit distilled from the fermented juice of the sugar cane and of coarse molasses, and is imported mainly from the West Indies. It is shipped to Great Britain at a strength of about 40 degrees over proof and is broken down at the Supply Reserve Depot to a strength of about 4·5 degrees under proof. The rum issued to the Army is therefore a relatively strong spirit, compared with the ordinary spirit of commerce, e.g. whisky usually sold being 30 degrees under proof.

2. Rum is coloured by the addition of a small amount of caramel (burnt sugar) usually to a dark brown shade, but the depth of the colour is no criterion of the quality of the rum.

3. It should be free from any foreign flavour, should be clear, and on the addition of water should not go cloudy.

4. Rum is issued in cases, each containing two 1-gallon jars well packed in shavings. To prevent pilfering the ends of the band of hoop iron round the centre of the case are joined by a wire and the wire sunk in a wax seal impressed, "Supply Reserve Depot." The corks of the individual jars bear the same impression.

The gross weight is stencilled on each case as well as the date of overhaul at the Supply Reserve Depot.

Proof Spirit

5. The strength of "proof" spirit is fixed by Act of Parliament as a spirit which weighs exactly $\frac{12}{13}$ths that of an equal volume of distilled water. At 51° F. such a spirit contains 49·3 per cent. of alcohol by weight, and 50·7 per cent. of water.

Duty is levied at so much a " proof " gallon ; a spirit which is 25 degrees over proof would require the addition of 25 parts of water to 100 of the spirit to reduce it to the strength of proof spirit.

6. The strengths of spirits used in the Army are laid down in the Handbook of Specifications for Supplies.

The strength of distilled spirits may be determined with fair accuracy with a hydrometer.

A special type, termed a Sikes hydrometer, is used by the Excise authorities. When special accuracy is needed the strength of spirit is determined by distillation methods.

Owing to the amount of sugar and other extractives in beer and wine, the alcholic strength cannot be determined from the specific gravity.

87. *Salt*

1. Salt occurs in nature principally in two forms :—

   i. Rock-salt.
   ii. Salt found in various inland seas, salt lakes, pools, marshes, etc.

Salt is prepared from both these sources, but common salt for domestic use is chiefly manufactured from brine pumped up from rock-salt strata.

2. Natural brines occur in Austria, France, Germany, India, the salt lake of Utah in the United States, and the Dead Sea. In England they are to be found in Cheshire, Lancashire, Yorkshire, Worcestershire and from deep boring in Staffordshire, Derbyshire and Midlothian.

3. *Rock-salt* is first dissolved in water, in order to get rid of impurities; artificial heat is then applied to evaporate the water and cause crystallization.

If the salt occurs in the solution in the proportion of 20 parts salt to 100 of water, artificial heat is at once applied to evaporate the water; but, if the salt occurs in a less proportion, natural evaporation is allowed to take place before the application of artificial heat.

4. The size of the crystals of salt on the grain of the salt depends upon the temperature at which the brine is evaporated.

5. *Fine salt* is prepared by boiling the brine in relatively small pans and raking out the salt frequently. Vacuum evaporators are often employed. *Common salt* and the larger grained fishing salt are made by evaporating the brine in larger pans and removing the salt less frequently; the longer the salt is in the brine the larger are the crystals.

The salt crystals are dried in special drying rooms after they have been removed from the pans or evaporators.

6. Good salt should be fine grained, white, dry and entirely soluble in water.

88. *Sugar*

1. Sugar is a natural constituent of the juice of many plants, but only two sources are of commercial importance, (i) the sugar cane, (ii) the sugar beet. The juice of the sugar cane contains 14 to 20 per cent. of sugar and beet juice 16 to 18 per cent. The yield of sugar an acre is much higher with cane than with beet, e.g.

Java variety, P.O.S. 2878 ..	6·8 tons
Hawaii	4–5 ,,
Cuba	2–2·5 ,,
Europe beet sugar	1–2 ,,

2. The sugar cane is cultivated in the West Indies, the East Indies and the Southern States of America. The canes are cut close to the ground, the leaves removed and the juice obtained by crushing the canes between rollers, the residual juice being extracted with water to remove the rest of the sugar. The juice is strained, heated with lime and filtered to remove various impurities. The clarified juice is evaporated in vacuum pans until crystals form; these are removed by centrifugals. The products obtained are raw sugar shipped to Great Britain for refining, or raw centrifugal sugar for direct consumption, e.g. Demerara together with molasses. Rum is made from the molasses in the West Indies.

3. The raw sugar is refined on the same principles as beet juice is treated after the first clarification.

4. The first stage in the process of obtaining sugar from beet is somewhat different from the above.

The washed beet are sliced by machinery and the slices treated with water in a series of diffusion cells; the sugar in the juice passes into the water until the slices are exhausted.

The diffusion juice is next treated with milk of lime, carbonated with CO_2 and filtered. The clean juice is concentrated, given a further treatment with lime and decolorized with charcoal.

The clear liquor is concentrated in vacuum pans until crystals form. The crystals are separated from the liquor by centrifugals, steamed and dried in a granulating machine, and delivered into 2-cwt. bags.

The process in the modern beet-sugar factory is automatic and continuous, the residual products being the beet pulp

and a quantity of molasses from which no more crystallizable sugar can be obtained. The molasses are used by yeast factories and for the manufacture of methylated spirit.

The beet-sugar factories usually produce granulated sugar only.

5. *Cube sugar* is made by running the sugar into moulds before drying and leaving it to set.

Castor sugar is fine granulated sugar.

Icing sugar is powdered granulated sugar.

Moist white sugars are second quality sugars, granulated from the later crystallizings of the liquor.

Golden syrup is usually prepared from ordinary sugar by converting about half the cane sugar to invert sugar.

Treacle is a higher-grade syrup than molasses.

Brown sugar, used for certain commercial purposes, consists of the end sugars separated by the evaporation process.

White granulated, castor and loaf sugars are about 99·9 per cent. sugar, the remainder being chiefly moisture. They are thus one of the purest of foodstuffs and are rarely adulterated.

Glucose is a carbohydrate allied to cane sugar. It occurs naturally in fruit juices and in honey. It is manufactured by the action of heat and acids on any starchy material. It comes on to the market either as solid lumps practically free from water, or as a thick syrup, and is used in brewing as a source of fermentable sugar.

6. Sugar should be white, clean, dry and entirely soluble in water.

89. *Tea*

1. Tea consists of the young shoots and leaves of the tea plant, a shrub cultivated largely in India, Ceylon, Java and China, and also grown in other sub-tropical climates.

The bulk of the imports to Great Britain are from the first three of the above countries, that supplied to the Army being Indian or Ceylon.

2. The tea plant is cultivated from seed in a nursery and transplanted into the garden when about one foot high ; the plucking of the leaves commences when the plant is three years old. The plant is carefully pruned to keep it to the size of a low shrub and to give the maximum number of shoots.

The plucking is carried out every two or three weeks, and after plucking the leaves are taken to the factory for manufacture.

3. The process of manufacture consists of :—

   i. *Withering.*—The leaves are spread on tiers of wire mesh trays in well-ventilated sheds, which dries out a fair proportion of the moisture in the leaf and prepares the leaf for

   ii. *Rolling.*—The rolling is done in a machine. This process expresses the juice, which can then be exposed to the air in the process of

   iii. *Fermenting.*—The rolled leaf is spread on tiles in cool well-ventilated rooms and left to the action of the air, the colour of the leaf changes and the aroma and flavour of the tea improve.

   iv. *Firing.*—The leaf is fired immediately after fermenting. The firing dries up the juice and the leaf becomes crisp and twisted, and is now the finished article.

4. Tea is graded before packing into one of the following descriptions :—

   i. *Unbroken teas :—*

      (*a*) Flowering Orange Pekoe, tip and finest leaf.
      (*b*) Orange Pekoe, finer leaf and some tip.
      (*c*) Pekoe, larger twisted leaf.
      (*d*) Pekoe Souchong and Souchong, largest leaves.

   ii. *Broken teas :—*

      (*a*) Broken Orange Pekoe, bits of fine leaf and tip.
      (*b*) Broken Pekoe, bits of fine leaf.
      (*c*) Broken Souchong } milled largest leaves.
      (*d*) Broken tea }
      (*e*) Fannings, small bits of leaf.
      (*f*) Dust, powdered tea.

5. Tea is stored in air-tight tins, and before packing is finally fired to ensure its dryness.

6. *Bulking.*—Different lots of the various grades are mixed at the factory to ensure uniformity of character and quality, and are then packed in metal-lined chests for export. Large coarse leaves are milled or cut before packing.

The chests bear the garden mark, a consecutive number and the net weight.

The net weight is usually from 100 to 135 lb.

7. Tea is purchased for army supply in original chests and is not a blended tea. The tea sold retail is usually a blended mixture.

8. *Valuation.*—The valuation of tea is carried out by tea experts. Its quality may be approximately determined in the following way :—

i. The leaves or pieces of tea should be even in size, neither too large (Souchong) or too small and fine (fannings).
ii. The leaf should not contain any dirt, or an undue amount of stalk or dust.
iii. The leaf should be free from any musty or other objectionable odour.

THE LIQUID

9. The tea should be made into liquor, tea infusers being used where available. Where these are not available, ordinary cups may be used. Boiling water is poured on about a sixpence weight of the tea, the cup covered with a saucer, allowed to stand five minutes and the liquor decanted from the leaf. The liquor is tasted without and with the addition of milk.

10. The liquor should be a bright red brown and fragrant. It should not be dull, without any perceptible aroma or flavour.

No foreign odour or flavour should be present and the liquor should not appear unduly thin or washy on the addition of milk.

11. The value of tea is based not only upon the grade but largely upon the character, which depends on the climate and soil.

12. *Allowance.*—It is the custom in the tea trade to allow 1 lb. in each case of tea, i.e., if the case is marked 101 lb., only 100 lb. is charged, but duty is payable on the full weight.

90. *Indian supplies*

1. *Atta.*—This is flour or meal prepared from wheat.

Atta should be clean and free from grit, the produce of good, sound, sweet and dry, hard Indian wheat ; it should be in good condition, with 16 per cent. of bran removed, be free from adulteration and fit for shipment abroad or for storage.

It should contain not less than 8 per cent. of gluten, and the proportion of moisture should not exceed 13·5 per cent.

2. *Dhall.*—This is a kind of pulse or split pea much used in India, both by Indians in a sort of porridge, and by Europeans to mix with rice as a breakfast dish.

When cooked it should have a pleasant taste and be free from smell. The percentage of moisture should not exceed 13·5 per cent., and it should not contain more than 3 per cent. of foreign grain and dirt combined.

3. *Ghi.*—This is the clarified butter largely used in India. Butter does not keep in sound condition in hot climates because of the water and curd it contains.

Ghi is prepared from butter by heating to remove the water and straining through muslin to remove the curd. The fat is run into bottles and corked down.

The heating destroys the bacteria and the fat keeps in an edible condition for a much longer period than does butter itself. Ghi is distasteful to Europeans but is highly prized by Hindus and is undoubtedly a valuable foodstuff.

Ghi purchased for the use of Indian troops should be bought under a guarantee of purity and of freedom from vegetable oil.

It should be made from pure butter fat only and be free from all adulterants. It should be of pleasant taste and smell in its normal state, and when boiled be of good appearance, clean and free from all excess of acid.

In India a common test is to rub a small quantity of ghi, which has been boiled, on the back of the hand. If the smell is musty or oily this is regarded as proof of adulteration. A common adulterant is cocoanut oil.

4. *Gur.*—This is an unrefined sugar manufactured from sugar cane during the current season. It should be pleasant in taste and smell, free from mouldy growth, fermentation or any adulteration.

The percentage of moisture should not exceed 10 per cent.

A good gur is of light brown colour, free from dust or fibre.

CHAPTER VI

COMPOSITION OF FOODS

(*See also* "Analysis and Energy Values of Foods," published by H.M.S.O.)

91. *Choice of foods*

1. The choice of proper foods and the quantities of each which should be embodied in the ration are matters of supreme importance to the health of the Army.

Experiments have shown that stamina and resistance to climatic conditions and disease depend very largely upon a proper and sufficient diet.

A knowledge of the general principles underlying the selection of the items which form the scales of rations for the Army is therefore essential for every R.A.S.C. officer.

2. Food has two principal functions, namely, to give energy and warmth, and to replace the worn-out substance of the body. These functions are known as katabolism (the breaking down of foods and tissues) and anabolism (the building up of the cells of the body).

3. The amount and kind of food required varies according to the climate and the amount of work the troops are required to perform.

It is possible scientifically to measure the work output and heat losses which take place under any particular condition of service, and with this information available to draw up the various ration scales which will be most suitable for the Army under every circumstance.

92. *Classification of foods*

1. The substances in a diet may be classified under :—

i. True foods, both organic and inorganic.
ii. Accessory factors.
iii. Adjuvants.

Organic True Foods

2. These comprise (i) nitrogenous foods; (ii) non-nitrogenous foods.

i. *Nitrogenous foods*—

(*a*) *Proteins*.—These are organic substances containing carbon, hydrogen, nitrogen and frequently sulphur and

phosphorus. They nourish and repair the tissues of the body and are the chief body building material.

Unlike fats and carbohydrates, proteins are not stored in the body, which merely absorbs sufficient to meet the daily requirements, i.e. repair of tissues, and any excess over and above this is excreted.

(*b*) *Extractives or flavouring material.*—These are organic nitrogenous substances which assist the body in making use of the food.

ii. *Non-nitrogenous foods*—

(*a*) *Fats*—These are organic non-nitrogenous substances which contain carbon, hydrogen and oxygen only. In this respect they are similar to carbohydrates, but differ from them in having less oxygen in proportion to hydrogen.

Fats are stored in the body as a depot of reserve energy and as sub-cutaneous fat to prevent loss of body heat.

(*b*) *Carbohydrates.*—These are organic non-nitrogenous substances which contain carbon, hydrogen and oxygen only. The hydrogen and oxygen are in the same proportions to each other as they are in water.

The carbohydrates met with in food are *soluble* and *insoluble*. *Soluble carbohydrates* consist of *sugar* (found in cane sugar, dried fruits, treacle, syrup, jam, sugar, etc.), and *dextrins* (found in cooked and partially digested starchy foods, such as browned crust of bread, malt extract, etc.).

Insoluble carbohydrates consist of *starches* (found in flour, bread, cereals, etc.) ; *cellulose* (the indigestible fibre in vegetables, bran, etc.), and *glycogen* (the form in which sugars are stored in the animal body, i.e. in the liver).

(*c*) *Vegetable acids.*—These are converted in the body into alkaline bicarbonates which help to maintain the alkalinity of the body fluids.

Inorganic True Foods

3. These consist of :—

i. *Water.*—This maintains the proper dilution of body fluids, flushes the body of its impurities, and assists in the dissipation of excess heat.

ii. *Mineral matter.*—This is composed of the inorganic salts present in the foods which form the unburnable residue or ash when the food is incinerated. The mineral salts play an important part in nourishing and repairing the tissues, especially bone. For example, lime salts and phosphates are required for hardening the teeth and bones.

Accessory Factors

4. *Vitamins.*—There are five well-defined vitamins, but recent investigation shows that some of these can be further resolved into two or more component vitamins.

5. The vitamins which are most commonly referred to are as follows :—

i. *Vitamin "A"* (fat soluble).—This vitamin promotes growth and resistance to infection. It resists heat but not oxidation. Foods rich in Vitamin "A" are cod-liver oil; milk, butter and cream (if from pasture fed cows); egg yolk; green vegetables (such as cabbage, spinach, lettuce, cress), carrots (although other root vegetables contain little).

ii. *Vitamin "D"* or antirachitic vitamin (fat soluble).—This differs from the other known vitamins in that it can be built up in the body by exposing the skin to the ultra-violet rays of the sun or of the mercury vapour lamp. It can be produced artificially in concentrated form and introduced into foods deficient in this factor: for example, margarine can be given a Vitamin "D" content equal to that of fresh butter. Natural foods rich in Vitamin "D" are cod-liver oil; egg yolk; milk, butter and cream (if from pasture fed cows). For a long time cod-liver oil has been given in the treatment of rickets, a disease which results from an absence of Vitamin "D."

iii. *Vitamin "B"* (water soluble).—This vitamin is essential for normal nutrition; it maintains weight and prevents beri-beri.

It occurs in many natural foodstuffs such as eggs, nuts, milk, wholemeal flour, whole barley, oatmeal, rye, wheat germ, liver, peas, beans, lentils and carrots. It also occurs in very large amounts in yeast.

Vitamin in concentrated form may be obtained under various proprietary names, among which the preparation known as Marmite, is excellent.

It is found in the outer covering of the wheat berry, but not in the endosperm, hence its absence from white flour. It is also absent in white rice, sago and canned meats.

iv. *Vitamin "C"* (anti-scorbutic).—This is another water soluble vitamin. It prevents scurvy, weakness in the joints, and loosening and falling out of the teeth. It is present to a great or lesser extent in all fresh raw foodstuffs. Foods rich in Vitamin "C" are green vegetables and fresh fruits, particularly cabbage, cress, lettuce, tomatoes, oranges, lemons and grape fruit. It is also present in definite amounts in potatoes and onions, even after storage for many months; and in raw

fresh meat juice. Sprouted pulses contain large amounts, a fact of which advantage was taken in Mesopotamia in 1916 and 1917 to prevent scurvy among the troops. It is not present in butter, beef fat, cheese, eggs, rice and beans.

It is very sensitive to heat; therefore cooking has a harmful effect. The longer the cooking the worse the effect; boiling for a short period is less harmful than slow cooking at a lower temperature. Cabbage cooked at 80° to 90° C. loses 90 per cent. of its Vitamin C.

Food Adjuncts

6. These consist of :—

i. *Stimulants.*—These act as tonics to the digestive system; examples of stimulants are: (alkaloidal) tea, coffee, etc., and (alcoholic) rum, beer, etc.

ii. *Condiments.*—These promote appetite and assist digestion; examples are: mustard, pepper, vinegar, salt, etc.

iii. *Residues.*—These provide the bulk necessary for evacuations.

7. No single component can support life except for a very short period, and all ordinary foods are composed of a mixture of these components in varying proportions.

8. The careful selection of the items and the regulation of the quantities to ensure that these components are present in the correct proportions are points of extreme importance in the drawing up of any ration scale.

93. *Energy value of food*

1. All energy can be expressed in terms of heat, and the energy value of a food is usually estimated in calories. A "calorie" is the amount of heat required to raise 1 c.c. of water through 1° C. A thousand calories are taken as the unit in estimating the value of a ration, and this unit is known as a "Kalorie."

When properly utilized in the body each ounce of fat produces about 264 Kalories of energy, and each ounce of protein or of carbohydrate produces about 116 Kalories. If the composition of a food is known, the number of Kalories which will be supplied in the body by, say, 1 lb. of the food can be calculated. (*See* Table II, page 174.)

Example.—A food contains 15 per cent. of protein, 2 per cent. of fat and 52 per cent. of carbohydrate. What is the Kalorie value a pound ?

100 oz. will contain 15 oz. of protein 2 oz. of fat, and 52 oz. of carbohydrate.

15 oz. of protein	$= 15 \times 116 =$	1,740 Kalories.
2 oz. of fat	$= 2 \times 264 =$	528 ,,
52 oz. of carbohydrate	$= 52 \times 116 =$	6,032 ,,
Therefore 100 oz. of the food	$=$	8,300 ,,

Therefore 1 oz. = 83 Kalories.

Therefore 1 lb. = (83 × 16) = 1,328 Kalories.

94. *Essentials for a satisfactory diet*

A satisfactory diet or ration must conform to the following requirements :—

i. *Sufficient protein.*—The daily amount required by a man doing moderate work is from 100 to 120 grammes = 3·5 to 4·2 oz. Animal protein is more readily absorbed, and therefore more valuable than vegetable protein. Thus, beef containing 15 per cent. of protein is a better protein food than lentils containing 24 per cent. of protein.

ii. *Adequate energy production.*—The energy (calorific) value required in a diet varies according to the amount of work done, or energy expended in other ways. An average man doing moderate work requires 3,700 Kalories daily, but during periods of hard work, e.g. under forward conditions on active service, the daily need may rise as high as 4,800 Kalories. Cold weather demands an increased Kalorie value in the diet in order to maintain body heat. The necessary daily amount of protein (*see* above) furnishes 492 Kalories and the remainder required is obtained from fat and carbohydrate. Sufficient fat should be included to furnish at least 25 per cent. of the total daily Kalories, the balance being obtained from carbohydrate. As a working basis the relative proportions of protein, fat and carbohydrate can be calculated on the ratio of 1 : 1 : 4 or 5, assuming the protein amounts to 100 grammes or 3½ oz. Where daily work involves great exertion, especially in cold climates, fats may supply up to 40 per cent. of the total daily Kalories.

iii. *Sufficient mineral matter.*—An ordinary mixed diet will always contain sufficient mineral matter (with the exception of common salt) for an average man. Common salt is the only mineral substance intentionally added to a diet, and a minimum daily allowance of ¼ oz. is required.

iv. *Presence of vitamins.*—These are irregularly distributed in various foods. They vary in their resistance to drying

and heat (B is the most, and C is the least stable), and are therefore frequently absent from tinned or dried foods. A diet deficient in vitamins will inevitably result in ill-health or disease.

As a rough-working standard, an active service ration should have at least 30 per cent. of its total weight (week by week) provided by foods which contain vitamins.

v. *Variety.*—A diet may contain the requisite amounts of all necessary components, may possess adequate energy value, and will yet be undesirable if it lacks variety. Monotony rapidly destroys the value of an otherwise sufficient ration.

vi. *Economy.*—Owing to variations in the amounts of refuse and of water in various foods, the true cost of an article of food should not be expressed as cash per lb., but as cash per oz. of protein or per Kalorie, i.e. comparative costs must be based upon comparative nutritive values.

95. *Proportion of refuse*

Practically all foods, as purchased or issued, contain some non-edible material (e.g. gristle in meat, outside leaves of vegetables), and the amount must always be taken into account in fixing any ration scale (*see* Table I, page 173).

96. *Opinion upon a ration*

In estimating the adequacy of a ration scale, the following procedure should be adopted :—

i. From Table I (page 173) obtain the net ration, i.e. gross amounts less refuse.

ii. From Table II (page 174) calculate the daily amounts of protein, fat and carbohydrate in the net ration ; and, using the factors given in Sec. **93**, calculate the number of daily Kalories supplied by each component, the sum giving the total daily Kalories.

iii. Note the daily amount of protein and whether it is sufficient.

iv. Note the sufficiency of the total daily Kalories, and whether an adequate percentage of these is obtained from fat.

v. Note whether a sufficient issue of salt is included.

vi. Note whether the ration appears to contain an adequate vitamin content.

vii. Note whether the scale will afford a varied diet.

97. *Ration scales*

1. Scales of rations at home in peace are laid down in Regulations for the Allowances of the Army, and for stations abroad in the local allowance regulations.

2. For examples of ration scales in the field, *see* Regulations for the Allowances of the Army.

98. *Emergency ration*

1. The purpose of an emergency ration is to bridge a gap, on isolated occasions only, of not more than twenty-four hours, in the normal delivery of supplies.

2. For this reason emergency rations are marked :—

i. Not to be opened except by order of an officer.

ii. To be consumed only when no other rations of any kind are procurable.

3. A suitable emergency ration should fulfil the following conditions :—

i. Be light and occupy as small a space as possible, yet strong enough to resist damage under active service conditions.

ii. Be of a convenient shape, suitable for carrying in the haversack.

iii. Should not deteriorate if kept for long periods.

iv. Should not be unduly thirst-producing.

v. Should be capable of being made into a beverage if required.

TABLE I

Proportion of Waste (Non-Edible) Material in various Foods as Purchased

Food	Non-edible
Side of beef	20 per cent. of weight.
Carcase of mutton	20 ,, ,, ,,
Side of bacon	14 ,, ,, ,,
Dressed fowl	26 ,, ,, ,,
Rabbit (skinned and dressed)	27 ,, ,, ,,
Fish (average)	45 ,, ,, ,,
Eggs..	11 ,, ,, ,,
Potatoes	8 ,, ,, ,,
Cabbage	40 ,, ,, ,,
Turnip (less leaves)	13 ,, ,, ,,
Carrots	20 ,, ,, ,,
Pumpkins	34 ,, ,, ,,
Oranges	26 ,, ,, ,,
Bananas	43 ,, ,, ,,

TABLE II

Approximate Composition and Calorific Value of the Edible Portions of some Common Foods (Average Samples)

Commodity (1)	Lb. (2)	Protein Grammes (3)	Fat Grammes (4)	Carbo-hydrate Grammes (5)	Kalories (6)
Apples, rings, dried ..	1	4·1	2·7	266·3	1,134
Bacon	1	43·1	247·7	—	2,480
Barley	1	31·7	3·6	362·4	1,650
Beans, butter, dried ..	1	84·4	3·2	282·1	1,532
,, haricot, large ..	1	75·7	7·7	278·1	1,522
Beef, frozen	1	80·7	107·5	—	1,331
Bloaters	1	73·5	44·4	—	715
Bread	1	32·7	0·9	218·2	1,037
Butter	1	—	370·0	—	3,442
Cheese	1	116·6	158·8	14·1	2,011
Dates	1	7·3	0·4	316·2	1,330
Flour	1	50·3	5·9	345·2	1,676
Herrings, fresh	1	65·8	47·2	—	709
Jam	1	1·4	—	314·8	1,296
Kippers	1	70·8	65·3	—	898
Lentils, split red	1	91·2	1·8	289·8	1,579
Liver, ox	1	90·3	14·5	20·0	587
Margarine	1	0·9	384·7	—	3,579
Milk (pint)	—	18·7	20·4	27·2	378
,, condensed (unsweetened)	1	43·2	41·6	49·6	768
,, dried, whole ..	1	110·1	109·8	159·2	2,126
,, ,, skim	1	120·2	54·9	204·1	1,838
Mutton	1	56·2	188·2	—	1,981
Oatmeal, coarse	1	55·8	37·2	317·1	1,875
Oats, rolled	1	59·4	29·5	315·2	1,809
Onions, Spanish	1	2·7	0·3	20·9	99
Peas, split green	1	100·2	3·6	283·0	1,605
Pea flour	1	99·3	6·3	291·2	1,660
Potatoes	1	8·6	0·2	89·8	406
Prunes	1	13·6	1·4	193·2	861
Rice	1	26·8	1·8	364·2	1,620
Salmon, tinned	1	88·48	33·6	—	688
Sugar	1	—	—	453·6	1,860
Syrup (golden)	1	1·4	—	346·6	1,427
Tripe	1	72·9	9·44	—	382
Vegetables, green (average)	1	8·13	0·71	23·3	136
,, root (average)	1	5·57	0·62	35·01	172

1 oz. = 28·35 grammes.

CHAPTER VII

CANNING

(For detailed specifications of all canned supplies, *see* Handbook of Specification for Supplies.)

99. *General*

1. A considerable proportion of the items of supplies issued to the troops, particularly on service, is packed in cans. A sound knowledge of the process of canning, the materials used, and the inspection of the finished product is therefore essential.

2. Canning is a method of preserving foods by enclosing them in an hermetically sealed container, and heating the closed container to a high temperature for a certain length of time.

3. The heating, termed processing, sterilizing or cooking, destroys the micro organisms in the foodstuff and the hermetic sealing prevents the access of fresh organisms. Food preserved in this manner remains sound and fit for consumption for very long periods.

4. The temperature of sterilization and the length of time the container is heated is varied according to the nature of the contents and the size of the can. Meat products are more difficult to sterilize than vegetables, and vegetables more difficult than fruit.

5. While the process of canning foodstuffs varies with the commodity treated, certain principles are observed in all forms of canning, namely, the articles to be canned should be of suitable quality, fresh and clean; they should be packed into sealed containers and thoroughly sterilized after packing; the containers should be of a suitable type and material; the original flavour and nutritive value of the articles should not be affected unduly.

100. *Meat canning plant and process*

The following is a brief description of a typical canning plant.

1. The plant consists of five stories, and is built of concrete, no wood entering into the construction.

The plant can deal with 10,000 sheep and 5,000 steers a day, and employs about 4,000 hands.

2. Absolute cleanliness is maintained throughout. A large number of employees spend their day sweeping up on every floor, with the result that there is a complete absence of smell and flies.

The employees are medically inspected daily, and are only allowed to work forty-eight hours each week.

3. The inspection of animals is under the control of the Government, who appoint their own veterinary officers.

4. Animals required for the War Office contracts are specially purchased. The ages vary from two to four years, the majority being three-year olds. All cattle are rested before slaughter and during this time are inspected for disease, especially anthrax and foot-and-mouth. The sellers of cattle are obliged by law to give a certificate that there is no disease among their herds.

5. According to requirements, the animals are driven first through a bath, where they are washed, and then up a long incline to the top of the works for slaughter.

6. On arrival they are taken in two batches of four in a closed compartment, and, unseen by the remainder, they receive stunning blows from two men standing above them. As they drop, they are rolled out on to the floor below and, hoisted by a shackle on the hind legs, they start on their journey through the plant.

7. From this time on, the animals never touch the floor at any juncture ; the whole process of preparation is carried out by the carcases travelling by gravity, on overhead rails and in a never ending stream. Bleeding, skinning and evisceration is all done on the move.

8. The post-mortem inspection begins on the killing floor after the animals are bled.

9. After skinning the animals are numbered in triplicate. One number is struck on the hide, one on the carcase and one on the head.

10. After evisceration, the mesentery, the liver and the lungs are all separately examined by individual veterinary officers. Should any disease be found, a man is informed and he places a coloured disc on the carcase which corresponds to the organ diseased.

11. The carcase, still travelling, is now divided by an electric saw. The sides pass by three more veterinary officers, who in turn incise the pre-scapular, the pre-crural and the inguinal glands.

The incision of the afore-mentioned glands, including those of the renal and iliac, is made on all the cattle killed.

12. Carcases bearing a coloured disc are switched from the main conveyor into the veterinary inspection room, where every gland is incised and examined. Anything unhealthy is condemned and the side or quarter affected is immediately dropped through a crusher in the middle of the room and cooked up for tallow and fertilizer.

13. Sound sides are passed along on their way to the chilling chamber. They are wiped by spotless white, steaming cloths, fed to the wipers by attendants behind.

14. All operations are carried out by men standing on platforms some distance from the floor, which allows free play for hoses, which are constantly in action.

15. The whole sides of beef are weighed, and passed through the mechanical band saw, which cuts them into portions. All bones are removed and the flesh passed to the cutting tables, where the skin, gristle and unwanted parts are removed. The meat is then put through a double rotary cutter, which discharges through a chute into the parboiling room.

16. The meat from the cutting room is received into buckets, placed into perforated baskets and " parboiled " in scalding tanks or drums. The parboiling process takes twenty-five minutes, during which time the meat is subjected to a temperature of 212° F. for ten minutes.

17. The next process is pickling. The meat is put into a hot solution of brine at a temperature of 160° F. and left not less than eight hours before being withdrawn and dipped into hot-water tanks in order to remove the excess pickle, and to raise the temperature of the meat.

18. The meat is picked over again to remove any small pieces of skin, gristle or large pieces of meat, prior to being ladled into the rotary stuffing machine. Clean cans are fed under the stuffing nozzles of this machine and, as the plunger descends, the meat is forced into the cans. The cans leaving the stuffing machine are weighed, any shortage in contents being rectified by hand with the aid of podgers. The cans are carefully weighed to ensure the correct weight of their contents.

19. Full cans are passed for cleaning off the surplus fat round the caps. A bridge piece is adjusted below the seating of each cap to prevent any solder in the next process or sealing from contaminating the contents.

20. The caps are placed in position, and the cans passed to the automatic rotary spindle capping machines, where

the caps are firmly held in position and carefully soldered on. Each can is examined, and the capping soldering tested. All that are correctly soldered are passed to the vacuum closers.

21. The vacuum closing machine consists of a circular annular passage along which the cans are passed, until the whole of the moving part is loaded with cans; the cover to the loading side is closed and the valve opened. A vacuum of 20 inches is drawn across the cans, which effectually extracts the air contained in them. As soon as the air is extracted, a spot of solder is placed over the air-hole or vent by means of an electric soldering iron, and the cans are thus effectually sealed.

22. All cans are again examined and check-weighed on a limit scale. All which do not give a standard finished weight are rejected.

23. The cans are placed into the retort trucks and passed to the sterilizing room.

24. The cans as passed in the retort trucks are loaded into the rectangular cooking and sterilizing retorts. All cans are submitted to a temperature of 234° F. for $2\frac{1}{2}$ hours in order to destroy the micro organisms. This form of cooking is called "Processing." The length of time and temperature employed in this process varies in accordance with the size of the can and the nature of its contents. On removal from the retorts the cans are gradually cooled under sprays of water for at least six hours. The cooling causes the sides of the cans to become drawn in and assume the appearance familiar to all.

They are conveyed to the can-washing machine, where they are thoroughly washed in hot soda solution to remove all traces of grease. At this stage they receive another careful examination.

25. After the cans have been received from the can-washing machine and passed through a bath containing a mixture of pure lacquer and naphtha, they are placed on to a drying conveyor, where warm air is blown on to them, and the naphtha evaporated. On reaching the end of the conveyor the dried cans are packed into trucks and conveyed to the proving table, where they are stacked in piles and proved for fifteen days in an incubation room maintained at an average temperature of 90° F. They are labelled, the keys placed in position, and packed into wood cases for export.

26. The packing of the wood cases is done by hand. The cases are lowered into the nailing-up department, where

the lids are nailed on by an automatic single-ended nailing machine. The cases are passed along on a gravity conveyor, where two steel wires are placed into position and securely fastened.

27. The cases are loaded into trucks and conveyed to the stores department, where they await shipment instructions.

28. From every batch of canned products, a sample is drawn by the sample department, and the tins are opened and immediately inspected by the management. The meats are passed to the chemical laboratory for a full analysis to be made, and the fat content determined.

101. *Fruit canning*

1. The principal fruits canned in Great Britain are plums, cherries, gooseberries, strawberries, loganberries, blackberries, damsons, raspberries, blackcurrants and apples.

Canada, Australia, New Zealand and South Africa chiefly can apricots, peaches, pineapples, grape fruit, pears and plums.

2. Fruits are hand-sorted, any diseased or damaged fruit being removed, and are then treated according to their individual characteristics, e.g. cherries are pitted, peaches are peeled by a special process, pears are generally peeled by hand, apples are pared, cored and sliced by machinery, gooseberries are "snibbed" and currants "trigged" in special machines, strawberries are "plugged" by hand.

3. After being prepared, the fruit is graded, either by hand or machinery: it is then washed and filled into cans by hand. From the filling table the cans are transported, usually by belt-conveyor, to a draining machine and then to the syruping machine which adds the syrup.

4. Both cane and beet sugar are used in the manufacture of syrup. Sugar counteracts the natural tartness of the fruit and helps to preserve its natural flavour and colour. It also causes a certain amount of toughening of the tissues of the fruit, and thus prevents it from breaking up in the can. The amount of sugar used varies from 6 to 10 lb. to the gallon of water, according to the class of fruit treated.

5. After the syrup is added the "exhausting" process takes place. In fruit canning, heat is the method usually adopted.

6. The cans are pre-heated for five or six minutes at a temperature of about 170° F., and then pass to a machine which puts on the lids and automatically closes them on the container. The cans then pass into a continuous cooker in which their temperature is raised to between 160° F. and 190° F. for a

sufficient length of time to complete the sterilization. The time varies according to the size of the can and the kind of fruit, the average being about ten to fifteen minutes. The cans are then cooled.

7. A vacuum of 9 to 11 inches is normally produced in the cans after processing and cooling.

102. *Vegetable canning*

1. The principal vegetables canned in Great Britain are beans, beetroots, carrots, celery, peas, new potatoes, spinach and turnips. Canada also cans vegetables of various kinds.

2. Vegetables are prepared according to their kind, for example, peas are shelled, beetroots and carrots are thoroughly washed and peeled. As far as possible the preparation is carried out by machinery.

3. After being thus dealt with the vegetables are graded and then blanched for a short time in boiling water.

This is followed by a final wash in cold water.

4. They are then filled into the cans and covered with hot dilute brine. Brine containing 2 to 3 per cent. salt is generally used ; good quality salt is essential, as any impurities may tend to spoil the appearance of the product. Pure soft water should be used ; calcium salts may cause a cloudy brine and toughen the vegetable tissue, while iron salts cause the vegetables to blacken. Machines are available for blanching, washing and filling.

5. From the last machine the containers pass direct to the closing machine, and after being sealed they are loaded into retorts in which they are sterilized. On removal from the retorts the cans are cooled and stacked. The final operations consist of labelling and boxing.

103. *Miscellaneous commodities supplied in cans and canisters*

1. The preservation of a number of other commodities for army use, more particularly overseas, is dependent upon their being supplied in hermetically sealed cans. Among such items are jam, marmalade, syrup, biscuits, oatmeal, and baking powder.

2. These commodities are not subject to a sterilizing process after packing, the keeping quality being due to a high-sugar content or low-moisture content, and the exclusion of air and moisture.

3. Jam, marmalade and syrup are placed in the cans and these are closed whilst the contents are hot ; this produces

an exhaust in the cans and the heat is sufficient to destroy yeast and mould cells.

4. Sound cans are needed in order to prevent leakage and the access of air and moisture. If moist air enters the cans the condensation of moisture on the surface of the jam permits the growth of mould.

5. Army biscuits are supplied with a moisture content below 6·5 per cent. If the canisters are not air-tight the biscuits take up moisture from the air, soon lose their crispness and go stale and may be attacked by meal worm.

6. Oatmeal goes out of condition very soon if the moisture content exceeds 9 to 10 per cent.—the specification limit is 8 per cent.—and is also liable to attack by insect pests.

7. In the case of baking powder access of moist air causes interaction of the components to take place, and the powder loses its efficiency.

104. *Cans and canisters used for the preservation of supplies*

1. The efficient preservation of canned foods, as well as the avoidance of all risk of metallic poisoning, necessitates careful consideration of the materials employed in the manufacture of the cans.

2. In recent years, a great deal of scientific and trade attention has been directed to the canning of foodstuffs, resulting in general improvements in methods of manufacture, and in the introduction of various machinery for folding and hermetically closing cans without the extensive use of solder.

3. *W.D. specifications* do not normally lay down details of the class, type or quality of tinplate solder, etc., to be used in the manufacture of containers.

The specifications, however, require the containers to be well made, hermetically sealed, and equal in all respects to samples which have been submitted by the contractor and approved by the W.D. inspector.

TINPLATE

4. Tinplate is the material used in the manufacture of cans ; the name is somewhat misleading, as it is not a sheet of tin, but a sheet of steel covered with a thin layer of tin.

5. Mild Siemens steel is generally used. The steel bar is first cut into lengths, heated and rolled into sheets. The sheets are then cut into the required size. In this state they are known as " rough black plates " and are covered with a coating of iron oxide.

6. The oxide film is then removed in a solution of sulphuric or hydrochloric acid and the sheets are washed, the process being termed " pickling."

7. The sheets are then annealed and after being pickled again and washed they are ready for tinplating. The steel sheet passes through a layer of zinc chloride flux, enters the bath of molten tin and emerges through a layer of palm oil, which prevents oxidization of the tin layer. The plates are then cleaned from grease and polished.

8. Tinplates are manufactured in various sizes and gauges. All measurements and prices are based on the standard box of tinplate of 112 sheets, size 20 × 14 inches, weighing net 108 lb. These are called *I.C.*

Lights are plates thinner than I.C. The variations commonly used are 100 lb. and downward in gradations of 5 lb. a box.

Taggers are very thin sheets.

Crosses are plates thicker than I.C.

9. The gauge or thickness of the plates varies over a wide range, but for normal canning purposes plates ranging from B.G. (Birmingham Gauge) 28·0 to 32·5 are most commonly used. Such plates are 0·015625 to 0·00925 inch thick.

10. The quality of the tinplate is a matter of great importance from the double standpoint of preserving the contents and avoiding reaction between the tin or iron of the plate and the contained foodstuff.

11. It is essential that the coating should be well put on so that no flaws, blisters, or other defects are disclosed. If this is badly done, the iron is attacked where the tin coating is absent, and perforation of the can takes place. Flaws in the tin coating may be detected by examination with a powerful lens, and by chemical means.

12. Quality is described by the following trade terms, which vary slightly in their significance according to the works at which the plate is produced :—

Coke.
Best coke.
Charcoal.
Best charcoal.

13. The term *coke* was originally applied to plates made from coke iron, but since the invention of Bessemer and Siemens steel it applies to either of these two processes, and refers to the quality of the tinning and finish.

Best coke denotes plates invariably made from Siemens steel, and having a better finish than *coke*.

Charcoal implies a better finish than *Best coke* and *Best charcoal* again is better finished and better tinned than *charcoal*.

14. The production of cans for the food packer is tending to become a specialized industry, and factories solely concerned with the manufacture of cans are in operation.

In these factories the tinplate is converted by machinery into standard uniform cans, at rates up to 1,000 a minute. The packer is supplied with empty cans and lids, the latter being seamed on by machinery when the can has been filled.

With these cans the contents do not come into contact with any soldered surface, and the risk of contamination of the foodstuff with lead from the solder is eliminated.

15. In the case of certain types of container, e.g. preserved meat cans, the ends are soldered on to the outside of the body of the can; and in these cases, where soldering is employed, the specification requires resin flux to be used. The use of spirits of salt is not permitted, as this acid gives rise to soluble tin and lead salts and, should any of the fluxing solution gain access to the inside of the cans, contamination with tin and lead is likely, as well as corrosion of the plate.

16. In most cases the interaction between the foodstuff and container is so slight as to be negligible; but in the case of certain acid and coloured fruits, the contents of the cans may dissolve some of the tin or penetrate to the iron of the plate where there is a defect in the tin coating. This solvent action leads to the production of gas by the solution of the iron in the acid and also the cans may be perforated. The contents are also discoloured.

17. To avoid these occurrences the inner surface of tinplate used for fruit canning in Great Britain is given one or two coatings of a resistant lacquer, which is stoved on the plate before the cans are made.

18. Darkening of the contents takes place with certain vegetables; this is remedied by coating the plate with a special sulphur resisting lacquer.

19. All cans supplied to the War Department, except those for biscuit, milk and certain dry goods, are required to be painted or lacquered all over on the outside to preserve them from rust. The lacquer is usually sprayed on and hardens by drying.

Each can is required to bear an adhesive label printed with the description of the contents, brand, name of contractor and date of canning (month and year), together with the warranty period and date of expiration of the warranty.

105. *Defects in cans and contents, and their causes*

1. *General poor quality.*—This is due to the use of poor quality raw material and under- or over-cooking.

2. It is unlikely that preserved meat will be found adulterated. The mixing of other meats such as horsemeat with beef can be detected without difficulty.

In the case of meat products the most common defects are poor texture, odour or flavour, and too high a proportion of fat and inedible tissue.

i. *Texture.*—The meat should be fairly soft and easy to masticate. Hard, dry or stringy meat suggests that it is derived from old cattle.

ii. *Flavour.*—The flavour and odour should indicate a sound product. Meat that is flat in odour or flavour may have been immersed in a poor pickle liquor. Deficiency of flavour may be due to over exhaustion of the meat for the purpose of obtaining a high yield of meat extract. In such cases the meat is often highly salted to cover up the deficiency of meaty flavour.

iii. *Fat content.*—The meat should not contain an excessive amount of fat, as such meat tends to fall to pieces when the cans are opened in a hot climate and its greasy appearance is not appetizing.

The meat packed for the Army is leaner than ordinary commercial pack.

iv. *Inedible tissue.*—On cutting the meat into slices very little gristle and skin tissues should be visible. When the appearance suggests an excessive amount, the sample should be hand sorted, all the inedible tissue picked out, separated from the edible meat and weighed. The specification limit for such tissue is 5 per cent.; this is just over ½ oz. for each standard can.

3. In the case of vegetables and fruit the contents may be mushy, cloudy or thick; this is due to over-ripe fruit and over-cooking. Where damaged fruit or vegetables have been packed, the broken edges usually show up brown.

Rawness or hardness is due to under-ripe fruit and under-cooking.

4. *Blown cans.*—These are cans in which the ends are convex, bulged or domed instead of being concave or drawn in. A can becomes blown because gas is being generated inside it, and the increase in pressure forces the ends outwards.

Blowing arises because :—

i. the contents are not sterile and certain organisms causing decomposition with the production of gas are multiplying inside the can, or

ii. the tin coating or lacquering of the plate is defective and the contents are effecting solution of the iron of the plate, and producing the gas hydrogen at the same time, or,

iii. in the case of fruit products, yeast has fermented or the plate has been attacked by the acid juice.

Spoilage may be prevented in the case of i. by increasing the sterilizing temperature and time, thus ensuring the destruction of the organisms; and also by using fresh, sound and clean foodstuffs and maintaining the filling plant in a cleanly condition. Unsound or dirty foodstuffs are highly infected with bacteria and sterilization is much more difficult. The factory plant should be clean, as particles of foodstuffs remaining in it become infected with bacteria and act as centres of infection of sound produce.

In the case of ii. (internal corrosion of the plate) spoilage is liable to occur where there is a defect in the tin-plate; the contents gaining access to the iron of the plate slowly dissolve it and, if the area of corrosion is small, a pin-hole develops. With a larger area the gas developed is sufficient to cause the end to swell and the tin to have a blown appearance.

The gas developed from corrosion is usually much less than that from bacteriological causes, and such cans are usually termed " swells." Swells occur with canned fruit more often than with other products.

Corrosion does not cause much trouble in temperate climates, but in countries where the storage temperature is high considerable spoilage is due to this defect.

Spoilage due to corrosion is lessened by using the best quality tinplate, stove lacquered in certain cases, and storing the goods at a low temperature.

A high exhaust in the case of fruit cans delays the appearance of " swells."

5. *Leakers.*—A leak may be of such a size as to cause loss of the contents of the can, or a minute one which causes spoilage by the admission of air and bacteria.

The cause of leakage is usually defective seaming at the top

and bottom of the can. Small pin-holes may be produced by corrosion.

6. *Discoloration.*—This may occur, in the case of meat products, under the cap of the tin. It is due to overheating the surface of the meat when soldering down the cap.

This detracts from the appearance of the meat and leads to waste of the top slice.

Such discoloration is not injurious, but it should not occur to any marked extent.

Discoloration may occur through the action of the contents on the tinplate; it is rare except with red-coloured fruits in unlacquered cans. Blackening may occur with certain vegetables, due to the formation of tin sulphide.

7. *Souring.*—Decomposition of the contents of cans may be brought about by organisms which do not produce gas and consequently do not cause cans to become blown. This is relatively rare and is found in the case of milk more than with other products.

8. *Metallic contamination.*—All foodstuffs exert a slightly solvent action on tinplate, but the rate of solution in most cases is slow and the amount of tin passing into the foodstuff is so small as to be negligible. The amount of tin present is usually less than $\frac{1}{2}$ grain per lb. of foodstuff; the W.D. specification maximum is 1 grain per lb. Opinion differs as to the amount deleterious to health, but anything over 2 grains per lb. has been stated by the health authorities to be undesirable.

Small amounts of lead and copper are often present, derived from solder or from the manufacturing plant. The amounts do not normally exceed $\frac{1}{100}$th grain per lb.

106. *Inspection of canned foods*

1. A number of cases should be opened and the cans examined individually. This examination will show the absence or otherwise of blown, leaking, rusty, over-filled or under-filled cans and slack packs.

2. *Blown cans.*—These are readily observed where there is considerable gas pressure inside the cans by the end being convex. Slight internal pressure which may be due to incipient blowing or to hydrogen swells may be detected by tapping the ends of the can. Sound cans give a dull note and the ends have a solid feel; cans containing gas give a hollow note and the ends have a slack feel.

Confirmation may be obtained by placing a drop of water on the end of the can and piercing the can through the drop of water with the point of a tin-opener. In the case of a normal can the water is drawn into the can; with a slightly blown can air escapes through the drop of water. There is no vacuum inside cans of condensed milk and these tests do not apply to this commodity.

The contents of all blown cans are unfit for issue and the cans should be rejected.

3. *Leakers.*—Gross leakage results in loss of contents and damage through the rusting of adjacent cans. When accepting a consignment from a contractor, the seams of the can should be examined to see they are sound and a number of the tins immersed in hot water (200° F.) for two minutes. A stream of bubbles will indicate a point of leakage.

4. *Rust.*—Cans which are well lacquered and stored under well-ventilated conditions remain free from rust for some years. Bad storage conditions, where moisture condenses on the cans, lead to spots of rust developing and eventually the cans may be rusted through. Dry ventilated storage is desirable for army supplies, which are sometimes held for long periods.

5. *Filling of the cans.*—Cans are sometimes over-filled, no head space is left and on closing the contents are under pressure. This gives the end of the can a domed appearance, resembling that of a blown can. The solid feel of the can enables these to be distinguished from blown cans, but over-filled cans are not a commercial article because of the doubt of the consumer as to quality.

Under-filled cans are light and the contents usually move about freely on shaking the can. These light cans are undesirable because the greater amount of air in them causes the contents to become stale.

The term slack pack is applied to cans which have no exhaust; they are produced when the can is sealed cold. Slack packs are undesirable because such cans may develop a slightly blown appearance in a hot climate, and the amount of air in the can causes the contents to lose their flavour more rapidly and also increases the rate of corrosion in the plate.

6. *Examination of contents.*—Selected cans should be weighed and then opened; the empty can may be weighed to obtain net contents. The contents should be examined as to their appearance, odour and flavour. These enable an opinion to be formed as to the grade or quality of the goods and the soundness or otherwise of the condition.

7. Cans should be washed out with hot water if necessary and the insides examined as to the amount of corrosion of the plate. Corrosion is the actual eating away of the thin tin coating, and a corroded area appears rougher than the surrounding plate. Black staining of the plate occurs more or less with all meat and vegetable products, and is due to the action of sulphur compounds in the product on the surface of the tin giving rise to a film of insoluble black tin sulphide. A stained surface is brighter and smoother than a corroded surface.

8. Examination on the above lines will, in most cases, enable a sound opinion to be formed as to the proportion of defectives and the general quality of the consignment, i.e. whether it should be accepted or not. In the case of a large consignment from a contractor, or in cases where there is doubt as to quality, samples should be submitted for chemical analysis.

107. *National Mark scheme*

(*See* Leaflet issued by the Ministry of Agriculture and Fisheries)

The National Mark scheme for the voluntary grading and marking of canned home-grown fruit and vegetables (under the Agricultural Produce (Grading and Marking) Act, 1928) came into operation in 1930.

The aim of the scheme, which was prepared by the Ministry of Agriculture and Fisheries in consultation with the National Food Canning Council and with the support of the National Farmers' Union, was to develop the market for the rapidly growing supplies of canned home-grown produce by a policy of standardization, involving the definition of national standards of quality and the marketing of supplies in accordance with those standards, under the National Mark.

CHAPTER VIII

FUEL AND LIGHT AND LUBRICANTS

Note.—In peace the R.A.S.C. is concerned with the supply of fuel and light and the supply and issue of lubricants for mechanical transport vehicles.

Officers of the R.A.S.C. should be able to judge the quality of the various commodities used for fuel and light, and should be acquainted with the management of coal yards.

The regulations governing issues of fuel and light are laid down in the Regulations for the Allowances of the Army and in the Regulations for Supply, Transport and Barrack Services.

108. *Fuel*

1. The value of any substance as fuel depends on the amount of heat produced during combustion by a certain bulk of that substance.

There are, of course, other important points to be considered, such as whether the fuel lights easily, whether it is capable of being burned in an open grate or requires the strong draught of a furnace to cause perfect combustion, or whether it makes a fire with plenty of flame, or burns without flame or smoke.

2. *Calorific values of fuels.*—The calorific value of a fuel is generally expressed in terms of the number of British Thermal Units (B.Th.Us.) generated by the complete combustion of 1 lb. of the material, one B.Th.U. being the quantity of heat required to raise the temperature of 1 lb. of water 1° F.

Fuels vary considerably in heating power. Thus, crude petroleum may have a value of 20,000 B.Th.Us., the best coals from 17,000 to 18,000 B.Th.Us. and poor coal about 10,000 B.Th.Us. A fair average for the usual types of coal is 12,500 B.Th.Us.

When fuel is burned in air, the products of combustion generally leave the system at a temperature above the boiling point of water, so that the water which is produced on combustion remains as steam. This involves the loss of the latent heat of the steam. When the calorific value of a fuel is determined in a calorimeter, the conditions are such that the latent heat is not lost, so that the heating value of a fuel determined calorimetrically (the "gross" calorific value) is higher than can be realized in practice (which depends upon the "net" calorific value). The difference between the

"gross" and "net" calorific values for any particular fuel depends upon the proportion of hydrogen present. In the case of a coal containing 5·0 per cent. of hydrogen, if the "gross" calorific value is 14,700 B.Th.Us. the "net" value is 14,200 B.Th.Us., i.e. about 3·5 per cent. lower.

3. *Different descriptions of fuel.*—The principal substances used as fuel in the Service are :—

i. Wood (kindling, fuel and bavins).
ii. Charcoal.
iii. Coal.
iv. Coke.
v. Oil.

109. *Wood fuels*

1. *Kindling wood.*—Kindling wood is used for lighting fires. Fir, birch, ash and hazel are the most suitable kinds. All wood for kindling should be dry, sound and well seasoned. Old packing cases and unserviceable wooden articles of all sorts form excellent kindling wood.

2. *Fuel wood.*—Fuel wood is used in camps for cooking and baking purposes. It should be sound, full-grown and neither decayed nor damaged ; if ship timber, it should not have been exposed below the water-line. The best wood for fuel is that which has been stacked for a year or two under cover. Fuel wood should be selected according to the kind of fire required.

Air-dried wood contains from 20 to 25 per cent. of moisture, and woods which contain higher amounts, such as green, freshly hewn wood, which may contain up to 50 per cent. of moisture, should be avoided as far as possible. On this account also, wood which has been felled in mid-winter is to be preferred, as it then contains less sap than at other times of the year. Excessive moisture in wood is objectionable, as it interferes with combustion, reduces heating power, and produces much smoke and soot.

Woods are classified as "hard," "half-hard," and "soft." Hard woods, of which ash, beech, birch, box, chestnut, elm, nut and oak are examples, burn slowly without much flame and give a glowing fire. Soft woods, e.g. larch, fir, spruce, aspen, lime, pine, poplar and willow, burn rapidly with plenty of flame, especially the resinous kinds. Half-hard woods include acacia, alder, horse-chestnut, maple, mulberry and Scots fir.

3. *To estimate the contents of a stack of wood.*—No formula can be laid down for estimating the weight of a stack of irregularly-cut logs.

A rough estimate can, however, be made of the weight of wood regularly cut and stacked.

A "cord" of yellow pine, i.e. a pile of regularly cut logs measuring 4 feet by 4 feet by 8 feet, weighs roughly 2,700 lb., equivalent to 21 lb. a cubic foot, or 107 cubic feet to the ton. The harder the wood the heavier it weighs. English oak treated in the same way would average about 30 lb. a cubic foot, or 75 cubic feet to the ton. The weight of half-hard wood is about the mean between the two extremes.

A ton of deal boards occupies about 50 cubic feet, while a similar weight of broken packing cases, odds and ends from ordnance workshops, etc., which is very dry and necessarily contains many interstices between the pieces of wood of which it is composed, occupies, roughly, 220 cubic feet.

4. It is sometimes impossible in camps to have every load of fuel wood weighed on delivery. If it is delivered in rough logs, a few loads may be weighed and an average struck. If the wood is delivered in 4-foot lengths, a good way of checking the quantity is to make rectangles 6 feet by 4 feet, and at each corner drive a stake into the ground, leaving 4½ feet above the ground. When the spaces enclosed by these stakes are built up with wood, each will be found to contain about a ton. This system also facilitates stocktaking.

If a weighbridge be available in the neighbourhood, it should, if possible, be used for each load.

5. *Bavins.*—"Bavins" is the name given to bundles of brushwood which are used for lighting fires in field ovens. Each bundle ordinarily weighs 40 lb. when dry. Bavins, like fuel wood, should be cut in mid-winter, and should be stacked in the same manner as sheaves of corn (that is, in stooks) to dry. They should consist of the same sorts of woods as fuel wood.

Bavins should be stacked so that the number of bundles may be easily counted, and the number multiplied by 40 will give weight in pounds contained in the stack. Laid on the ground two layers thick, they form a very convenient base on which to stack flour, hay, etc., in the field.

110. *Charcoal*

Charcoal is the residue of wood burnt out of contact with the air.

It is used in some tropical climates in open-air stoves for cooking purposes. It burns with little flame and no smoke, and gives out intense heat. The greatest care must be taken to ensure adequate ventilation when charcoal is being burned, to avoid contamination of the atmosphere by carbon monoxide.

This gas is colourless and odourless and is intensely poisonous. Charcoal should be purchased fresh, and used as soon as possible, as it absorbs water from the atmosphere very quickly. After a week's exposure to the air in dry weather it absorbs 15 per cent.; in wet weather, if exposed to rain, it absorbs as much as 60 per cent. It should be of the best quality, made from olive, or equally hard wood, should be very dry, and the contractor should be paid for the amount weighed into store and not for the amount issued to the troops. It should be kept under cover. There should always be an apparent surplus of this article, on account of its increase in weight by absorbing water when kept in store.

111. *Coal and coke*

Coal

1. Coal is fossilized vegetable matter, containing from 67 to 93 per cent. of carbon. It is classified according to its age, on which depend its density and behaviour during combustion.

The oldest formation of coal is anthracite, the next bituminous coal, and the most recent brown coal or lignite.

2. *Anthracite.*—Anthracite, sometimes called "stone" or "fossil" coal, shows scarcely any vegetable structure, does not soil the fingers, is very hard, of iron-black colour and metallic lustre. It is difficult to ignite, and requires a strong draught or blast to make it burn, but gives out intense heat with very little flame or smoke.

It is very valuable for smelting purposes, is very heavy and dense in texture, and occupies a space of about 39 cubic feet to the ton.

3. *Bituminous coal.*—There are many varieties of this coal, the older formations approaching anthracite in appearance and density.

The colour is of various shades of black, sometimes greyish-black. The lustre is more "waxy" than that of anthracite, and in some varieties dull.

4. "*Steam*" or "*Non-caking*" *coals* resemble anthracite in behaviour on combustion. They are difficult to ignite and require a strong draught. They are chiefly valuable for engines and for smelting purposes. As they do not cake in burning, no obstruction is offered to the draught in the furnace. They burn with little smoke or flame, but give out intense heat. They are unsuitable for combustion in an open grate. The Southern Welsh coal is of this type.

5. In W.D. contracts for steam coal the specification lays down clearly the type of coal that is required and the purpose for which it is to be used. This is of great importance, as it is essential to select the coal which is most suitable for the various purposes, which may differ to a great extent.

For example, in selecting coal for steam raising, it is necessary to specify the type of boiler, whether hand or mechanically stoked, the draught available, the B.Th.U. limit, and the maximum permissible ash, moisture and limit of volatile content.

6. The specification of typical steam coal is as follows :—

Minimum Calorific value of dried sample.	Not less than 12,000 B.Th.Us.
Percentage of ash and other incombustibles.	Not greater than 10 per cent. by actual weight.
Percentage of moisture absorbed by the coal.	Not greater than 7 per cent. by weight.
Volatile content.	Not less than 17 per cent.

7. *Smith's coal* is a somewhat softer variety than steam coal, but harder than household coal. It is delivered in smaller lumps than is usual with other classes of coal.

8. *Household coal.*—The best household coals are of the description called " pitch " or " caking " coal. This kind ignites readily and burns with a yellow flame, emitting jets of gas and giving abundance of flame and smoke. When well heated it combines into a solid mass, thus preventing loss of slack.

In testing household coal as to quality, the following points should be noted :—

i. Whether it ignites easily or with difficulty. The more easily it ignites the better.

ii. Whether it burns with a long or short flame. The longer the flame the more cheerful the fire it will make.

iii. Whether it binds or cakes together, or whether it breaks up and disintegrates. The more it cakes the better.

iv. Whether it generates a smell. Few coals are without sulphur or iron pyrites, but if these are in excess the coal is of very little value for household purposes, owing to the objectionable smell it makes when burning.

v. The percentage of ash. There should not be more than 5 per cent.

Unfortunately, the better coal is in other respects, the more smoke it produces.

All the above points, with the exception of v., can be noted by watching the behaviour of the coal on combustion in an open grate. Laboratory facilities are required to determine the percentage of ash, and any questions should be referred to the W.D. Chemist.

A schedule is usually included in the contract on which the following details are shown :—

Estimated requirements.
Price.
Colliery description of coal.
Seam from which coal will be drawn.
Size of screens.

The contractor is bound to supply coal as specified in the schedule.

Household coal occupies a space of roughly 45 cubic feet to the ton.

9. *Brown coal or lignite.*—The texture of brown coal is sometimes woody and sometimes earthy. It differs from mineral coal in showing a red streak when scratched with a sharp instrument. If ignited by means of a blow-pipe it continues to burn.

It has very little heating power compared with its bulk, and can only be used advantageously where it occurs in large masses, and the price of true coal and wood is high.

Coke

10. *Coke* is produced by the destructive distillation of bituminous coal, either in coke-ovens or in gas-works.

11. *Coke-oven coke* is used for foundry work. It is produced by heating the coal gradually to a very high temperature (about 1000° C.) which results in the production of a very hard, unfriable coke, almost entirely free from volatile matter. It is able to withstand high crushing stresses, as in blast-furnace work. It contains all the ash and nearly half the sulphur present in the original coal. The calorific value is about 14,540 B.Th.Us.

Supplies of coke-oven coke should fulfil the following conditions :—

i. Be uniform in size and free from dust.
ii. Be dense, hard and evenly carbonized.
iii. Not crumble on storage, or under pressure in a cupola or pot-furnace.
iv. Not clinker in use.

12. An examination of samples taken from any portion of the supply should show that :—

i. the coke does not contain more than 0·5 per cent. of moisture.

ii. the dry coke does not contain more than :—

(*a*) 9 per cent. of ash.
(*b*) 0·85 per cent. of sulphur.
(*c*) 1 per cent. of volatile matter.

13. *Gas-works coke* is used in the furnaces of boilers, and in stoves and bakery ovens, and may be used with advantage in an open grate for the purpose of keeping the fire in.

It is a by-product from the manufacture of coal gas. The gas is produced in horizontal, inclined or vertical retorts, to which heat is applied more rapidly than to coke-ovens. This gives a high yield of gas, but the resulting coke is softer and more friable than coke-oven coke.

Supplies of gas coke should be good quality, freshly made, dry and free from dust. The proportion of moisture may vary from 2 to 20 per cent. If it is large, the heat of the grate or boiler is partly used to dry out the water which escapes as moisture into the flues, carrying heat with it and thereby reducing efficiency.

The calorific value of gas coke of average quality as usually sold, and including moisture, is about 12,500 B.Th.Us. Coke breeze (as coke dust is called) is about 10,000 B.Th.Us.

14. Coke occupies about 82 cubic feet to the ton.

112. *Oils—General*

1. *Definitions.*—

Aromatic hydrocarbons.—A group of cyclic hydrocarbons of the general formula

$$C_n H_{2n-6}$$

Benzene (C_6H_6) is the first member and is followed by toluene (C_7H_8) and the xylenes (C_8H_{10}). Aromatic hydrocarbons are obtained from certain crude petroleums and are produced in the gasification of coal. They confer anti-knock properties on motor fuels and in addition to being employed as solvents are extensively used as raw materials in the chemical industry (dyes, explosives, drugs, etc.).

Asphaltic matter.—A constituent of crude lubricating oils, which is preferably removed during refining on account of its tendency to produce deposits in engines. It is also formed when mineral oils are heated in air, and the amount produced under appropriate conditions furnishes valuable information as to the probable stability of an oil in use. For specification purposes it is defined as the benzene-soluble portion of the precipitate obtained when oil is diluted with a suitable light petroleum distillate.

Bauxite.—A natural mineral, consisting principally of hydrated oxide of aluminium together with some silica and ferric hydroxide. It is an important source of aluminium and is employed also in the purification of petroleum products.

Benzene.—An aromatic hydrocarbon.

Benzine.—A continental term, roughly synonymous with motor spirit. It should be avoided on account of the probability of confusion with *benzene*, which is an entirely distinct material.

Benzol or benzole.—A mixture of benzene with other aromatic hydrocarbons (mainly toluene and the xylenes). Benzene is the principal component, but the exact composition depends upon the source and the conditions of distillation. Benzene is called *benzol* in Germany.

Benzoline.—A petroleum distillate more volatile than motor spirit.

Catalysts.—A term applied somewhat loosely to substances in the presence of which certain chemical reactions will proceed which, in their absence, would either occur only partially or not at all. Ideally, catalysts do not undergo permanent alteration in use and may be recovered practically unchanged. In practice, however, they are rendered inactive by impurities so that they do not give indefinite service. They are characterized by being effective in relatively small proportions.

Cracking.—A descriptive term applied to the thermal decomposition of hydrocarbons, whereby complex substances of high molecular weight yield simpler and more stable products. Gases and coke are produced simultaneously.

Flash point.—A term chiefly applied to mineral oil to indicate the temperature at which the oil, on being slowly heated, will give off inflammable vapour in sufficient quantity to "flash" or ignite on the application of a light. The determination is carried out in the Abel apparatus. Materials flashing below 73° F. are subject to special regulations as regards storage and transport.

Gasoline.—An American term for motor spirit, sometimes contracted to "gas."

Hydrocarbons.—Compounds consisting of carbon and hydrogen only. According to their composition they may be gaseous, liquid or solid at ordinary temperatures. The numerous hydrocarbons are conveniently classified according to the relation between the numbers of atoms of carbon and hydrogen in their molecules. The following types are the more important: Aromatics, Naphthenes, Olefines and Paraffins.

Hypochlorites.—Salts of hypochlorous acid ($HOCl$), now largely prepared by electrolysing brine. Hypochlorites are powerful oxidizing agents, which makes them valuable as bleachers and sterilizers. They are employed in petroleum technology to oxidize objectionable sulphur compounds.

Naphthene hydrocarbons.—A group of cyclic hydrocarbons of the general formula

$$C_nH_{2n}$$

The simplest member is penta methylene, C_5H_{10}. Certain of the olefine hydrocarbons are identical in composition and molecular weight, but they differ in molecular structure.

Olefine hydrocarbons.—A group of unsaturated hydrocarbons of the general formula

$$C_nH_{2n}$$

The simplest member is ethylene. *See also* Naphthene Hydrocarbons.

Paraffin hydrocarbons.—A group of saturated hydrocarbons of the general formula

$$C_nH_{2n+2}$$

The first member, CH_4 (methane), is a gas. Pentane (C_5H_{12}) and Octane (C_8H_{18}) fall within this group.

Saturated hydrocarbons.—Hydrocarbons which contain the theoretical maximum number of hydrogen atoms per molecule. Such hydrocarbons will react with chlorine and similar substances only by substitution, i.e. one atom of hydrogen is displaced from the molecule for each atom of chlorine which enters.

Unsaturated hydrocarbons.—Hydrocarbons in which the number of atoms of hydrogen per molecule is less than the theoretical maximum. Such hydrocarbons can react with chlorine and similar substances without loss of hydrogen; the amount of chlorine, etc., so combining affords a measure of the degree of non-saturation.

Production of Mineral Oil

2. *Mineral oils* (motor spirit, burning oils, lubricating oils, etc.), are obtained from crude petroleum and shale oils. These crude oils consist principally of complex mixtures of hydrocarbons (compounds of carbon and hydrogen only) together with relatively small amounts of other substances containing, in addition, oxygen, nitrogen and sulphur. The chemical individuals present in petroleum and shale oils have not been by any means completely identified, but it has been established that the hydrocarbons in the petroleums from particular areas are markedly similar in chemical constitution and behaviour.

3. *Crude petroleums* may be broadly classified as "paraffinic," "naphthenic," "asphaltic" and "mixed-base" according to the main types of hydrocarbons present. Pennsylvanian oils are typical of the first group, Russian oils of the second, Californian oils of the third and Texas oils of the fourth. Asphaltic oils contain a higher proportion of sulphur than the others, and on this account are more difficult to refine. Up to the present it has not been found practicable in general to prepare from these oils such a wide range of products as can be prepared from other types.

Crude petroleums are first of all subjected to fractional distillation, and in this way a variety of products is obtained. The most volatile constituents distil off first and from these, after purification, further distillation and, possibly, blending, motor spirit is prepared. The next fraction, after purification, is known as "white spirit," and is used instead of turpentine in the manufacture of certain paints, polishes, etc. The third main fraction, after appropriate treatment, constitutes ordinary mineral burning oil. In the case of highly asphaltic crude oils distillation is discontinued at this point,

the residue being used as fuel oil. Further distillation of less asphaltic oils yields gas oil, which is used as fuel and for increasing the illuminating power of coal gas and other gases, and finally heavy oils, from which are eventually prepared mineral jelly, paraffin wax and various lubricating oils. The residue remaining in the stills is pitch or coke, according to the oil used and the method of distillation employed.

As far as possible, distillation is continuous and automatic, and the heavy oil is removed under much diminished pressure. Many types of plant utilize pressures as low as 4 millimetres of mercury in the absence of steam, or 20 millimetres with steam injection into the oil, and in the best modern practice hydrostatic pressure is reduced by heating the oil in layers only about ½ inch deep. All these precautions are designed to minimize decomposition ("cracking") of the valuable heavy lubricating oil fractions.

4. The products obtainable in any particular case, and their relative proportions, depend upon the nature of the crude oil used, as do the methods of purification subsequently required. The lighter distillates are refined to remove colouring matter and such compounds of sulphur as may render the material or its decomposition products malodorous or corrosive. Concentrated sulphuric acid, followed by caustic alkali, was at one time in general use, but it has been found wasteful and is being displaced by other materials. Among these may be mentioned hypochlorites (prepared locally by electrolysis of salt water), and bauxite and other natural absorbents, through which the oils are filtered. Refining of "cracked" distillates presents greater difficulties (*see* Sec. **113**, 5), but passage of the vapours over heated bauxite or similar material is believed to be generally effective.

5. Burning oils which contain any appreciable proportion of aromatic hydrocarbons (benzene, toluene, etc.) burn with smoky flames and require special purification. The process commonly used involves treatment with liquid sulphur dioxide, which dissolves the aromatic hydrocarbons and gives a non-smoking product. The aromatic hydrocarbons so removed are recovered and used for blending with motor spirit.

6. Shale oil is produced by destructive distillation at the lowest practicable temperature of the organic matter present in shale, and will thus be seen to resemble very gently "cracked" petroleum. It is in general distilled and refined in the same way as petroleum, and yields similar products. Production has declined rapidly in Great Britain within recent years as the Scottish deposits are nearing exhaustion,

and satisfactory methods have not yet been devised to enable the sulphurous Kimmeridge deposits to be worked. Vast deposits of shale exist in America and elsewhere.

Production of Motor Spirit from Coal

7. The urgent necessity for making Great Britain less dependent upon imported petroleum products has led to an intensive study of methods for the production of motor spirit from coal.

The following is a brief outline of the principal processes employed for the purpose.

8. *High-temperature carbonization.*—The light tar oils obtained during the high-temperature treatment of coal (in coke ovens, gas-works, retorts and blast furnaces) yield "benzol" on distillation and further amounts of aromatic hydrocarbons can be recovered when the gas is "stripped" by scrubbing in heavy oil. The crude benzol so prepared is refined by processes similar to those described in the case of petroleum distillates, and can then be used as motor fuel, either alone or mixed with petrol. It consists of a mixture of the aromatic hydrocarbons, benzene, toluene and xylene.

9. *Low-temperature carbonization.*—Much attention has been paid during the past few years to the development of processes of low-temperature carbonization. Such processes produce: (i.) a semi-coke fuel which ignites readily; (ii.) gas and vapours in considerable quantity from which a certain amount of motor spirit is obtainable; (iii.) a tar oil which is more suitable for the production of fuel oil and motor spirit than are the products of gas retorts and coke ovens. The primary technical difficulties associated with low-temperature carbonization have now been largely overcome, and several processes have been developed to a commercial scale. Their success will depend largely upon the prices obtainable for the tar oil products in competition with imported petroleum products, and the extent to which the smokeless fuel can compete with ordinary coal and coke for general domestic and commercial uses. From each ton of coal carbonized approximately 20 gallons (about 10 per cent.) of tar oil and motor spirit are obtained.

10. The methods of converting the low-temperature carbonization by-products into motor spirit include:—

- i. *Hydrogenation.*—Treatment with hydrogen in the presence of catalysts at high pressure.
- ii. *Cracking.*—With or without catalysts and hydrogen at atmospheric or comparatively low pressures.
- iii. The treatment of tar vapours from the retorts before condensation.

These methods apply to both high- and low-temperature tars.

11. *Hydrogenation of coal.*—Unlike low-temperature carbonization, which produces them as a by-product, the process of hydrogenation has as its main function the production of liquid fuels.

The treatment of coal with hydrogen at pressures of some 200 atmospheres and at a comparatively high temperature of about 450° to 500° C. was developed by Dr. Bergius, who took out the first British patent for the process in 1914.

The output of petrol is approximately 1 ton for every 3 tons of coal consumed, the situation being that 2 tons of coal yield about 1 ton of petrol, but require one additional ton for heating purposes.

Trials of petrol produced under this process have been carried out on Army vehicles.

Hydrogenation of coal is still at a relatively early stage of development and gives rise to very great engineering difficulties on account of the high pressures and temperatures employed. So long as petroleum remains plentiful it is perhaps doubtful whether hydrogenation of coal will be commercially profitable unless, of course, it can provide new and valuable products. If, however, petroleum should advance in price or prove difficult to import for any reason, hydrogenation of coal would assume much greater importance.

113. *Petrol and other motor spirits—Their properties, composition and specifications*

1. Petrol, benzol and benzol mixture should be practically colourless and entirely free from undissolved water, suspended matter or deposit. The odour varies with the composition, but is not important provided that it is not sour or sulphurous.

2. The more important requirements for a motor spirit are as follows :—

i. It should contain a sufficient proportion of constituents easily volatile at fairly low temperatures in order to ensure easy starting of the engine in cold weather. The volatility should not be excessive, however, or there may be danger of "vapour lock" in the fuel pipes when the engine is hot.

ii. It should contain a much larger proportion of constituents of decidedly lower volatility in order to ensure satisfactory performance when the engine has warmed up. At the same time the volatility of the "end fraction" of the fuel should not be too low or there is danger of incomplete combustion,

with consequent waste of fuel, loss of power and dilution of the lubricating oil.

iii. It should contain a suitable proportion of hydrocarbons of intermediate volatility in order to secure satisfactory and rapid warming up of the engine after starting.

The above requirements are usually judged by means of a distillation test, using a standard form of apparatus (usually that specified by the Institution of Petroleum Technologists). The following are typical distillation results for the motor spirits used in the Army, the figures being temperatures reached when certain percentages by volume have distilled over at normal atmospheric pressure (760 mm. of mercury) :—

	10 per cent.	25 per cent.	50 per cent.	75 per cent.	97 per cent.
Petrol, Grade I	60° C.	83° C.	110° C.	140° C.	190° C.
,, ,, III ..	70° C.	90° C.	115° C.	145° C.	200° C.
Motor Benzol	85° C.	86° C.	90° C.	95° C.	120° C.
Petrol-benzol mixture ..	76° C.	87° C.	100° C.	135° C.	180° C.

The figures for petrol and for the mixture vary to some extent according to the source of the petrol and the treatment to which it has been subjected.

Petrol-benzol mixture normally used in the Army is made by mixing one part of benzol with three parts of Grade I petrol.

3. Other requirements for motor fuel are as follows :—

i. It should not contain appreciable amounts of impurities likely to cause corrosion or excessive blackening of the fuel system. Such impurities are acids, alkalis and reactive sulphur compounds, and these can readily be detected by chemical tests.

ii. It should not contain more than 0·01 per cent. of non-volatile residue (" gum," etc.) and must not form " gum " on storage. An evaporation test is used for determining the non-volatile residue, and various other tests have been suggested for determining the probability of " gum " formation in storage. The Institution of Petroleum Technologists and the British Standards Institution are at present engaged in devising standard tests for " gum " in petrol and in benzol. " Gum " is usually due to the presence of " cracked " spirit (*see* para. 5, below).

iii. The specific gravity of motor spirit is of no particular significance in the case of petrol and depends on the source and method of manufacture. There is, however, a distinct

difference between the specific gravity of petrol (approximately 0·730 – 0·760 at 15° C.) and of benzol (approximately 0·870 – 0·885 at 15° C.).

4. A new British Standard Specification for "motor benzol" is in course of preparation by the British Standards Institution.

5. Modern petrol is frequently a blended material containing a proportion of "cracked" spirit. In essence "cracking" involves breaking down complex "heavy" hydrocarbons into simpler and more volatile ones by means of heat and pressure. In any particular class of hydrocarbons the volatility increases with diminishing molecular weight, so that the products of "cracking" are clearly more volatile than the original material. It was on this account that "cracking" was first introduced, since it offered a method of augmenting the supplies of motor spirit.

"Cracked" spirit is highly unsaturated (low proportion of hydrogen to carbon) and is sometimes liable to form "gum" on storage or in use. Such "gum" is of course objectionable, since, if present in sufficient proportions, it will cause blockage of the fuel system (particularly the carburettor jets) or sticking of the valves. Improved methods of manufacture have, however, resulted in the production of blends of "cracked" spirit which are free from objection in this respect.

The use of such "cracked" spirits also tends to reduce "knocking" in the engine, a matter of importance in modern internal combustion engines. In this respect the chemical composition of motor spirit is of great interest. It may be stated generally that the paraffinic hydrocarbons are most prone to detonate, the heavier and less volatile members of the series being the worst offenders in this respect. For example, it is well known that kerosene (paraffin oil) causes violent "knocking" if it is used as a motor fuel in an ordinary motor-car engine. The aromatic hydrocarbons (benzol), on the other hand, are excellent anti-knock fuels, as are also the unsaturated hydrocarbons in the "cracked" spirit mentioned above.

There is a further class of special anti-knock constituents which are sometimes added to petrol which are exceedingly effective in very small proportions. A typical example is lead-tetra-ethyl.

114. *Lighting oils*

1. Two classes of oils are used for lighting, viz. :—

i. Vegetable oils, e.g. colza or rape oil ; and
ii. Mineral oils, e.g. kerosene.

Of these classes the latter is much the more important.

2. *Rape oil* is obtained from rape and similar seeds by pressing. The crude oil is refined by agitation with sulphuric acid and water, followed by washing with milk of lime and then with water.

Full details of these oils are given in the Handbook of Specification for Supplies.

3. *Mineral oils.*—The types of mineral oils normally used in the Service are :—

i. Kerosene oil, Grade I.
ii. Kerosene oil, Grade II (vaporizing oil).
iii. Mineral burning oil.

Kerosene, Grade II, besides being used as a burning oil for lamps, may also be used as a vaporizing oil.

4. Kerosene should be not more than faintly yellow in colour, and should contain no water, suspended matter or deposit. It may be examined in these respects by holding a tumblerful against the light. Kerosene showing a deep yellow colour should not be used without chemical examination, since a deep colour may denote faulty refining or the presence of objectionable " cracked " constituents.

No kerosene is free from odour, and the oil derived from shale is usually the more pungent. There is no objection to odour unless it is sour or sulphurous, this being indicative of faulty refining.

5. The flash point of kerosene is usually above 100° F.

6. Kerosene should burn brightly in an ordinary lamp without dimming or smoking the lamp glass, and there should be little or no hard crust on the wick after four to five hours. The accurate determination of illuminating power requires special apparatus, but for ordinary purposes a fair estimate may be formed from the nature and brilliance of the flame. No oil, however good, will give a good light unless the lamp is kept scrupulously clean and filled every day. Wicks should be kept carefully trimmed and new wicks should be thoroughly dried before use.

7. Kerosene may readily be distinguished from motor spirit by its much lower volatility (it does not evaporate when rubbed on the hands), by its higher flash point and by its more oily feel.

115. *Transport and storage of motor spirit, benzol and kerosene*

1. For transport by sea specially constructed tank steamers are used, the hulls of which are divided into compartments by transverse and longitudinal bulkheads, with cofferdams

fore and aft to divide the cargo space from the living accommodation and engines, respectively. On arrival at its destination the cargo is pumped into storage tanks, from which it is transported in tank wagons to subsidiary bulk depots, whence it is further distributed by road wagons or in cans.

2. The following are the approximate figures of capacity of the various types of transport and storage in use in civil life.

	Petrol Gallons	Petrol Tons
Tank ships	1,800,000 to 4,500,000	6,000 to 15,000
,, lorries	500 to 1,000	1½ to 3½
Storage tanks	345,000 to 2,700,000	1,150 to 9,000
Rail tank wagons..	2,500 to 4,000	8¼ to 13¼

CAPACITY (PETROL IN CANS)

	Gallons	
	Two-gallon cans in cases	Two-gallon cans uncased
10-ton railway truck	1,232	1,750
3-ton lorry (4-wheeled)	512	700
30-cwt. lorry (4-wheeled)	256	350
15-cwt. lorry (4-wheeled)	128	200
Medium 6-wheeler	512	700

1 two-gallon can of petrol, full, weighs 18 lb.
1 two-gallon can of petrol, empty, weighs 3¼ lb.
1 case of petrol holding four full cans (8 gallons), weighs 100 lb.

Petrol in two-gallon cans (cased)	176 gals.=1 ton gross.
,, ,, ,, (uncased)	250 gals.=1 ton gross.
Petrol in bulk	300 gals.=1 ton gross.
Aviation spirit in 50-gallon steel drums	230 gals.=1 ton gross.

3. For details of storage of petrol in bulk and in cans, *see* Sec. **164.**

116. *Fuel oils*

1. Fuel oils for heavy oil engines range from crude distillates (lighter types) to the residues left after removing the lighter fractions from highly asphaltic oils (heavier types). Speaking generally, content of asphaltic matter is parallel to viscosity,

the lightest oils being limpid at ordinary temperatures and containing under 1 per cent. of asphaltic matter, whereas the heaviest are comparatively thick and may contain up to 12 per cent. of asphaltic matter. The gross calorific value ranges from 19,000 B.Th.Us. for the lightest oils to 18,750 for the heaviest.

2. The fuel oils normally used in the Service are :—

i. Diesel oil.
ii. Light fuel oil, for oil engines.
iii. Heavy fuel oil, for heavy oil engines.
iv. Gas oil.

3. *Test samples of fuels and oils.*—Instructions regarding the method of dispatch of samples of fuels, oils, etc., for test are laid down in the Regulations for Supply, Transport and Barrack Services.

117. *Methylated spirit*

1. Alcohol has many important industrial uses. The revenue duty on alcohol in a potable form is extremely high, and for industrial purposes it has been necessary to permit the sale of duty free spirit in a non-potable condition in the form of methylated spirit.

Methylated spirit is the name given to strong plain alcohol or spirit, not less than 60 per cent. overproof, which has been mixed with nauseous substances in order to render the mixture unfit for use as a beverage. Spirit so treated is said to be denatured.

The strong spirit for methylation is produced at distilleries. The methylating operations and wholesale and retail distribution are subject to strict statutory requirements.

2. Four kinds of methylated spirit are permitted, the differences between them being in the nature and quantity of the denaturant.

i. *Methylated spirit* (*mineralized*).—A mixture of 95 parts of spirit with the following denaturant: $9\frac{1}{2}$ parts of wood naphtha (crude methyl alcohol obtained by distilling wood), $\frac{1}{2}$ part crude pyridine. To every 100 gallons of the mixture is added $\frac{3}{8}$ gallon of petroleum oil and $\frac{1}{40}$ oz. of violet dyestuff.

ii. *Methylated spirit* (*industrial*).—A mixture of 95 parts of spirit with 5 parts of wood naphtha.

The distribution and use of this methylated spirit is subject to more stringent requirements than in the case of the mineralized variety.

iii. *Methylated spirit (industrial, pyridinized)*.—Similar to (ii) except that ½ per cent. crude pyridine is also added. Pyridine is a nauseous substance obtained from coal tar.

iv. *Methylated spirit (power)*.—To every 100 parts of plain spirit is added 2½ parts wood naphtha, ½ part crude pyridine, 5 parts petrol or benzol, and a small amount of red dyestuff.

3. Three other varieties, known as :—

Methylated spirit, industrial, Grade I (68 o.p.),
Methylated spirit, industrial, Grade II, lead-free, and
Methylated spirit, mineralized, lead-free,

are not normal army issues, and are used only in special circumstances.

4. The Excise authorities permit other denaturants for special individual cases which arise in certain industries.

5. Methylated spirits are made in various strengths, common strengths being 61, 64 and 66 overproof. They are also made at the strength of absolute alcohol, 74 overproof.

118. *Light*

1. The substances used in the Service for the production of light are :—

i. Candles (stearine and magazine).
ii. Oil (mineral and vegetable).
iii. Electricity.
iv. Gas.

2. *Candles* are of two sorts, " dips " and " moulds." Dips are made by repeatedly dipping the wicks (of loosely rolled cotton) into melted fat ; moulds are made in machines.

Candles are made of various substances—animal fat, or tallow, palm oil, cocoanut oil, spermaceti, wax and paraffin.

All these substances go through various processes to render them fit for the manufacture of candles.

The quality of a candle depends :—

i. on the amount of light it is capable of producing ;
ii. on its having a high-melting point ;
iii. on its remaining stiff (that is not bending over) at a high temperature.

3. *Oils* for lighting purposes are dealt with in Sec. **114**.

4. *Electric light*.—Electricity is supplied to barracks, etc., under arrangements made by the Royal Engineers, or with private companies. Current may be direct or alternating, and

there is at present no standard of voltage or, in the case of alternating current, of periodicity (cycles a second). The kilowatt-hour is the Board of Trade unit of electrical energy, and supply companies are not permitted to vary the line voltage by more than 4 per cent. above or below the nominal value.

5. *Gas.*—Coal gas contains about 95 per cent. of combustible matter (mainly hydrogen and methene, together with about 6 to 7 per cent. of carbon monoxide). It is now sold on the basis of its heating value, the calorific power for 1,000 cubic feet being determined at frequent intervals by gas examiners. It should be noted that carbon monoxide is dangerously poisonous, and that a mixture of 1 part of coal-gas with 5 to 15 parts of air is explosive.

119. *Management of coal-yards*

1. To ensure thorough supervision of a coal-yard, it should be arranged so that stock can be correctly and rapidly taken at any moment. If the coal is stacked so that the cubic

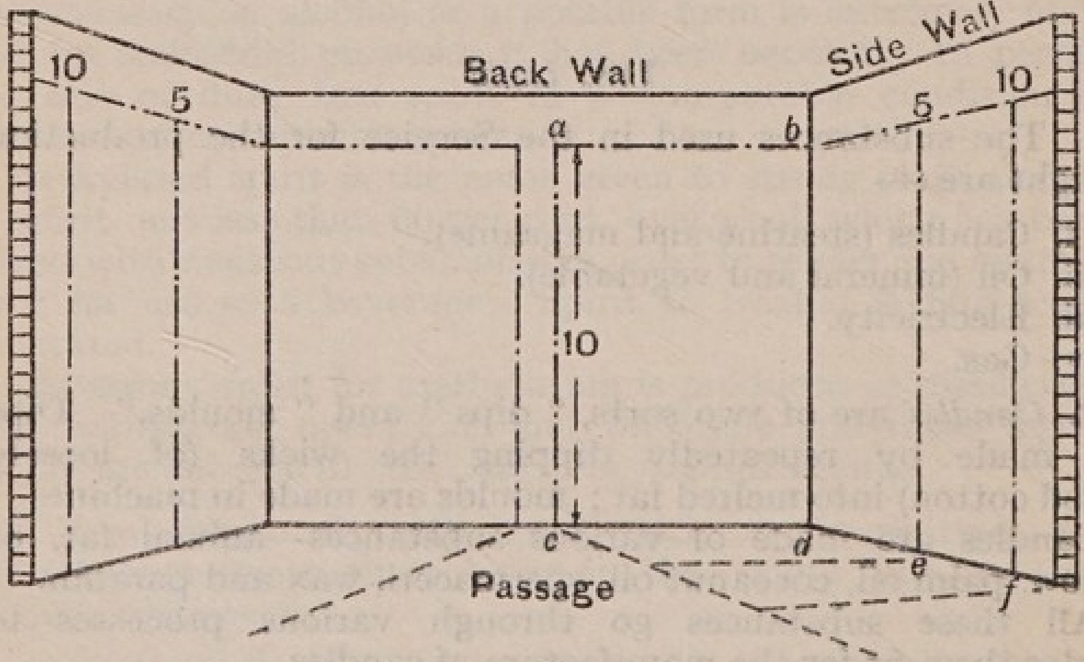


FIG. 1.—COAL-YARD

a b 5 10. Elevation line. *a c*. Vertical line on back wall parallel to which the coal heap is built. 5 *e* 10 *f*. Lines denoting number of tons of coal in the yard when each bay is full.

dimensions of the different heaps can be accurately determined, it is easy to ascertain the total stock in the yard.

There should always be at least two heaps in each yard. Issues should be made from one, and receipts added to the

other. Neglect of this rule will cause complications in account, and provide opportunity for fraud. Moreover, as coal disintegrates, if stored for a long period, and deteriorates to slack, there should be a periodical turn-over of all coal in the yard. This object also is attained by keeping separate heaps for issues and for receipts, the former being worked out before issues from the latter are begun.

2. The marking of a coal-yard depends upon its shape. The normal shape is rectangular, and it should be so marked out by the Royal Engineers as to admit of two stacks of coal being made against the back and side walls of the yard, with a passage down the middle. The space for each stack is divided by perpendicular lines on the walls, into bays (*see* Fig. 1), each bay containing as a rule 210 cubic feet, representing 5 tons of coal. The height of the heap is marked by a horizontal line 10 feet from the ground, which is a convenient height for piling the coal. The number of tons which can be stacked in each bay is marked in figures on the wall.

The coal should be stacked as high as the elevation line, and the outside walls of coal neatly built parallel to the perpendicular lines on the back wall.

The surface should then be carefully levelled.

3. A coal-yard is allotted as a rule to each accounting unit, but at certain stations a reserve yard also is kept, which is on charge of the officer in charge of barracks.

In reserve yards a separate record is kept by the issuer for each heap and, when the heap is run out, the total issues from it should be compared with the original quantity received, any surplus being taken on charge immediately.

The N.C.O. or barrack warden in charge of a reserve yard is required to render to the barrack office a weekly state of receipts and issues. This state, which shows at a glance the stock on hand, is forwarded to the barrack office on Saturdays, accompanied by the issuer's book of receipts and issues, in which all transactions have been posted daily as they occurred. The state and book are examined and compared with the office records, when, if correct, the state is filed for future reference, and the book initialled and returned to the issuer.

Receipts of Coal

4. The officer in charge of barracks, having ascertained from the various accounting units the quantity of coal required for the ensuing month, sends to the contractor, not later than the twentieth of the month, a requisition for the amount to be delivered by certain fixed dates during the ensuing month.

This detail is necessary in order to ensure that the necessary quantity is delivered, and to enable the officer in charge of barracks to exercise a detailed supervision over the receipts, as each consignment arrives at the place appointed.

5. The colliery and other certificates required to accompany the coal, when delivered, are specified in Regulations for Supply, Transport and Barrack Services, and in the Special Conditions of contract.

6. On arrival at the station, coal trucks should be checked, with the pit certificate, by the officer in charge of barracks or his representative, care being taken to see that no other coal is being received by the contractor than that recorded in the certificate, or if so, that it is not for issue to the troops. If found correct, the coal may be delivered into the yards, each load passing over a weighbridge, the gross, tare and net weights being taken, and the detail entered on checks. (N.B.—Weighbridges should be frequently tested, and care should be taken that the adjusting keys are not improperly used.)

This weighing should be done by, or in the presence of, the issuer in charge ; otherwise, should deficiencies or errors occur, a shifting of responsibility will probably be the result. In the case of coal being delivered into a regimental yard, the delivery should take place in the presence of a representative of the officer in charge of barracks and a representative of the unit receiving the coal. The handing over of the coal from the contractor to the officer in charge of barracks, and from that officer to the unit, is thus performed in one operation. If the coal is delivered in sacks, at least two from each load should be weighed.

7. The following is the usual course at reserve yards :—

The receipt checks are in duplicate, one being given to the contractor and the other retained by the issuer. The latter having entered the receipts in his receipt book, signs the check, and on the following morning sends to the barrack officer a recapitulation of receipts for the previous day, to which the receipt checks are attached. At the end of each day, the issuer's yard book is compared with these checks, and if correct, the amounts received are entered against each coal-yard in the yard book, and it is by this latter book that the contractor's bill is checked when received.

If the contractor receives coal by the shipload, he has to take it into his own store in the first instance, as the demands from the troops would be insufficient to clear the whole cargo. It is then impossible for the officer in charge of barracks to be sure that the coal delivered, after the first few deliveries,

comes from the pit described in the certificate. Should any doubt exist on this point, a sample of the coal delivered should be taken and sent to the pit owners for report.

8. The main points to be observed in the management of coal-yards are :—

i. Division of the yard into correctly marked out and properly stacked heaps, each containing a known quantity of coal, and so arranged that one heap is run out and checked before issue from another is begun.

ii. To arrange that all consignments are received, and all issues made, in the presence of the issuer.

iii. To ensure that receipts and issues do not take place concurrently at the same heap.

iv. To see that the coal described in the pit certificate, and no other, is actually put into the yard.

v. Monthly stocktaking, and checking of accounts at short intervals.

vi. To ensure that surpluses are brought on charge immediately they are discovered.

vii. To insist on the cause of any deficiency being enquired into, and to have the matter settled at once.

viii. If a transfer becomes necessary between two issuers, the transfer should be witnessed by an officer, and signed as correct by the issuer who takes over the stock.

In the case of a regimental coal-yard, the officer in charge of barracks is responsible only for sub-paragraph iv. of the above.

9. Coal should, when possible, be kept in covered sheds, and not exposed to the action of the weather, nor should it be kept, even under cover, for a long time exposed to the action of the air; otherwise disintegration will take place, and a large quantity of slack will be formed.

10. *Screened coals* are those that are passed over gratings to separate the smaller pieces called " smalls " or " slack."

Round coal means massive coal in large lumps and free from slack.

Selected, or hand-picked, coal means a quantity of coal consisting exclusively of large lumps.

11. *Coal measurement.*—

42 cubic feet of loose screened coal weigh a ton.

40 cubic feet of loose unscreened coal weigh a ton.

One bushel of coal, measured when dry, weighs about 80 lb. The same bulk of coal, if measured wet, paradoxical

as it may appear, will weigh less. The fact is proved conclusively that in the dry coal, the small particles run to fill up the cavities, making the whole an almost solid mass, whereas in wet coal the hollow cavities are closed over, the fragments clog together, and the whole weighs less than a similar measure of dry coal.

Stocktaking

12. An approximate stocktaking in a properly marked coal-yard is a simple matter. The amount contained in full bays is ascertained from the marks on the wall. If any bay is only partly full, the amount is estimated by observation.

Coal which has been in store some time lies closer, and consequently weighs heavier for its bulk, than on delivery. A ton of screened coal recently stacked occupies 42 cubic feet, after six months 41 cubic feet, and after twelve months 40 cubic feet. As coal delivered at home stations is seldom kept many months in the yard, the measurements marked on the walls can usually be taken as correct.

Coke occupies about twice the cubic space of coal.

13. Before stock is taken in a reserve coal-yard, the issuer's book should be closed for the day, and a memorandum should be taken of the remains on the day as shown in the book, as well as of the quantities actually found in the yard; the difference between the two is the surplus or deficiency. Should a surplus be found, it should be at once taken on charge in the yard and magazine books. A tendency to make a surplus should be discouraged.

When stock is taken in a reserve coal-yard, the opportunity should be utilized to check all the implements as detailed on the inventory board.

14. At camps where a R.A.S.C. representative is present, a coal-dump will usually be established, from which issues will be made to units.

The procedure as to deliveries, issues, pit certificates, etc., at coal-yards in barracks will be followed as far as possible in camp.

120. *Lubricating oils and greases*

(*See also* Manual of Military Vehicles.)

Lubricating Oils

1. Mineral oils are most generally used for lubrication, and a wide variety of lubricants may be prepared by judicious blending of appropriate "stocks." Admixture with a small proportion (about 3 per cent.) of fatty oil is sometimes

advantageous, and in exceptional cases fatty oil may be used alone (e.g. castor oil, in the lubrication of aero engines).

2. Service specifications are designed to provide lubricating oils suitable for certain specific purposes. That the basic oils (" stocks ") used in blending are of good quality and have been carefully refined is ensured by prohibiting the presence of mineral acid or more than a trace of ash, by limiting the amounts of organic acids and saponifiable matter, by stating minimum flash points, and by limiting the amounts of asphaltic matter before and after heating under defined conditions. The grade of oil appropriate for any specific purpose depends upon the viscosity. Viscosity is measured by the time which a standard volume of the oil takes at a given temperature to flow through the jet of a Redwood viscometer. The numerical part of the present Service nomenclature of lubricating oils denotes average Redwood efflux times in seconds at 140° F., so that Service designations indicate " body " or viscosity.

3. The letter in front of any particular Service oil represents its nature, e.g. M = mineral, C = compound.

4. Viscosity diminishes with rise in temperature, so that oils become thinner at working temperatures. The effect of temperature varies according to the origin of the oil and method of refining, so that viscosities must be determined at several temperatures to ensure that the oil is not excessively thin at high temperatures, or unduly thick at low. As an additional safeguard against the latter possibility a low cold test is also required, i.e. the oil must not stiffen until a reasonably low temperature is reached.

5. Service oils should not be darker than deep red-brown in colour, and should not be dull or opaque when viewed in glass tubes 1 inch in diameter. They should be free from water, suspended matter and deposit, and the odour should not be sharp or rancid. When a little of the oil is thoroughly mixed with an equal volume of warm, distilled water, the water should not redden blue litmus paper.

6. Used oils are commonly dark and opaque and may contain appreciable amounts of suspended matter and deposit. They may also have a marked odour, owing to contamination with residual fuel. Chemical examination is necessary to establish the extent and seriousness of the deterioration, and should be arranged in any case of abnormal running which cannot be definitely explained after general mechanical examination of the engine concerned.

7. The following lubricating oils are those which particularly concern the R.A.S.C., as being those used in Service mechanically propelled vehicles.

Oil M.120.
Oil M.220.
Oil M.265.
Oil M.600.
Oil M.800.

Detailed instructions regarding the use of these oils are given in the various lubricating tables issued from time to time.

8. The Handbook of Specifications for Supplies gives full particulars of these oils, and the nature of the tests carried out to ensure that they are suitable in every way for the purpose intended.

9. The following are some simple tests of lubricating oils for which no elaborate laboratory apparatus is required :—

i. *Viscosity.*—To compare relative viscosities, place a drop of each type of oil on a clean sheet of glass. The sample which flows further in a given time, when the glass is inclined, is the least viscous at the particular temperature at which the test is made.

ii. *Gumming.*—To test gumming, expose a thin layer of oil at a temperature at least as high as that at which the oil will be used, and note if any thickening or gumming takes place, or if a skin forms on the surface.

iii. *Acidity.*—Shake a little of the oil with a little warm distilled water and allow to separate. A drop of the lower (aqueous) layer should not produce a red stain on sensitive litmus paper.

iv. *Grit, or other foreign solid matter.*—Thin some of the oil with clean paraffin or petrol. Filter it through blotting paper and note if there be any residue.

10. Lubricating oils are normally issued in 5-gallon drums, which are coloured, according to the type of oil, as follows :—

M.120—Yellow.
M.220—Bright green.
M.265—Drab.
M.600—Blue.
M.800—Black.

Gross weight of a drum of M.220 (home pack)	= 53 lb.	0 oz.
,, ,, ,, ,, ,, (export pack)	= 54 ,,	4 ,,
Weight of drum (home pack)	= 6 ,,	8 ,,
,, ,, (export pack)	= 7 ,,	12 ,,
Net weight of contents	= 46 ,,	8 ,,

11. Mineral oils should not deteriorate in storage provided the oils have been efficiently prepared and blended, the containers are clean, dry and effectively sealed, and steps are taken to ensure that the oils do not become contaminated by dirt, grit or water.

GREASES

12. Lubricating greases consist of mineral oils and soaps, with or without graphite. They are used for heavy bearings and where bearings run slightly warm. Heating softens the grease, so that it feeds better to the bearing, but drainage of oil must be avoided, since soaps alone are not efficient lubricants.

13. Only one type of grease is now used in Service mechanically propelled vehicles, i.e. Grease M.T. (*See* Handbook of Specifications for Supplies for details of specification and tests.)

14. Grease M.T. is normally issued in kegs, weighing 13½ or 14-lb. gross with a net content of 10 lb. of grease.

Grease is liable to depreciate in storage owing to separation of the constituents taking place, and the tendency of the fatty oils used in its manufacture to oxidize, causing rancidity and discoloration.

Water is also present in the grease in the form of an emulsion, and unless containers are effectively sealed changes may take place through loss of water.

RECOVERY AND UTILIZATION OF USED OIL

15. Waste oil drained from sumps of motor vehicles has been successfully employed as fuel for cooking in the field. Various appliances are now available, however, whereby used oil can be so treated as to make it suitable for further use.

The solid impurities in used oil commonly consist of carbonaceous matter (derived from partial carbonization of the oil, and the main cause of its blackness), metallic particles (due to abrasion) and mineral matter (road dust, etc.). Used oil also contains in solution a proportion of unburnt fuel (normally, somewhat less than 10 per cent.), which is the cause of its markedly reduced viscosity, and bodies which are generally termed " asphaltic matter," and which consist in part of partially oxidized oil.

Certain oil-purifying devices rely on centrifuging or filtration for removing solid matter from used oil, but, as the carbonaceous particles in particular are in a very fine state of sub-division, they are usually at best only partially removed by such means. More complete removal may be effected by treating the used oil with aqueous solutions of suitable chemicals, whereby

coalescence of the fine particles is brought about and their sedimentation is facilitated. Chemical treatment has been found also to reduce the proportion of asphaltic matter in used oil (a result which no purely physical or mechanical treatment is likely to achieve, and which enhances the stability of the product).

Residual fuel (" diluent ") is not removed by any of the processes so far described, and the only practicable method of achieving this is by means of heat, either under atmospheric pressure or reduced pressure. Heating of used oil must, of course, be carried out with all due precautions against fire. On account of its favourable effect in promoting coagulation of finely divided matter in the oil, heating should precede any other method of purification.

Recovery of used oil can now be effected at a cost of a few pence per gallon, and where particular types can be collected in sufficient quantity it may possess substantial advantages. Provided the original oil was of good quality and the conditions of use have not been unduly drastic, the recovered oil should have at least limited uses, and it is of interest to note that many motor-transport and power-producing concerns are now employing recovered oil in considerable quantities.

CHAPTER IX

DISINFECTANTS AND MISCELLANEOUS CHEMICALS

(For further details, *see* Handbook of Specifications for Supplies.)

Note.—Various substances used as general disinfectants and for other purposes are obtained under contract through the R.A.S.C. Normally such chemicals are used under the instructions of a medical officer.

121. *Liquor cresoli saponatus fortis*

1. This disinfectant is manufactured by boiling the cresylic acid fraction of coal tar with a vegetable oil, caustic alkali and water. The ingredients combine to give a black emulsion.

Vegetable oil and alkali are used, as they produce a strong soap solution, which has the power of taking up large amounts of tar acid. Before use the black liquor is diluted with water; the dilution produces a white liquid containing the tar acids in the form of a fine suspension.

2. Concentrated and fairly permanent emulsions of tar acids are now prepared by using a little glue in the place of soap. These emulsions are white and have the same appearance as the black cresoli after dilution. This type of cresoli is referred to in the Army as white cresoli.

3. Cresoli is supplied in steel drums each containing 5 gallons.

122. *Chloride of lime*

1. This substance is also known as bleaching powder. It is obtained by treating slaked lime with chlorine gas in special chambers, the lime absorbing some 30 to 35 per cent. of the chlorine. The substance is a white powder with a characteristic odour and possessing powerful disinfecting and bleaching properties.

These properties are due to the fact that the powder evolves chlorine when treated with acids or exposed to damp air. The efficiency of the powder is determined by the amount of available chlorine it contains.

The powder loses its effectiveness after a few months in hot climates and also tends to cause rusting of the canisters. Stocks of the powder should, therefore, be overhauled every few months.

2. The powder is used by itself as a deodorant and disinfectant, and also in conjunction with formalin for the disinfection of quarters.

123. *Water sterilizing powder*

1. This is a form of bleaching powder, the keeping properties of which are improved by the incorporation of a proportion of quicklime. The amount of available chlorine is less than in fresh bleaching powder, but the amount present does not diminish appreciably on storage, even in hot climates.

2. The powder is supplied for the treatment of drinking water. The method of use is contained in the Regulations for Medical Services of the Army, 1932, Appendix 17.

124. *Formalin*

1. This is a solution of the gas formaldehyde in water, the solution containing about 40 per cent. of the gas. It is manufactured from methyl alcohol, coal gas, coke-oven gas and other sources, and is used in industry for many purposes, a recent use being in the manufacture of synthetic resins.

2. The disinfecting action of the fluid is due to the formaldehyde which is readily evolved from the solution. Diluted formalin is largely used as a disinfectant in a variety of ways, as a wash, as a liquor for soaking garments and utensils, as a spray, and with chloride of lime for the disinfection of rooms.

3. Formalin is supplied in Winchester quart bottles. On long storage the formaldehyde tends to change into the form of an insoluble white powder which separates from the liquid. The powder is simply a solid form of formaldehyde and is just as useful as the liquid for many purposes. Formalin has a powerful and penetrating odour and a marked asphyxiating effect on the throat. The liquid hardens the skin of the hands.

125. *Clarifying powder*

1. This is a mixture of pure sulphate of alumina with pure anhydrous sodium carbonate, and is used to clarify water before it passes into the water-cart for sterilization with water sterilizing powder. The powder gives a gelatinous

precipitate of alumina on treating with water, and a film of this alumina is deposited on the filter of the water-cart. This film retains all solid matter and only allows bright clear water to enter the cart.

2. The powder must have the correct composition if maximum efficiency is to be obtained. Where there is doubt as to the efficiency of old stock the powder should be tested on an Army water-cart, and any which fails to clarify turbid water should be destroyed.

126. *Chlorine*

1. This is supplied in liquid form in cylinders for use in certain systems of water purification. The small amount of the gas dissolved in the water is sufficient to destroy bacterial life, the residual chlorine being removed by storage of the water or by the addition of certain other chemicals.

2. The cylinders weigh approximately 140 lb. and contain 70 lb. of chlorine.

127. *Sulphate of alumina*

This is used in the purification of water. The sulphate is soluble in water, but is readily converted into insoluble gelatinous alumina. On sedimentation such suspended matters as clay and bacteria are carried down by this gelatinous material, and the water is purified to a large extent and is much easier to filter.

128. *Sulphate of copper* (*Bluestone*)

This is used to suppress the growth of algæ and other minute plants in stored water and in water mains. The amount required is small, 1 part in 2 to 3 million of water.

129. *Calcium chloride*

This is used to make the brine solution for circulation in refrigerating plants. It is hygroscopic and, therefore, supplied in sealed drums. Either the solid lump form or the flaked type is supplied.

130. *Pan oil*

This oil, obtained from petroleum, is used for cleaning urinals and keeping away flies.

131. *Creosote*

This is a crude tar acid fraction of the distillate obtained at gas-works ; it is largely used as a wood preservative, but is issued in the Army for the same purposes as is pan oil.

132. *Quicklime*

This is burnt or caustic lime, and has a powerful germicidal action when fresh and dry. It is issued in camps for use in latrines and in the disposal of other decomposing matter.

133. *Miscellaneous oils used as disinfectants*

Fuel oil, gas oil or kerosene may be poured upon stagnant pools to kill mosquito larvæ, and may be used upon decaying matter for a similar purpose. Crude creosote oil, made by distilling coal tar, is used for treating exposed timber and as a disinfectant. Gas oil or creosote may be used for cleaning urinals. Light shale oil applied to common woods renders them repellant to white ants and other tropical insects.

134. *Ethylene glycol*

1. This is used as an anti-freezing mixture in the cooling systems of motor vehicles.

2. The compositions of solutions suitable for use at various low temperatures are as follows :—

Lowest temperature anticipated	Composition of solution (by volume)	
	Ethylene glycol	Water
10° F.	1	3
0° F.	1	2

3. Ethylene glycol must be a clear liquid, practically free from colour and odour, and must not contain any visible foreign matter or impurities. It must be miscible with water in any proportion and with aqueous solutions of the strengths mentioned in para. 2, above, and must be suitable in every respect for use in the radiators of motor vehicles.

CHAPTER X

PROVISION

Note.—The system of supply of items for which the R.A.S.C. is responsible in peace, though varying somewhat in detail in commands at home and abroad, is the same in principle in all cases.

135. *Sources of supply*

Items are obtained as follows :—

i. *By headquarters contracts.*—Examples of items normally so supplied direct are frozen meat, petrol, coal, kerosine, fuel oil.

ii. *By issues from the Supply Reserve Depot, Deptford.*—Examples are preserved meat, biscuit, tea, sugar, salt, disinfectants, lubricating oils, hospital supplies and, in certain instances, forage.

Note.—Issues are also made from the Supply Reserve Depot to meet varying needs of commands abroad, such as preserved meat and biscuits to all stations, bacon to Mediterranean stations, and jam to most stations. In certain instances flour is also supplied.

iii. *By local contracts.*—Examples are hospital supplies, forage, bread (where no R.A.S.C. bakery exists).

iv. *From R.A.S.C. bakeries and butcheries.*

136. *Placing of contracts*

Contracts are placed in the following circumstances :—

i. *Headquarters contracts.*—These are placed by the Director of Army Contracts, in concert with the Director of Supplies and Transport. They are normally made if purchase by this means is more economical than by local contract.

The periods for which these contracts are made vary according to the items purchased, market conditions, etc., and no definite rules can be laid down, but the following are examples of normal practice :—

Petrol and coal ..	Annually.
Frozen meat	Half-yearly.
Sugar	Monthly.
Flour	Monthly.
Salt	Quarterly.

Headquarters contracts are placed in the United Kingdom for supply from home or abroad, according to circumstances. For example, meat for Mediterranean stations and China may be supplied direct from Australasia; forage and flour for China may be purchased in Canada or Australia.

ii. *Issues from the Supply Reserve Depot.*—Items issued from the Supply Reserve Depot are normally obtained by means of headquarters contracts, placed periodically according to market conditions and requirements to complete reserves held at the depot.

Examples are :—

Preserved meat ..	Annually.
Biscuits	As required.
Tea	Quarterly.
Salt	Quarterly.
Disinfectants	Quarterly.
Lubricating oils ..	Quarterly.
Hospital supplies ..	As required.

iii. *Local contracts.*—These are made by officers commanding R.A.S.C. in commands, subject to approval by A.Ds.S.T., where such exist. After acceptance the contracts are forwarded to War Office for review.

Local contracts are placed for varying periods, but are usually for three or six months.

iv. Both headquarters and local contracts are sub-divided into :—

(*a*) *Periodical contracts,* under which an approximate estimate of requirements is given to the contractor, and supply officers demand on the contractor for actual needs, as and when required.

(*b*) *Occasional contracts,* under which a definite quantity has to be delivered within a stated period or periods.

v. The procedure for advertising, opening and scheduling tenders is given in Regulations for Supply, Transport and Barrack Services.

137. *Conditions of contract*

The general conditions of all contracts are framed at the War Office, the form of contract being drawn up to suit the circumstances (local or otherwise) attending the provision of

the article required. Points of importance in connection with contracts are :—

i. The "specification," which is drawn up by the department directly concerned at the War Office, in consultation with trade experts.

ii. Where so provided in the contract, the contractor or his recognized agent is required to be resident in the place where the contract is being carried out, so that the R.A.S.C. officers concerned may be able to communicate immediately with some responsible person in case of emergency, or in case of failure of the supply of the article in question.

iii. Payment is made as provided in the contract, usually monthly.

iv. A contract cannot be sub-let without the sanction of the Secretary of State for War, and is not transferable without permission from the general officer commanding, or other officer acting under his authority or on his behalf.

v. A contract may not be varied either as to price or conditions without War Office authority.

vi. Contracts are terminable as provided therein.

vii. Contractors are sometimes required to keep reserves. As a rule this applies at home stations more to forage contractors than to those for other supplies, although contractors for bread are required to maintain reserve stocks of flour, usually seven days' supply.

138. *Conditions affecting the carrying out of contracts*

There are many conditions which affect the working of military contracts, but attention is directed especially to the following :—

i. *Locality.*—The effect of "locality" on some contracts, particularly those for forage, should be taken into consideration. Tenders are probably received from dealers in the neighbourhood of garrison towns, and, even though the contract may eventually be given to a firm whose head offices are at a distance, a considerable amount of forage will be purchased by the contractor from local dealers, and, therefore, the conditions under which forage of all kinds is bought and sold should be ascertained when making and supervising the working of a contract.

ii. *Labour.*—It was resolved in the House of Commons on 10th March, 1909, that the wages paid in the execution of an Army contract should be those generally accepted as current in the trade for competent workmen where the work is carried out, and a clause embodying this Resolution is included in all contracts.

iii. *Reserves.*—It may be necessary to include in some contracts, with the prior approval of the War Office provision for meeting unusual circumstances. For example, it is easy to understand, though perhaps not accurately to estimate, the great influence that a railway strike might have on the working of a large contract; and when it is evident that such a strike may occur, steps should be taken to see that contractors maintain sufficient reserves to keep up their ordinary supply to the troops.

139. *Special purchase*

1. In cases of emergency, when it is impossible to obtain all supplies under contracts already in existence, it may be necessary to make special purchases under the order of the officer i/c administration (or other administrative officer).

2. If time does not permit of the issue of tenders, every effort should be made to ensure that offers are obtained from as many firms as possible so that it may be established that the prices paid are fair and reasonable. When this procedure is adopted the bill (A.F. P 1922) should be headed, in red ink, " No contract, special purchase," and the words " in accordance with the terms of the contract " should be struck out of the certificate at the foot. For further instructions, *see* Regulations for Supply, Transport and Barrack Services.

140. *Purchase in default*

1. If the contractor fails to deliver the supplies demanded at the specified times and places, or to replace supplies condemned by a qualified officer, the responsible officer may purchase in his default, as provided in the conditions of contract.

2. It should not be forgotten that a contractor should be given an opportunity of effecting supply or of replacing supplies before purchase is made in his default.

3. If such purchase is effected by the military authorities, the excess cost incurred by the public over and above contract rates will be borne by the contractor.

4. Purchases in default should be made in the cheapest market reasonably available.

141. *Supervision of the execution of a contract*

It is essential for the efficient working of Army contracts that their supervision should be in the hands of expert military officers. The R.A.S.C. officer whose duty it is to inspect supplies has, in a sense, a two-fold duty to perform :—

i. *In regard to the troops.*—In all matters connected with supplies, he is the expert adviser of the officer commanding the troops, and regimental officers should be encouraged to consult him in all matters of difficulty or doubt regarding the provision or quality of supplies.

It is his duty to see that all supplies furnished to the troops are fully up to the conditions of contract, and are provided in such quantities and at such times as are required by the troops. On the other hand, he needs the assistance and support of the officer commanding the troops in his dealings with all units in the station.

ii. *In regard to the contractor.*—All ranks are strictly forbidden to have any social intercourse with contractors or their agents, but at the same time the latter should be treated with absolute fairness and justice, inasmuch as it is to be assumed that contracts are given only to tradesmen who are eligible and able to carry them out satisfactorily.

142. *System of inspection of supplies obtained by contract*

(*See also* Regulations for Supply, Transport and Barrack Services.)

1. The system of inspection of supplies varies in detail according to whether the items are obtained by means of headquarters contracts or local contracts, but the general procedure is the same in all cases.

2. Inspection is invariably carried out on delivery, and also during manufacture, if so provided in the contract.

3. In the case of supplies obtained under headquarters contracts, tender samples are first obtained and subjected to examination and analysis at the Supply Reserve Depot, Deptford.

Supply is then made in accordance with the approved sample, consignments being examined in bulk at the Supply Reserve Depot, Deptford, if delivered direct to that depot, or by R.A.S.C. supply officers in commands, when delivery is made direct to command supply depots or to units.

4. In cases of doubt as to the suitability of supplies, samples may be forwarded for analysis to the O.C. Supply Reserve Depot, Deptford, S.E.8, as laid down in Regulations for Supply, Transport and Barrack Services.

5. When headquarters contracts are placed for preserved meat, a R.A.S.C. officer is sent to the country where the meat is to be packed, to supervise the execution of the contract. This officer is responsible for the inspection of the cattle before slaughter, and for ensuring that all subsequent operations at the canning factory, until the meat is cased, ready for delivery, are carried out in accordance with the conditions of contract.

CHAPTER XI

SUPPLY OFFICE ORGANIZATION

143. *General*

1. An officer i/c supplies in peace has seven principal duties. These consist of :—

- i. Estimating the probable requirements of supplies.
- ii. Demanding supplies from the various sources.
- iii. Receiving and inspecting supplies from the various sources.
- iv. Custody of supplies whilst in stock, including stock-taking, both periodic and surprise, and on transfer of charge.
- v. Issuing supplies to the troops.
- vi. Accounting for supplies.
- vii. Passing bills for payment for all supplies received from contractors.

2. The chart on page 228 gives a suggested distribution of duties in a normal supply depot. The staff may be increased or decreased in accordance with the size of the depot. For example, the duties of the forage superintendent may in small depots be amalgamated with those of the depot superintendent.

144. *Forecast and provision*

1. Forecasting the demands of troops and providing the necessary supplies is the first duty of every officer i/c supplies.

2. The fixed ration scale of foodstuffs enables requirements at a normal peace station to be gauged within a fair degree of accuracy. Forecasting likely demands of forage, petrol and lubricants presents some difficulty, and estimates may from time to time have to be called for from consuming units.

3. Reserves, fixed by higher authority, are held in supply depots, or, as in the case of certain out stations, by units on inventory, and the officer i/c supplies is responsible that these reserves are maintained. Steps should be taken to ensure that all stocks held are continually being turned over, i.e. that the oldest stocks are issued first and that, where warranty periods exist, stocks are issued, as far as practicable, before the expiration of such periods.

Officer i/c Supplies

- **Chief clerk.**
  - **General correspondence.**
    - Daily state.
    - Ration allowance claims.
    - Monthly demands.
    - Registry.
    - Amendments to regulations.
    - Postage.
  - **A/cs.**
    - P.S. account.
    - Bills.
    - Petrol a/cs.
    - Debit vouchers.
    - A.F. G 1033—Petrol.
    - A.F. G 1033—Oils.
  - **Indents.**
    - Ration indents.
    - Forage indents.
    - Forage state.
    - Forage demands.
    - Preparation of issue books.
  - **Forms.**
    - Compiling books for preparation of A.Fs. F 3179, A.Fs. F 719—Forage, A.F. G 1033—Fuel, Costing and repayment issues.
- **Depot superintendent (outside).**
  - *Labour, etc.*
    - Labour.
    - Transport.
    - Salvage.
    - Guards.
    - Containers a/c.
  - *Groceries and Petrol.*
    - Grocery stores.
    - Issue of groceries.
    - Receipt and issue of petrol and oils containers a/c.
  - *Forage.*
    - Receipt and issue of forage and containers a/c.
- **Master baker.**
- **Master butcher.**

4. Detailed consideration of likely consumption and the reserves ordered to be held enable an officer i/c supplies to make timely demands fór the various commodities required in his depot on the various sources of supply. A smoothly running programme of intake should be compiled which will allow of ample notice being afforded the Supply Reserve Depot, Deptford, and the various contractors concerned before consignments are actually required.

5. A daily state should be prepared in respect of each commodity held on charge in the supply depot. This state reveals at a glance the daily consumption of the article in question and the actual stock and reserve held, together with a note of the amount of that article on order within the period under review.

6. All orders on contractors or other sources should be placed on A.B. 30. Such orders should be signed by an officer.

145. *Demanding and issuing of supplies*

1. Os.C. units indent for supplies on A.B. 55A, which shows the actual quantity of each commodity required.

2. The strength of units need only be shown on the forms when biscuits or preserved meat are compulsory issues. This ensures that units draw their full quota of these supplies, so that stocks can be turned over.

3. Separate A.Bs. 55A are rendered to the officer i/c supplies for rations, forage, petrol and lubricants. On manœuvres a separate A.B. 55A is rendered for fuel.

4. The officer i/c supplies is not responsible for the correctness of units' indents. The attention of Os.C. units, however, should be drawn immediately to any obvious errors.

5. The notice required before issue by the officer i/c supplies varies in different commands, being dependent upon the terms of the various contracts affected, and possible transport difficulties.

6. It will usually be found convenient to issue bread and meat daily, groceries weekly, and forage weekly or twice weekly, on specified days. A programme of issues to units should be arranged with the approval of station headquarters.

7. As a general rule supplies are collected by units. In certain instances, notably out-stations, it is necessary to arrange delivery of supplies to units from the supply depot or store. Issuers, where available, accompany these supplies, obtain from units on delivery a temporary receipt, and collect

containers that units may have to return. Only where direct supply by R.A.S.C. is not practicable should contractors be instructed by supply officers to make delivery to units. At such stations, where there is no R.A.S.C. meat store, and unless the G.O.C. decides otherwise, arrangements are made through Os.C. troops for one unit to receive meat in bulk and to make distribution to other units.

8. Units indent for petrol (on A.B. 55A) on the officer i/c supplies. Normally issues are effected by direct supply from the contractor to the unit. In exceptional circumstances, where it is more convenient to do so, officers i/c supplies may make petrol issues to units from stock. In certain abnormal situations, e.g. where a petrol pump has been installed in the supply depot, arrangements may be made for direct supply of petrol to M.T. vehicles. Demanding, issuing and accounting for petrol is dealt with in Sec. **152.**

146. *Hospitals and detention barracks*

1. In addition to normal supplies, indented for in the usual manner, special commodities for which contracts exist or for which special purchases have to be made are required by these establishments. The O.C. hospital and the commandant, detention barracks, demand for these commodities direct on contractors. All supplies received during the month are brought to account on A.F. F 731, in the case of hospitals, and on A.F. F 733 in the case of detention barracks, the accounts being forwarded monthly to the officer i/c supplies. Bills for these transactions when received by the officer i/c supplies are checked with these accounts before submission to the command paymaster or War Office for payment.

2. Officers i/c supplies have no other responsibilities as regards the accuracy of these accounts.

147. *Provision supply account*

1. The officer i/c supplies keeps an account of all his transactions, other than those relating to petrol and lubricants, in the provision supply account (A.F. F 754 for home stations, and A.F. F 753 for stations overseas). Petrol and lubricants are accounted for on A.F. F 755.

2. The provision supply account is a simple account of receipts and issues which is compiled at the end of each calendar month, the remains being carried forward to the next month's account.

3. Each entry is supported by a voucher.

4. The remains shown in the account must agree with the actual ground stocks in the depot and this is certified by the officer i/c supplies on the front page of the account.

5. If any surplus is revealed on stocktaking, it is taken on charge immediately in the account by certificate receipt voucher (*see* Sec. **148**, 1, iv.), while any deficiency brought to light is adjusted in the account by certificate issue voucher and dealt with in accordance with King's Regulations, 1928, para. 737.

6. As soon as possible after the end of each month, the completed account, together with all supporting vouchers, is forwarded to the local auditor of the command (or, where there is no local auditor, to the War Office).

7. Stocktaking on transfer of the charge when a change of supply officers takes place, is conducted in accordance with Regulations for Supply, Transport and Barrack Services.

148. *Receipt and issue vouchers to the provision supply account*

1. *Receipt* vouchers comprise :—

i. *Contractors' bills for supplies received.* — These are rendered by the contractor on A.F. P 1922, which form is furnished to him by the officer i/c supplies. After the bill has been checked (*see* Sec. **154**), it is forwarded to the command paymaster for payment, and the receipted bill is duly annexed by the command paymaster as a voucher to his cash account when forwarded to the local auditor. The receipted bill thus serves also as a receipt voucher to the provision supply account (*see* Sec. **154**, 2). In the case of bills for supplies obtained under a contract or order made by the War Office, the bills, after being checked and certified by the officer i/c supplies, are forwarded to the War Office for payment, unless the contract or order specially provides for payment elsewhere.

ii. *Way-bills.*—These are compiled on A.B. 10 and also on A.F. G 1033. They constitute military invoices. They are used between one supply depot and another on the transfer of supplies. The consignor prepares four copies. The first copy is retained as an office copy, while the second may be used as a packing note for the consignment or handed to the civilian carrier, if one is employed. The third and fourth copies are despatched by post to the consignee, who receipts

one and returns it to the consignor. This copy becomes the *issue voucher* to the entry in the consignor's provision store account. The remaining copy is retained by the consignee as a *receipt voucher* to his provision store account.

iii. *Conversion voucher* (A.F. G 1049).—This is used to record changes of description of an article, e.g. sacks when worn out might with authority be struck off charge as sacks, and taken on again as old sacking by weight. The voucher is signed by the officer i/c supplies, who quotes the authority for the transaction.

iv. *Certificate receipt voucher*.—This is prepared in manuscript and is used to take surpluses on charge when found. The voucher is signed and dated by the officer i/c supplies and contains a short summary of the facts of the case.

2. *Issue* vouchers comprise :—

i. *Way-bills*.—*See* para. 1, ii, above. The way-bill constitutes the consignor's *issue voucher* and the consignee's *receipt voucher*.

ii. *A.F. F* 3179.—This is prepared in duplicate by the officer i/c supplies at the end of each calendar month and is sent to each unit supplied during that month. It shows the total quantity of each commodity supplied to the unit during the period together with its price. (The O.C. unit requires the latter information to enable him to work out the total value of the supplies consumed, from which figure the regimental paymaster calculates the amount of commuted ration allowance payable.) One copy of the voucher is signed by the O.C. unit and returned to the officer i/c supplies, and this then constitutes the *issue voucher* for the issues to the unit concerned.

iii. *A.F. F* 719.—This is a similar form to A.F. F 3179, but is used for forage issues. A similar procedure to that detailed in the preceding sub-paragraph is followed.

iv. *A.F. G* 1033.—This is used for issues of petrol, oil fuel and lubricants. A similar procedure to that detailed in sub-para. ii, above, is followed.

v. *A.F. O* 1680 (*Debit voucher*).—This is brought into use when money is recoverable from a unit or individual for issues made on repayment or deficiencies. Four copies are prepared. Two copies,

accompanied by a demand slip (A.F. P 1921) are issued to the person liable for payment. *Both* copies should accompany the remittance to the cashier. The third copy is sent to the command paymaster as a notification of the existence of the debt. The fourth copy is retained by the officer i/c supplies for record purposes. When payment has been received, the cashier receipts one copy and returns it to the remitter. The command paymaster endorses the second copy with a reference to the account in which credit will be given and returns it to the officer i/c supplies. This copy then becomes an *issue voucher* supporting the necessary issue entry of stock in the provision store account. If the officer i/c supplies does not receive the second copy from the command paymaster, endorsed as above, within a reasonable period (for military personnel seven days are usually allowed to make payment), he will assume that payment has not been received and will report the matter to command headquarters through the usual channels.

vi. *Certificate issue vouchers.*—These are compiled in manuscript form and used to balance the account in the case of losses, etc., in accordance with the instructions laid down in King's Regulations, 1928, para. 737.

vii. *Authorities for condemnation of supplies.*—When supplies are condemned (*a*) by a board or (*b*) by a responsible officer, the write-off in the provision store account is supported by the proceedings of the board in the case of (*a*) and by the officer's certificate in the case of (*b*) (Regulations for Supply, Transport and Barrack Services, 1930, paras. 128–132).

149. *Hospital and detention barrack accounts*

The hospital provision account (A.F. F 731) and detention barrack provision account (A.F. F 733), prepared by and received from the hospital or detention barrack concerned, accompany the provision supply account to the local auditor or War Office, as the case may be.

150. *Subsidiary books to be maintained*

In order to ensure the accuracy of the provision supply account, the officer i/c supplies keeps certain books and records.

These contain the daily transactions within the depot and enable the main account to be compiled and checked easily. The following subsidiary books are necessary in the supply office.

i. *Indent book.*—This serves to consolidate units' demands, and enables the officer i/c supplies to see at a glance his total issue commitments for the immediate future. The form (*see* specimen below) is to be completed for each day, immediately on receipt of A.Bs. 55A from units.

INDENT BOOK

(All issues in pounds weight unless otherwise stated)

Unit	Biscuits	Flour	Pres. meat	Tea	Sugar	Salt	Bran	Hay	Oats			
For Issue 25–8–29	Fo	r C	onsu	mp	tio	n,	26	–8–	29.			
13 Hy. Bty.	20	—	15	2	6	1	—	—	—			
23 Fd. Coy.	172	—	129	4	16	3	—	—	—			
2 E. York	124	—	93	10	40	14	—	—	—			
1 R.U.R.	100	—	75	9	33	6	—	—	—			
Totals	416	—	312	25	95	24	—	—	—			

ii. *Order book.*—All demands on contractors or other supply depots are forwarded on A.B. 30. The demand is signed by an officer. When the A.B. 30 has been completed, a copy is made in the order book. The latter then reveals at all times a record of all orders placed on all sources of supply.

ORDER BOOK

From whom ordered and date	Item	Quantity ordered	Quantity delivered	Initials of receiving officer and date	Remarks
A. Black, London, 22–8–29	Frozen beef	806½ lb.	810 lb. meat wrappers 6 brown, 6 white	(Sgd.) A.B. Capt 25–8–29	For delivery on 25–8–29

iii. *Receipts book.*—This forms a complete record of all supplies received by the supply depot. It is required to check contractors' bills. The specimen form shown below should be repeated for every item of supplies dealt with, i.e. held on charge in the provision supply account.

RECEIPTS BOOK

Oats

Date received	Truck numbers	Weights			From whom received	Quantity	Containers	Initials of S.O. and remarks
		Tons	Cwt.	Qrs.				
22–8–29	11,943	1	10		B. White	3,360 lb.	20 oat sacks	(Sgd.) A.B. Capt.
						3,360	20	

iv. *Issue books or sheets.*—These contain a complete daily record of all issues made to units, and the units' receipts or the receipts of the persons conducting supplies to units. They are handed daily to the supply officer by the issuers with a view to their being posted in the stock book (*see* sub-para. vi., below).

v. *Abstract of issues.*—In order to arrive at the monthly totals required for insertion on A.Fs. F. 3179, F 719 and O 1680, issues are abstracted daily to a form similar to the following :—

ABSTRACTS OF ISSUES

2nd Bn. The East Yorkshire Regiment

Date	Biscuits	Flour	Pres. meat	Tea	Sugar	Salt	Bran	Hay	Oats	Petrol
	lb.	lb.	tins	lb.	lb.	lb.	lb.	lb.	lb.	gals.
1–8–29	124	—	93	10	40	14	—	—	—	—
2–8–29	36	—	27	—	—	—	—	—	—	—
29–8–29	36	—	27	—	—	—	—	2,240	2,688	—
30–8–29	36	—	27	—	—	—	—	—	—	—
31–8–29	36	—	27	—	—	—	—	—	—	—
Total	268	—	201	10	40	14	—	2,240	2,688	—

vi. *Stock book.*—This is posted from the daily summary of receipts and issues, and reveals at a glance the daily transactions within the supply depot. It may be checked with the tally boards (records kept by store-keepers of all receipts, issues and remains of every commodity under their charge), issue sheets or issue books, and actual ground stocks. It is posted and balanced daily. This enables the officer i/c supplies to ascertain immediately what stocks are held at any time, and also furnishes him with an effective record for stocktaking purposes. The book is kept in the accounts office and issuers are not allowed access to it.

STOCK BOOK

Date	Casualty	Biscuits	Flour	Pres. meat	Tea	Sugar	Salt	Bran	Hay	Oats
		lb.	lb.	tins	lb.	lb.	lb.	lb.	lb.	lb.
22–8–29	Receipts	3,000	2,800	900	400	480	336	1,080	22,400	3,360
	Issues	1,000	1,700	—	120	100	—	1,080	11,200	2,240
	Remains	2,000	1,100	900	280	380	336	—	11,200	1,120
23–8–29	Receipts	3,000	3,000	—	—	—	—	2,160	—	—
	Issues	1,000	2,100	500	—	—	112	—	—	—
	Remains	4,000	2,000	400	280	380	224	2,160	11,200	1,120

vii. *Container account.*—In home commands non-returnable containers are not accounted for, with the exception of wooden packing cases, which are convertible to kindling wood, and certain other items for which special disposal instructions are issued. In commands abroad all containers are accounted for. Containers when accounted for are taken on charge, on receipt, in the provision supply account, and remain on charge until finally disposed of by the supply officer. It is therefore necessary to keep an accurate check on their whereabouts. When issued to a unit they are not struck off charge, but are signed for on an issue sheet or issue book, and from these an account, as shown below, is compiled. Undue accumulation of containers and meat wrappers should be avoided. A debit voucher (A.F. O 1680) is passed to units failing to return containers issued within a specified period.

CONTAINER ACCOUNT
2nd Bn. The East Yorkshire Regiment

Date	Bags, flour		Bags, sugar		Cases, wooden		Canisters		Meat wrappers	
	Issd.	Retd.	Issd.	Retd.	Issd.	Retd.	Issd.	Retd.	Issd.	Retd.
31–8–29	2	—	1	—	1	—	3	—	—	—
1–9–29	—	—	—	—	3	—	7	—	—	—
5–9–29	2	2	1	1	—	4	—	10	—	—
6–9–29	—	2	—	1	—	—	—	—	—	—

151. *Discrepancies on consignments*

(*See* Regulations for Supply, Transport and Barrack Services, 1930, paras. 124–126.)

When supplies received do not agree with the consignor's voucher, a discrepancy report is prepared in duplicate on A.F. F 783. The original is attached to the receipt voucher and the duplicate forwarded to the consignor attached to his issue voucher. In all cases only the numbers, etc., actually received are taken on charge by the consignee and a receipt given only for these numbers, etc., except as at iii. below. The discrepancy is dealt with as follows :—

i. In cases where the discrepancy as shown on A.F. F 783 is admitted by the consignor, adjustment is made either by a further issue to the consignee, or by the consignor's acceptance of the discrepancy report, which then forms a certificate voucher to his account.

ii. In cases where the discrepancy is not admitted by the consignor, it is dealt with by him in accordance with King's Regulations; and where authority is obtained for any loss to be borne by the public, such authority is attached to the issue voucher.

iii. In cases where it is clear that the full numbers charged were actually issued by the consignor and it is also evident to the consignee how the deficiency arose—such as a loss in unloading a vessel—the enquiry (as ordered by the King's Regulations) is made by the consignee, and a report of the proceedings attached to the receipt voucher in explanation of the difference between the numbers brought on charge and those allowed to stand as charged in the issue voucher.

All cased goods should normally be signed for on receipt as "Received unexamined." Railway companies, however, usually stipulate that claims for losses in transit must be prepared within three days of delivery, and care should be taken to secure that this is done.

152. *Accounting for petrol*

Where deliveries are effected direct to units by the contractor.

1. On receipt of the unit's indent for petrol, the officer i/c supplies makes out a set of vouchers in quadruplicate (War Office petrol voucher book A.F. G 827) ordering the contractor to send the required amount of petrol of stated grade and pack to the demanding unit. The original and triplicate copies are sent to the unit, which passes the original to the contractor; the duplicate copy is sent by the O i/c supplies to the contractor direct as a warning of the unit's demand. The quadruplicate copy is retained in the voucher book.

2. On delivery of the petrol, the contractor or his agent and the O.C. unit, complete all three vouchers both as regards petrol and containers delivered and any containers returned empty.

3. At the end of the month, the contractor submits his bill to the officer i/c supplies, supporting each transaction shown by the completed original voucher (A.F. G 827). At the end of the month the officer i/c supplies renders A.F. G 1033 in duplicate to the O.C. unit for all issues, including containers, made during the month and the duplicate, completed by the O.C. unit, becomes a voucher to the supply officer's petrol account. All contract transactions are supported by a completed voucher (A.F. G 827).

4. The officer i/c supplies is not responsible for accounting for petrol consumed by units. Os.C. units account for all petrol (including containers) received and issued, on A.B. 165, which is rendered direct to the local auditor.

5. In the case of containers written off by Os.C. units on issue to vehicles, transferred, lost, etc., or petrol and/or containers taken on charge from sources other than the parent supply depot, Os.C. units support the entry in A.B. 165 with the necessary authority or explanation.

6. The officer i/c supplies cross-checks the contractor's bill and vouchers with the vouchers of the various units and so compiles the necessary entries in the petrol account. The receipt vouchers for these entries comprise one copy of A.F. G 827, while the issue vouchers comprise the duplicate A.F. G 1033.

Where petrol is issued to units by officers i/c supplies from stock.

7. In these cases issues are vouchered monthly to the unit on A.F. G 1033, in duplicate, and the completed duplicate copy, on return, forms the issue voucher to the petrol account.

Where petrol is issued direct to M.T. vehicles from a pump in the supply depot.

8. The officer i/c supplies records the issues on A.F. G 825 in triplicate, and forwards the original and duplicate copies to the O.C. unit, who accounts for the petrol on A.B. 165.

9. At the end of the month, the officer i/c supplies compiles A.F. G 1033, in triplicate, for the total quantity of petrol issued to the unit during the month, and forwards the original and duplicate copies to the O.C. unit. The duplicate copy, on return from the unit, duly completed, becomes the issue voucher to the petrol account.

153. *Accounting for lubricants*

Issues of lubricants to units are accounted for in the same way as petrol. (*See* Sec. **152.**)

154. *Passing bills for payment*

1. Bills for general supplies and provisions for hospitals, prisons, etc., are rendered on A.F. P 1922, to an officer i/c supplies, from whom blank forms are obtained.

2. On the receipt of a bill in the supply office, the number and date of the contract under which the service was performed is inserted in the appropriate space. The officer i/c supplies then certifies on the bill that the supplies have been delivered up to contract specification and the quantities are checked with the *receipts book*, or, in the case of supplies for hospital and detention barracks, with the receipted indents (Regulations for Supply, Transport and Barrack Services, 1930, para. 145), amendments being made if necessary. A receipt voucher number is then given to the bill (except when it relates to supplies for hospital and detention barracks) and the corresponding number is inserted against the receipt entry in the provision supply account.

3. The bill clerk then checks the bill in the following manner :—

i. Checks prices, rates, computations and total—amending if necessary.

ii. Inserts station and date of delivery if not already done.

iii. Rules through the spaces not used.

iv. Ensures that the bill is signed by the contractor or his authorized agent.

v. Ensures that the quantities charged for correspond with those shown as received in the provision supply account, hospital account or detention barrack account.

vi. Enters bill correctly in the bill book (A.B. 223).

4. The officer i/c supplies then repeats any or all of the above checks and also :—

i. Checks entry in the bill book (A.B. 223) and initials it.

ii. Initials the appropriate receipt entry in the original and duplicate copies of the provision supply account. This prevents the bill being passed twice.

iii. Checks the bill or bills with the confidential list (A.F. P 1964); makes the following endorsements on the confidential list *in his own handwriting*—" Certified that this list of . . . bills forwarded to you to-day is correct and contains nothing already passed for payment "; signs the certificate and *posts it himself* under confidential cover to the War Office or the command paymaster, as the case may be (*see* Sec. **148**, 1, i).

iv. Sends the bills shown on A.F. P 1964 to the War Office or the command paymaster, but under separate cover.

5. When the provision supply account is forwarded to the local auditor, a list of bills still to be passed accompanies it. This contingency, however, does not normally arise if the officer i/c supplies takes appropriate action to ensure that bills are rendered punctually.

6. Special care is to be taken by the officer i/c supplies to see that bills are correctly dated before transmission to the War Office or command paymaster. Failure to ensure this precaution may lead to a loss of discount. Consequently when A.F. P 1922 is returned to a contractor for amendment or correction, steps should be taken to ensure that the date of rendering the bill is amended by the contractor to represent the date on which the bill is finally rendered in its correct form.

CHAPTER XII

SUPPLY ARRANGEMENTS IN CAMPS AND ON MANŒUVRES

155. *Routine on manœuvres*

At army manœuvres the provision of supplies and their distribution will normally follow the procedure laid down in R.A.S.C. Training, Vol. II. The peace system of accounting will be adopted as far as circumstances permit.

156. *Routine in camps*

1. When a considerable number of troops is sent out for training in camps, it is essential, whenever practicable, to arrange for an R.A.S.C. officer or a subordinate to assume duty and responsibility for all R.A.S.C. services.

2. It will usually be found necessary to establish a small supply depot, which should be readily accessible from the various encampments which it has to supply.

3. All supply commodities, including forage, fuel, petrol and lubricants, should be delivered at this depot in the first instance, and after inspection by the officer, warrant officer or N.C.O. in charge, should be stored in such a manner as to provide adequate protection against theft and weather conditions.

157. *Lay-out of depots*

1. It is impossible to lay down definite rules for the formation of depots which will suit all circumstances, but the form of lay-out shown on Plate 43 (page 242) could usually be adapted to meet most cases which will arise. A suggested scale of equipment, to be used as a guide only, for a depot supplying 7,500 men is given in Appendix I.

Position and Aspect of Depots

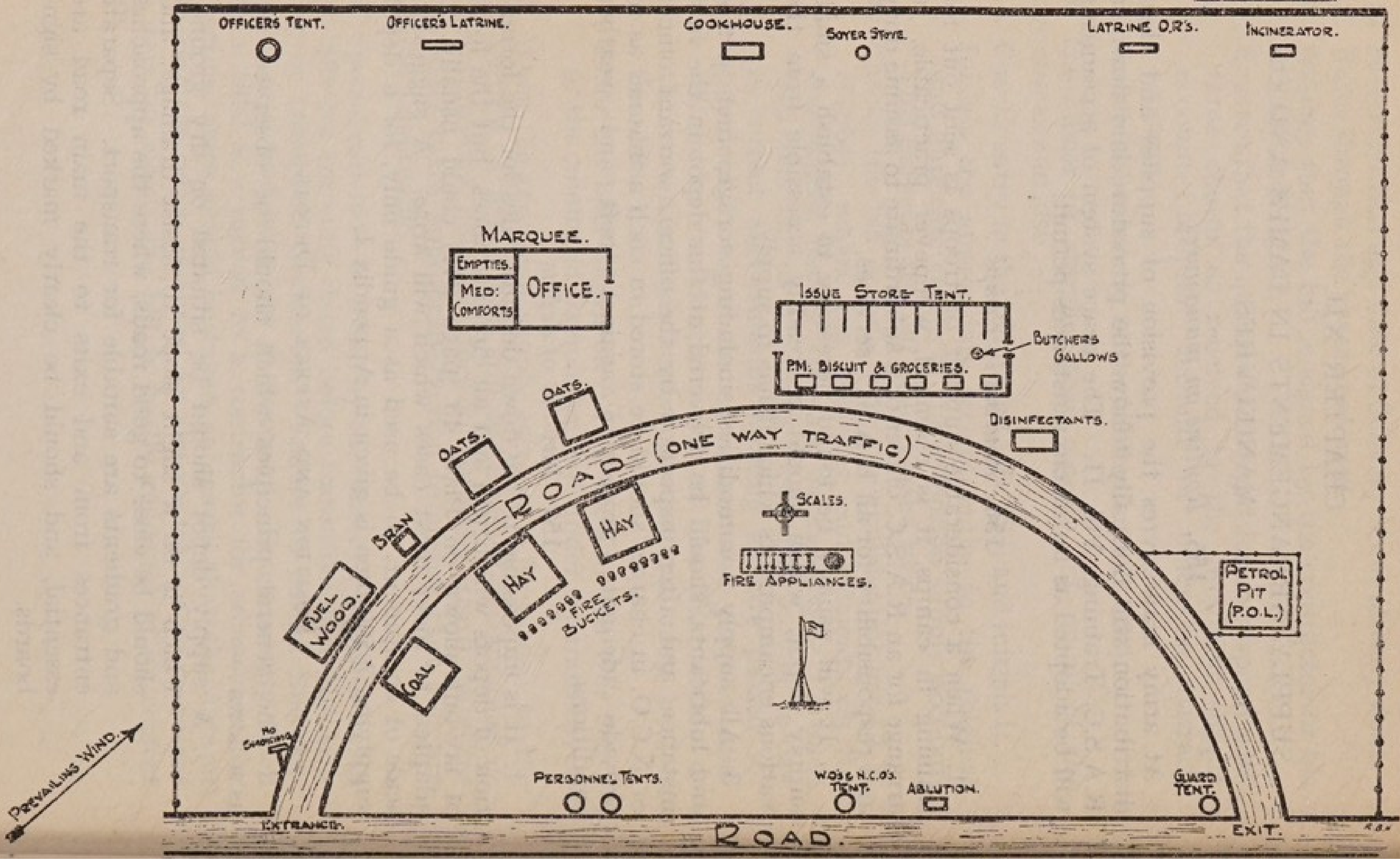
2. The general principles which should be observed are as follows :—

i. A supply depot should be situated on dry ground, which is on a slight slope to assist drainage, and should be close to good roads, where the approaches and gradients are suitable for transport. Separate entrances from and exits to the main road are essential, and should be clearly marked by sign-boards.

PLATE 43.—SPECIMEN LAY-OUT FOR A TEMPORARY SUPPLY DEPOT

(TO FEED APPROX: 7.500 MEN).

NOT TO SCALE.



ii. A good water supply is essential. Latrines, urinals, refuse pits, etc., should be situated at least 100 yards from, and when practicable to the leeward of, the kitchens, and below the water supply; they must never be placed in or near gullies, nor in any situation from which the drainage or filtration could reach, and so pollute, the water supply.

iii. The depot should be situated as near as possible to mounted units, so as to minimize the cartage of the daily issue of forage.

iv. Forage stacks should be situated to windward of the depot in order to minimize risk from fire.

v. The field kitchen and field bakery (if established), should be sited on the leeward side of the depot in order to diminish risk by fire.

vi. There should be plenty of space in the interior of the depot in order to prevent congestion and blocking of wagons.

vii. The depot should be surrounded by barbed wire whenever possible.

158. *Storage and custody of supplies*

1. The following methods of storing supplies, etc., should be used whenever possible :—

Flour should be stored under cover; it should not be placed on the ground, but on a foundation of empty cases or bavins, etc. Every effort should be made to preserve flour from becoming damp.

Bread.—A good store for bread can be made with hurdles; bread should not be stacked more than three loaves high.

Meat should be stored in a cool and well-ventilated store.

Oats and bran should be stacked with the mouths of the sacks inwards, on a foundation of wood bavins or other suitable material at least 9 inches deep. A sail-cover should be spread over this as dunnage.

Hay.—A foundation of bavins or other suitable material is required.

Preserved meat, biscuits and bacon.—Dunnage is not essential, but is desirable; in no instance should different commodities be placed in the same stack.

Bacon, particularly in hot weather, should be stacked so that air can penetrate freely between the cases.

Groceries should be kept in the marquee, if one is provided for the purpose, but in any case under cover and should be stacked on dunnage.

Salt and sugar, on account of their quick absorption of moisture, must be kept perfectly dry.

Fuel wood should be stacked in the open. Stacks should be 4 feet high and divided off into 10-cwt. lots.

Light.—Candles can be kept in the grocery marquee.

Petrol, oil and lubricants should be stacked separately, normally in a pit specially dug for the purpose.

Hospital comforts should be kept under lock and key, if possible ; if not, they should be in the personal charge of the senior warrant officer or N.C.O.

2. The principle of laying out dumps is that bulky goods should be near the entrance while the lighter articles are near the exit. This enables the heavy commodities to be loaded first on vehicles and allows groceries, etc., to be stacked upon them.

3. The issue store tent should be divided into several " stalls " with cases of preserved meat and biscuits to admit of one stall being permanently allotted to each unit being fed.

Bread should be carried straight into units' stalls.

159. *Duties of an officer in charge*

1. The officer in charge of a depot is responsible for the supply of all troops who may be encamped near his depot, of troops passing through, and of any other troops who may be directed to draw from the depot.

2. Before proceeding to his depot he should receive a list of contractors, etc., and the approximate number of troops he has to feed.

3. The following points should be observed :—

i. He should communicate with the contractors as soon as possible, and issue the necessary instructions to them as to delivery of supplies. Forage and fuel wood should be on the ground before the troops arrive, and other articles in ample time for issue to be made on their arrival.

ii. He should ascertain the correct postal and telegraphic address of his depot, and inform the A.D.S. and T., and the O.C. R.A.S.C., respectively.

iii. He should find out the names of all tradesmen in the neighbourhood who would be able to furnish supplies in case of sudden emergency.

iv. He should carefully inspect all forage, and have it weighed and stacked on receipt.

v. He should personally attend all issues of supplies.

vi. He should sleep at his depot.

vii. If supplies are drawn on repayment, he should not overlook the conditions of issue on repayment prescribed by Regulations for the Allowances of the Army.

viii. He should see that units return the sacks in which their oats have been issued to them, and that a correct tally of sacks is kept.

ix. As soon as the last issue has been made, he should arrange to close his depot. This involves the removal of any supplies left over, arranging with all contractors or their agents for their bills to be properly made out before he leaves the locality, checking and packing the equipment of the depot ready for transmission to the R.A.O.C., and informing the transport officer concerned accordingly. The ground on which the depot has been situated should be left thoroughly clean.

CHAPTER XIII

MEASURES TO BE TAKEN FOR THE PRESERVATION OF SUPPLIES STORED IN DEPOTS

(*See* Regulations for Army Fire Services, as regards fire precautions.)

160. *General*

1. When, owing to the absence of storage accommodation, supplies have to be stacked in the open, adequate protection from weather is a matter of the first importance.

This will mainly involve the provision of :—

i. cover for the tops and sides of the stacks,
ii. dry foundations,
iii. ventilation, in cases where the supplies are liable to overheat.

2. Tarpaulins or sail covers provide the readiest method of protecting the tops and sides of the stacks. They should be lashed, or otherwise firmly secured.

3. Foundations may be constructed of almost any available material, such as railway sleepers, rails, logs, hurdles, or large stones. On no account are full packages of supplies to be used for this purpose. Foundations need not, as a rule, be made higher than is necessary to raise the stack just above the ground level, except in localities where heavy accumulations of surface water may be expected, when the height should be increased, and additional protection afforded by a system of surface drainage.

4. If circumstances demand that stacks be built up while rain is falling, they should be pulled down again, so soon as an opportunity offers, for the issue of their contents. But in any case, such stacks should not be allowed to stand untouched for any length of time.

5. Ventilation is secured by leaving air spaces through the stacks. Supplies liable to heat in the stack must be subjected to frequent examination. Issues should be made from the stacks longest on hand, to minimize loss by deterioration.

6. Space is as a rule the determining factor when the question of stacking comes to be considered.

Given ample space, it is as a general rule better to build a number of small stacks than a few large ones.

The advantages of small stacks are :—

i. They are quickly built and covered over, so that the risk of damage from sun or rain is minimized.

ii. Stocktaking, and consequently accounting, is facilitated. It is often almost impossible to make even an approximate estimate of a large stack that has been broken into for issue.

iii. Issue is facilitated. It will often happen that a small stack can be handed over to a fatigue party *en bloc*, and thus the labour of checking it down package by package is saved. It is unsatisfactory to issue to several units at a time from the same stack ; this is avoided by having several small stacks instead of a large one.

iv. A more regular turnover is ensured.

7. The most suitable height for stacks in small depots is 7 to 8 feet. 10 feet may be regarded as the maximum, as for every additional foot above this height the labour of erecting is enormously increased.

8. On the other hand, large stacks will often be the most suitable to build at depots where large reserves of supplies are maintained. Issues will be on such a big scale that such stacks are quickly disposed of, once issue from them begins. They occupy less ground space, which in enclosed surroundings, such as usually characterize such depots, is an advantage. Moreover, when once built, their contents are better protected from the elements than are the components of small stacks.

9. The following are general rules to be observed for building stacks of supplies :—

i. A stack should be composed of packages of uniform dimensions only, and on no account should packages of more than one article be mixed.

ii. Each stack should be built on a well-defined plan, and in such a manner that its contents can be easily counted.

iii. A sloping roof should in all cases be added to stacks which are built up rectangular in section.

iv. Ample space should be left between stacks for the free passage of vehicles.

v. Foundations should be laid before the building of a stack is begun.

vi. If possible, numerous air passages should be left when building stacks which will in all probability remain untouched for a length of time. When this is done, a careful record of the contents of a stack will be prepared contemporaneously with its erection, since, particularly if the stack is irregular in shape, the usual methods for rapid computation when stock-taking would not give accurate results.

10. The majority of service packages are rectangular in shape, having a greater length than breadth. Those placed with the longer side parallel to the front of the stack are known as "stretchers," those with the shorter side to the front as "headers."

11. *Tally boards* (devised locally) showing receipts, issues and remains, should be placed on each stack and *must be kept up to date.*

12. Particulars and dimensions of the various packages to be dealt with are contained in Appendix III.

161. *Stacking of cased goods*

1. The methods illustrated in Plates 44 to 49 (pages 249 to 254) constitute the most satisfactory ways of stacking cases, and all the principal cased supplies can be classed under one of these groups.

2. It is most important that all cases should be piled in such a manner as to render *stocktaking* easy and accurate; the construction of a stack should be uniform throughout, *and in no instance should different commodities be placed together in the same stack.*

3. *Bacon cases.*—Bacon, particularly in hot weather, should be stacked so that air can penetrate freely between the cases (Plate 49, page 254). Slight variations in the size of cases containing bacon render high stacking unsafe; it is therefore inexpedient to build to a greater height than eight to ten boxes.

4. *Square case stacking.*—A number of cases have approximately square bases; these may be conveniently stacked as shown in Plate 44.

If measurements should vary 1 or 2 inches, care should be taken to ensure that the longest sides face the same way, thus avoiding any waste space between the cases. If this precaution is not taken, the stack will not be firm, and stock-taking will be rendered more difficult.

Plate 44.—Square Case Stacking

(Cased goods)

Fig. 1.—To indicate construction

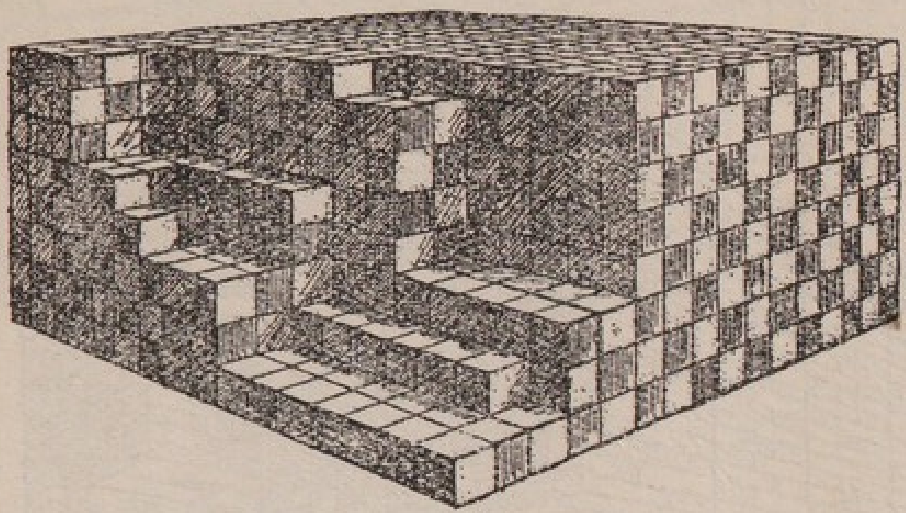
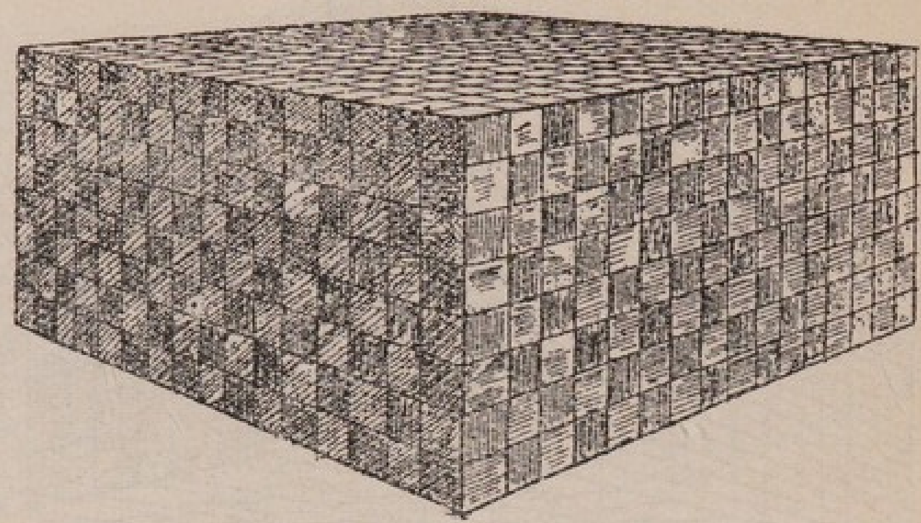


Fig. 2.—The completed stack



Note.—This method of stacking can be used with cases the bases of which are approximately square; they are simply piled one on another, with the corners of each case flush with the corners of adjacent cases.

Method of counting.

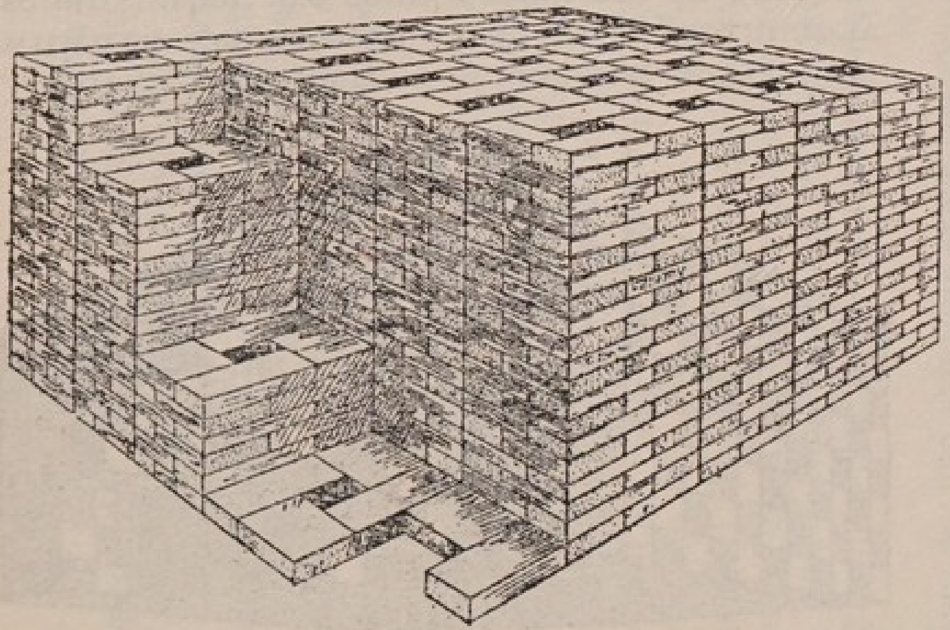
Count the numbers of cases in the length, width and height of a stack, then multiply all three figures together.

Number of cases in above stack $= 16 \times 16 \times 8 = 2{,}048$ cases.

Plate 45.—Pillar Pile Stacking

(Cased goods)

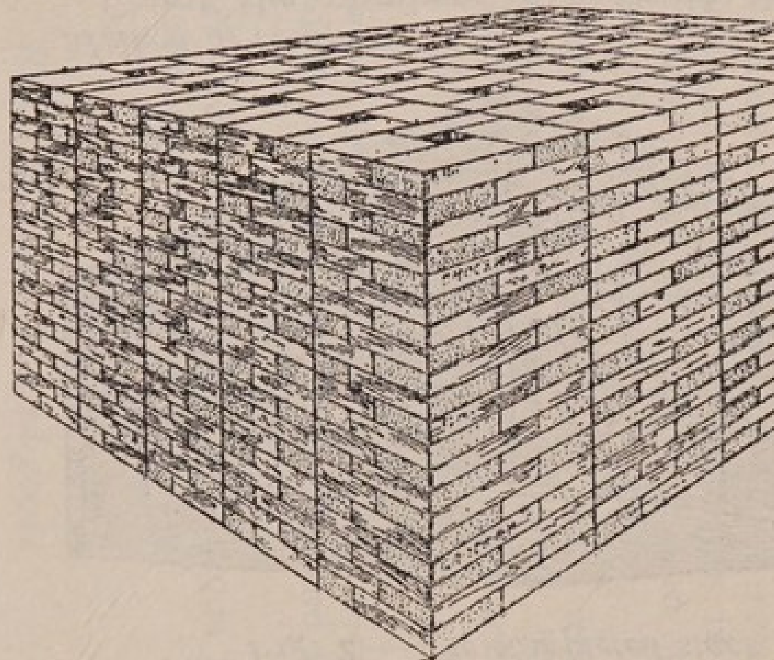
Fig. 1.—*To indicate construction*



Method of stacking.

In every pillar the tiers consist of four cases each; placed so that the sides of a case are parallel with the sides of the case opposite; the following tiers will be reversed in alternate formation.

Fig. 2.—*The completed stack*



Method of counting.

Count the number of cases in height, multiply by 4, and then multiply the total by the number of pillars in the stack.

Contents of above stack = 2,000 cases.

PLATE 46.—TOWER STACKING IN THREES

(Cased goods)

Fig. 1.—*To indicate construction*

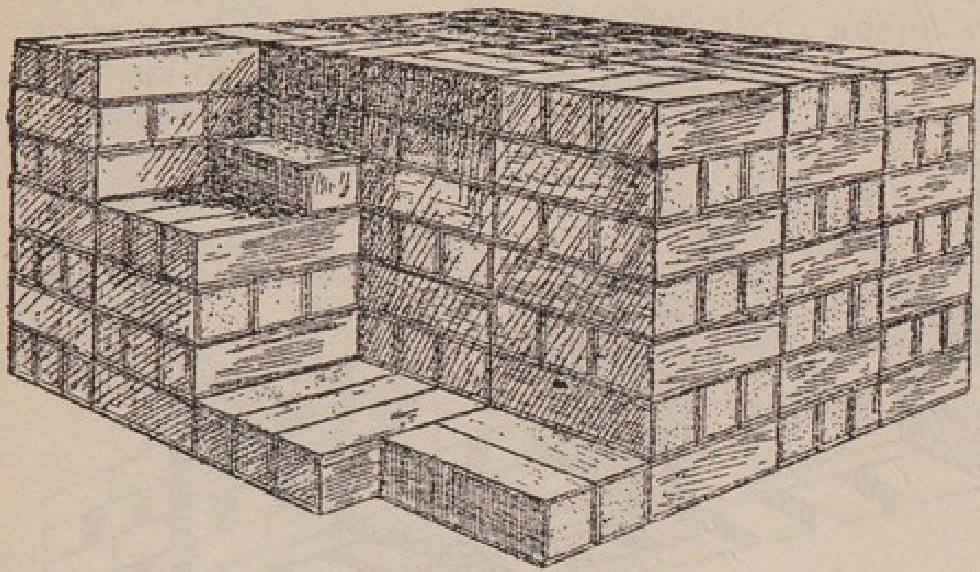
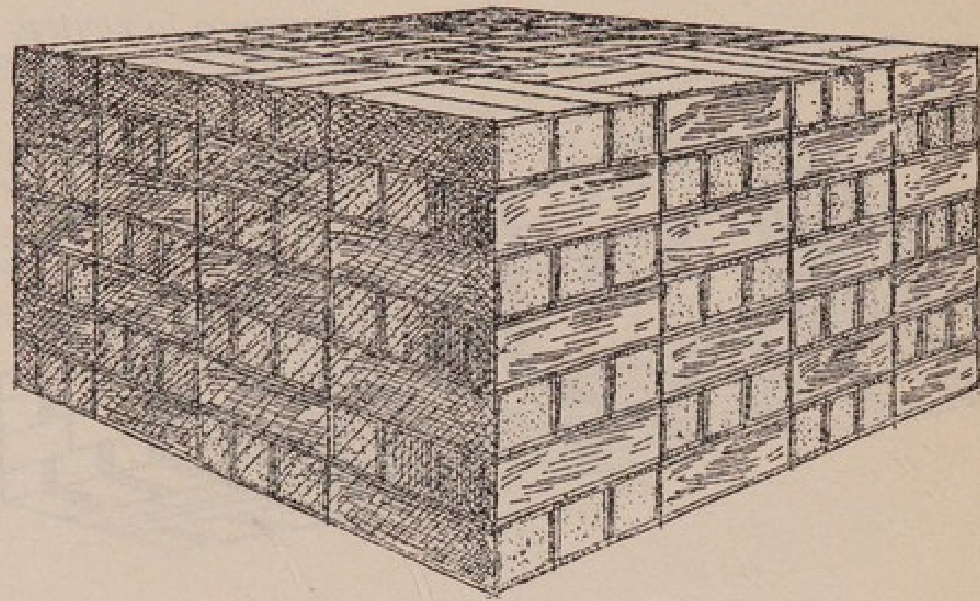


Fig. 2.—*The completed stack*



NOTE.—Each tier consists of a group of three cases, the divisions between each being at right angles to the divisions of cases in every alternate tier.

This is the most secure method of stacking cases in column formation, but can only be employed with cases the length of which is approximately three times that of their breadth or width.

Method of counting.

Multiply the number of cases in height by the number of towers in the stack, then multiply the total by 3.

Contents of above stack $= 7 \times 16 \times 3 = 336$ cases.

PLATE 47.—TOWER STACKING IN FIVES

(Cased goods)

Fig. 1.—To indicate construction

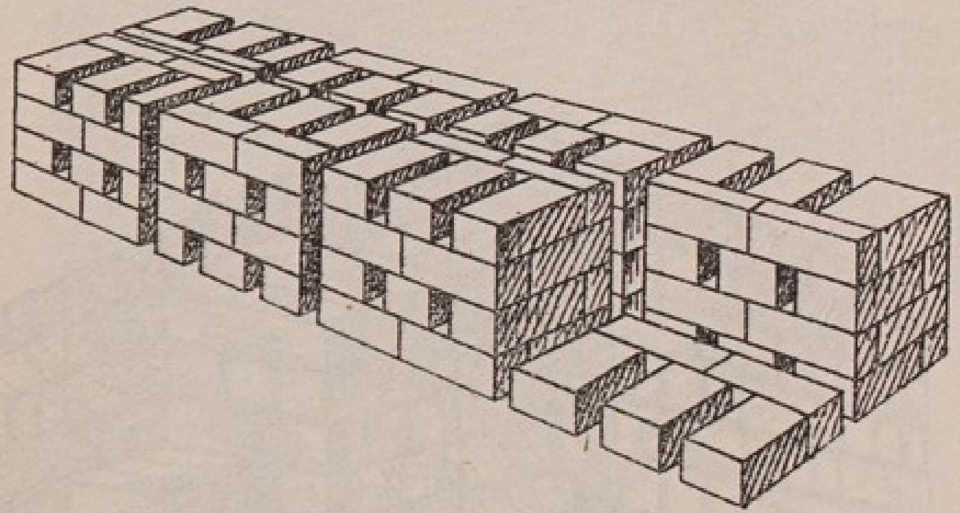
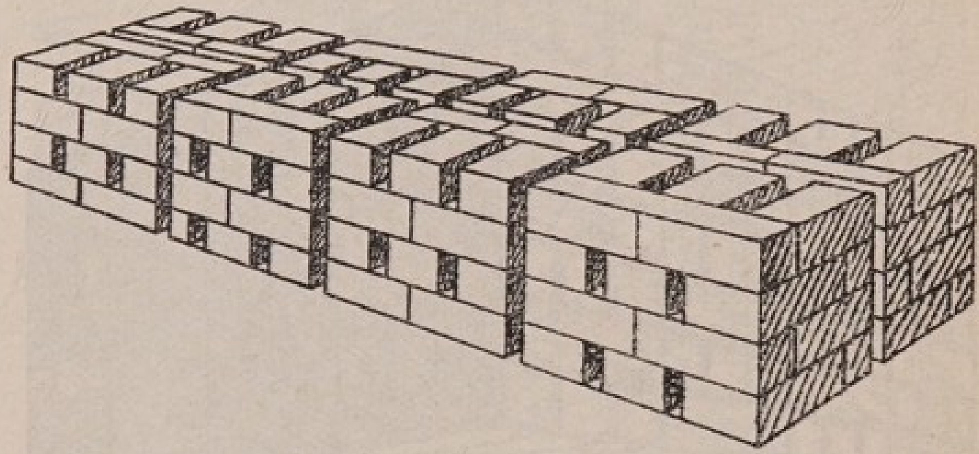


Fig. 2.—The completed stack



NOTE.—The base of a tower is oblong. Each tier consists of five cases, two of which are placed end to end and the remaining three at right angles to the first two cases.

The position of cases in each following tier is reversed so that all divisions between cases are overlapped by cases above.

Method of counting.

Count the number of cases in height at the corner of a tower and the number of towers in a stack; multiply these together and then multiply their product by 5.

Contents of the above stack $= 4 \times 8 \times 5 = 160$ cases.

Plate 48.—Tower Stacking in Sevens

(Cased goods)

Fig. 1.—To indicate construction

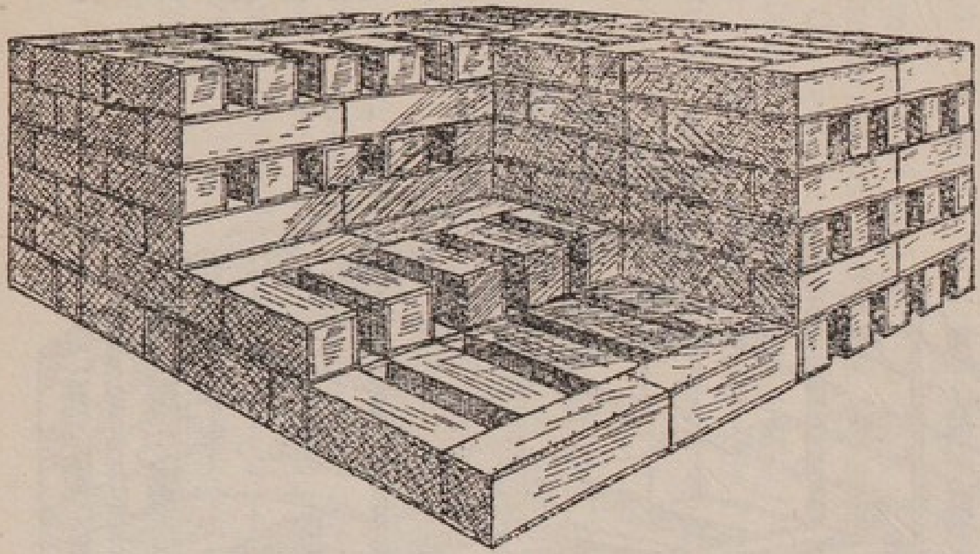
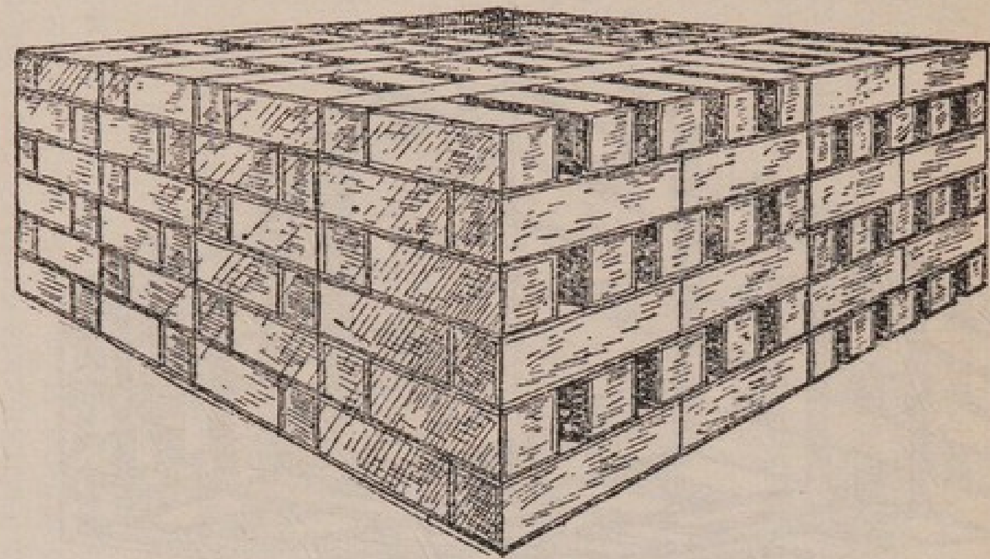


Fig. 2.—The completed stack



Note.—The base of a tower is oblong. Each tier consists of seven cases, two of which are placed end to end and the remaining five arranged at right angles to the first two cases. The position of cases in each following tier will be reversed so that all divisions between cases are overlapped by cases above.

Method of counting.

Count the number of cases in height at the corner of a tower and the number of towers in a stack; multiply these together and then multiply the totals by 7.

Contents of above stack $= 6 \times 8 \times 7 = 336$ cases.

PLATE 49.—TOWER STACKING WHEN VENTILATION IS NECESSARY

(Cased goods)

Fig. 1.—To indicate construction

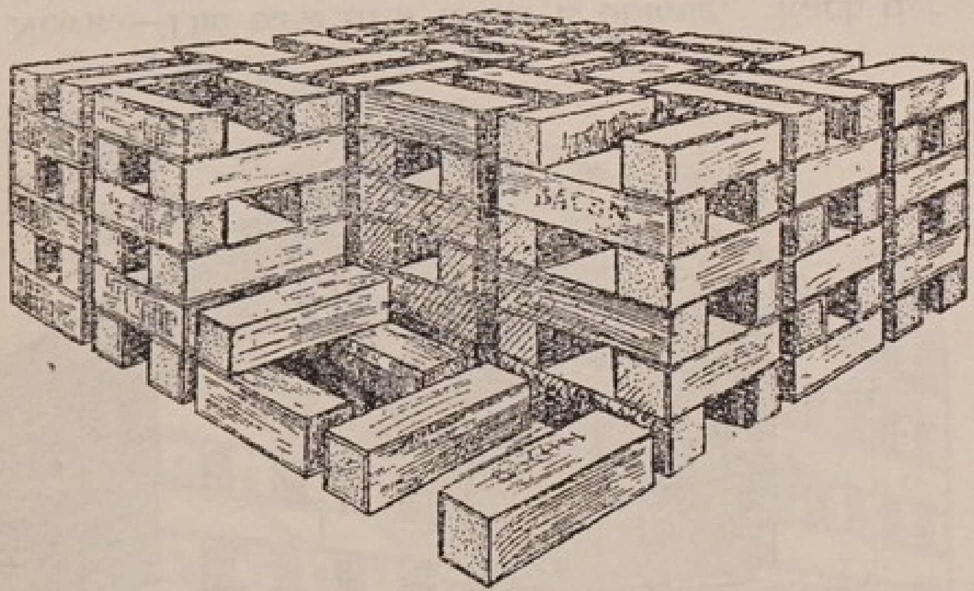
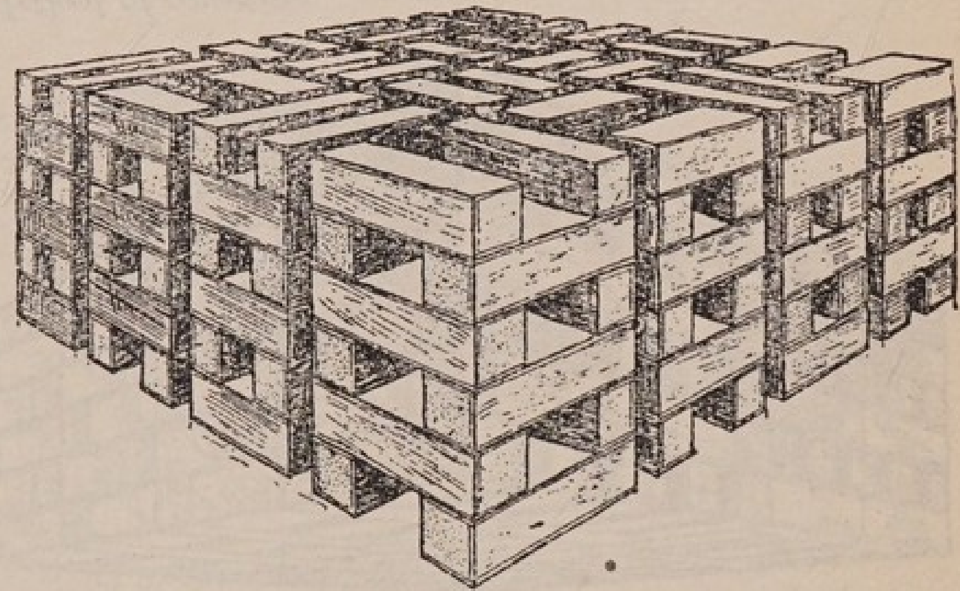


Fig. 2.—The completed stack



NOTE.—Each tier is composed of two cases, the outside faces of which are flush with those above and below. Each column is separated from the next by a distance of 6 or 8 inches.

Method of counting.

Count the cases in height at the corner of one column, double this total, and then multiply the result by the number of columns in the stack.

Contents of above stack $= 6 \times 2 \times 16 = 192$ cases.

5. " *Pillar pile* " *stacking*. (Plate 45, page 250).—This form of stacking requires more ground space than " square case " or " tower stacking in threes," but it enables stacks to be built to an appreciable height, and supplies are preserved in better condition because of the existence of a central air shaft.

6. " *Tower* " *stacking*.—When the length of cases measures approximately three times their width or height, they should be stacked, as shown in Plates 46 to 48, by " tower " stacking, either in " threes " " fives " or " sevens." All the towers should be built independently, and the cases of one tower should not intersect the cases of another. " Tower stacking in sevens " occupies more space than " Tower stacking in threes," but the base of the " tower " is larger, and the stacks may be built to a greater height with safety.

162. *Stacking of sacked goods*

(*See* Plates 50 to 52)

1. The greatest inconvenience experienced in stacking sacks of grain, bran, sugar, rice, etc., is a tendency for the sacks to slip ; even though the outside appearance may look regular, some internal inaccuracy frequently causes the sides to bulge and give way. This is due either to an unreliable consistency (i.e. too loose or too tight stacking) or to building too high.

2. *Slanting walls and thrusts*.—When the outside walls of a stack lean inwards, an outward pressure is directed upon the base, with the result that the tiers, generally the second to sixth, are displaced.

If the walls tend to slant outwards, the thrust will be directed internally and displacement will take effect at a higher level.

3. *Stacking in sixes* (Plate 50, page 256).—The advantage of this form of stacking over the old " bulkhead " method is the independence of each column, making stock-taking easy, and enabling stacks to be built to a greater height.

When the stacking is in sixes, each tier directs the thrust to its own centre; sacks are thinner at the neck or ear end than at the base, so that when the ears of all sacks are placed towards the centre of each pile they tend to slide together on to the dividing line. This internal thrust makes the columns secure in themselves and independent of those adjacent.

PLATE 50.—STACKING IN SIXES

(Sacked goods)

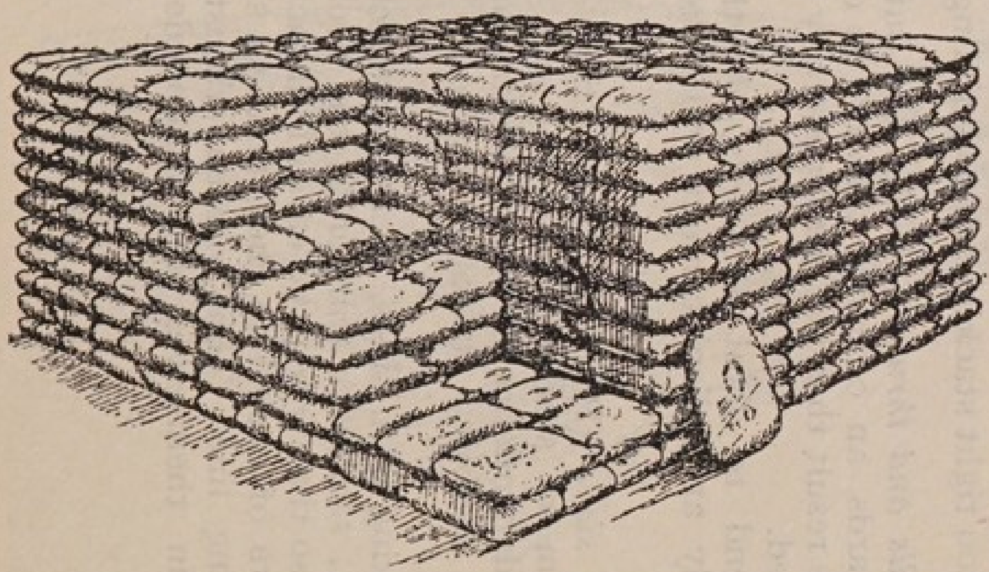


Fig. 1.—To indicate construction

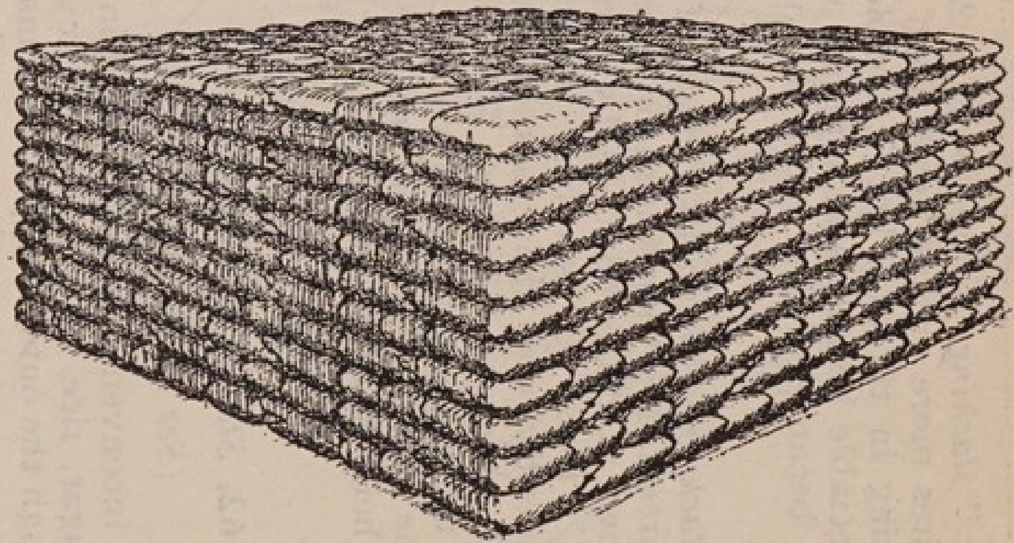


Fig. 2.—The completed stack

Method of stacking.

Every tier consists of six sacks; placed so that the ears meet in a central line, the position of each following tier will be reversed.

When this method is used for stacking bran, dunnage should be placed between each tier.

Method of counting.

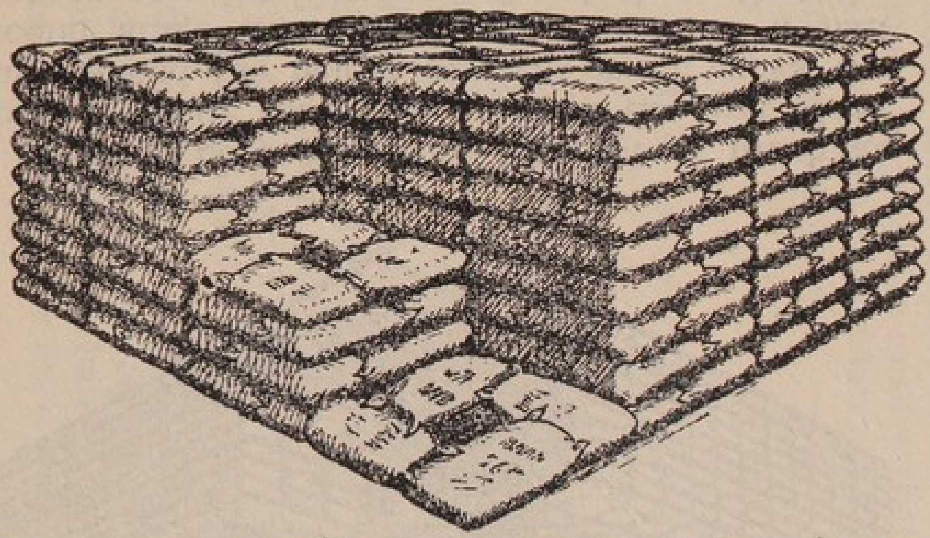
Count the number of tiers in one column and the number of columns in the stack; multiply these together and then multiply the total by 6.

Contents of above stack $= 11 \times 16 \times 6 = 1{,}056$ sacks.

Plate 51.—Pillar Pile Stacking

(Sacked goods)

Fig. 1.—To indicate construction

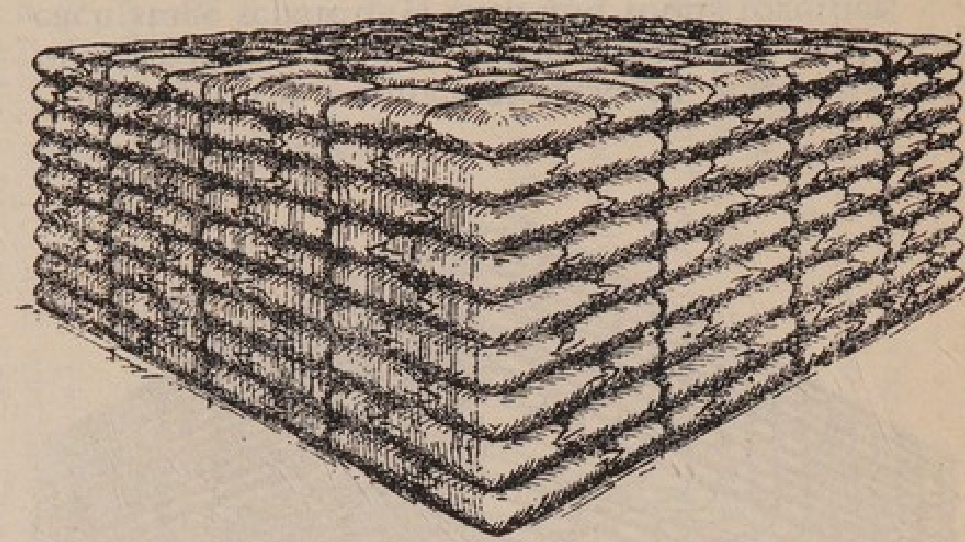


Method of stacking.

The tiers consist of four sacks each ; placed so that the long sides of a sack are parallel with the long sides of the sack lying opposite, the sacks of the following tiers will be intersected by the divisions of sacks underneath.

This method is not advocated when it is necessary to stock bran for a long period.

Fig. 2.—The completed stack



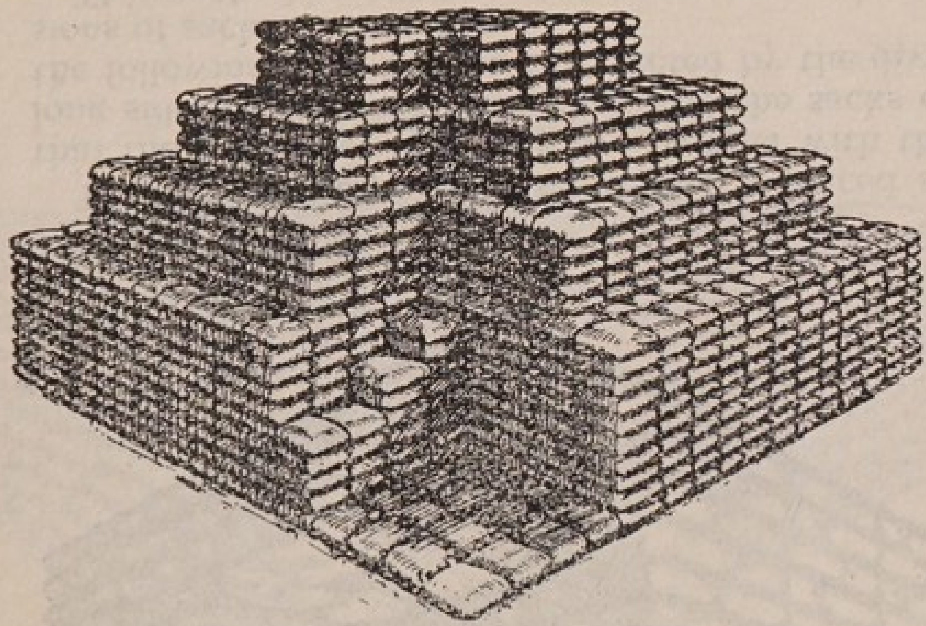
Method of counting.

Multiply the number of sacks in height by the number of columns in the stack, and then multiply the total by 4.

Contents of above stack $= 9 \times 16 \times 4 = 576$ sacks.

PLATE 52.—STACKING SHORT SACKS

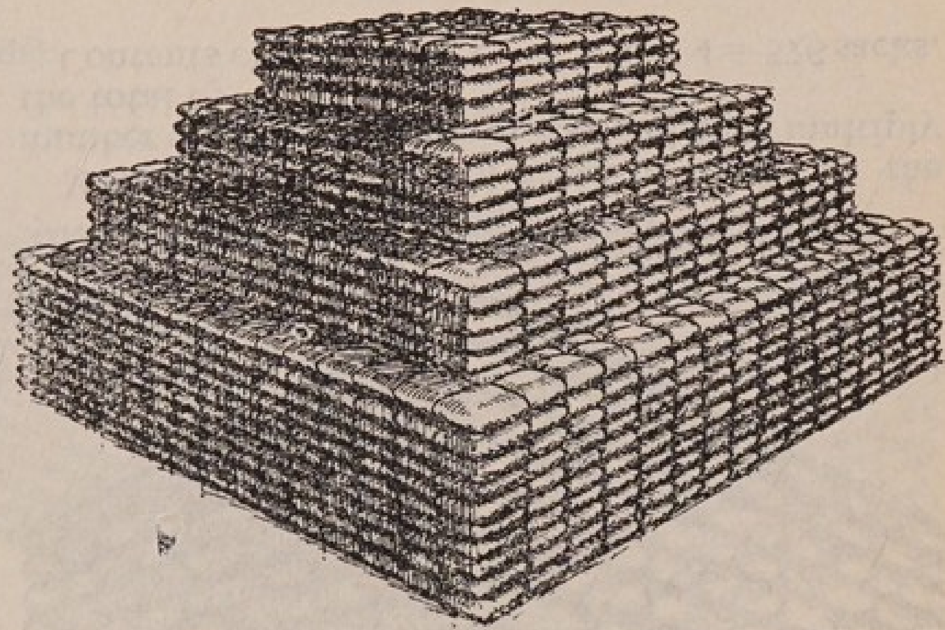
Fig. 1.—*To indicate construction*



NOTE.—The ears should be kept as much as possible inside the stack. When the first block has reached the height of eight or ten sacks, the second stage should be begun one and a half sacks nearer the centre of the stack, so that the divisions between the bags do not correspond to those beneath.

When large stacks are to be built it will be found advisable to recede half a stack towards the centre when adding each stage.

Fig. 2.—*The completed stack*



Method of counting.

Multiply the number of sacks in height by the number in length, and by the number in width, of each stage separately, then add totals together.

1st stage	..	$10 \times 16 \times 16 =$	2,560
2nd ,,	..	$5 \times 13 \times 13 =$	845
3rd ,,	..	$5 \times 10 \times 10 =$	500
4th ,,	..	$4 \times 7 \times 7 =$	196
			4,101 sacks.

Contents of above stack = 4,101 sacks.

4. *Stacking in the open.*—When it becomes necessary to stack sacks in the open, *the stacks must be built on dunnage.* Tarpaulins will be required as protection, and a sloping roof formation is essential.

When a height of twelve or fifteen sacks has been reached, a second stage should be constructed half a column nearer the centre, and built up five sacks higher before the third stage is begun. It should be noted that a slight angle is sufficient for drainage purposes, and is more quickly built and covered over than high angular ridges.

5. *Bran stacked in pillar pile.*—Bran when stacked in any solid formation is liable to become hot and deteriorate; it should therefore be stored under cover in "Pillar pile" formation (Plate 51, page 257), *or, when in large quantities, in tiers of six, with dunnage placed between each tier.*

Care should be taken not to build the stack too high, eight or ten sacks being about a desirable limit. Bran which has been pillar piled has been found to keep in good condition for a limited period, owing to the ventilation this method affords.

6. *Stacking of short sacks, oats, maize, etc.*—Where sacks measure the same length and width, a special form of stacking is necessary (Plate 52, page 258). The first stage should be carried up to a height of ten sacks, all ears should point as much as possible to the centre, and when each stage is added, great care must be taken to ensure that the foundation sacks cross the intersections of the tiers beneath, thus binding and strengthening the structure.

163. *Stacking of compressed hay*

(*See* Plate 53, page 260)

1. Bales of hay vary in size, weight and compression, so that no definite rules can be adhered to in building stacks. The best and strongest bales should be retained for the outside walls and corners; each bale should be intersected by the division of the two bales lying immediately underneath. When a stack is nearing completion, the part left until the last should be within one of the sides and not the corners. It is desirable to construct the corners and three walls slightly in advance of the interior.

2. *Stocktaking* presents difficulties, and, therefore, it is necessary during the period of construction to keep a rigid check upon the number of bales built into a stack. Tally-boards of receipts and issues must be kept up to date.

Plate 53.—Stacking Compressed Hay

Fig. 1.—To indicate construction

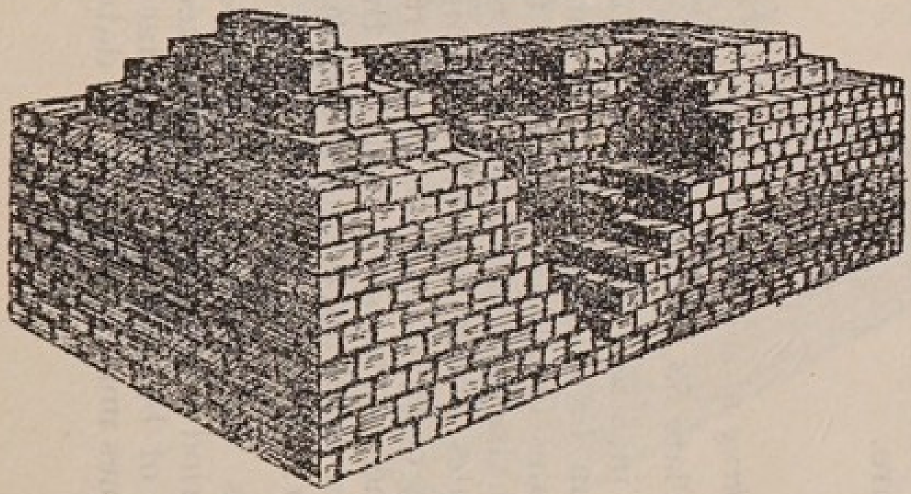
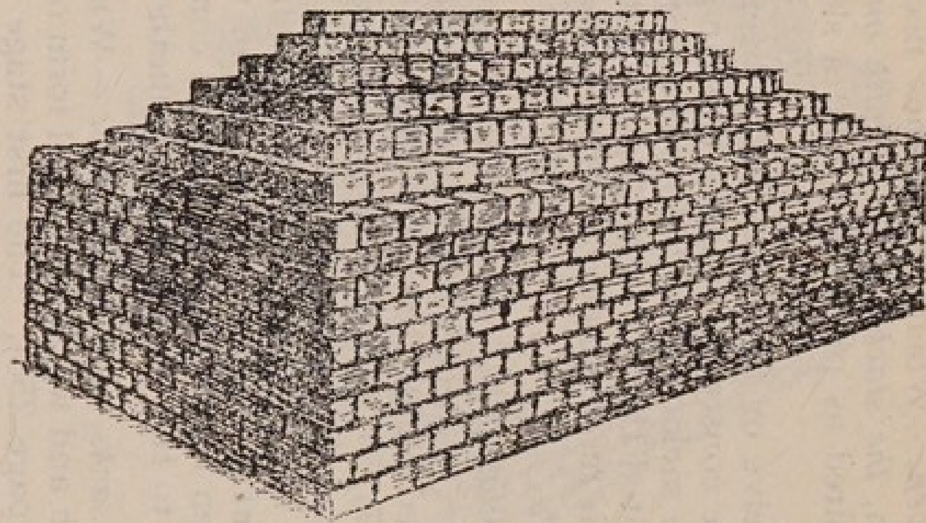


Fig. 2.—The completed stack



Method of stacking.

Retain the best and largest bales for constructing the outside walls and corners and see that the divisions between bales do not correspond with the divisions on the tiers above or beneath. As a general rule the first stage should be carried up to a height of seven to ten bales and the following stages recede half a bale towards the centre of the stack.

Note.—Owing to the various sizes of bales of hay, the different weights and compression, it is impossible to estimate accurately the contents of a stack. The only reliable method of stocktaking is from the original checking and the careful entries of receipts and issues on to the tally-board.

3. *Sheeting of hay stack.*—In order to prevent hay being damaged by rain, stacks must be carefully protected by sheeting.

A convenient method is to fix tarpaulins between the first and second stages, allowing them to hang down to the ground and cover all four sides ; when the stack is completed, these tarpaulins will be overlapped by those placed upon the ridge or roofing.

4. The method of estimating the weight of hay in a hayrick is described in Animal Management.

164. *Storage of petrol*

1. Petrol is stored in one of the following ways :—

i. In bulk in tanks.
ii. In 2-gallon cans or 4-gallon tins uncased.
iii. In 2-gallon cans or 4-gallon tins cased.
iv. In 50-gallon steel drums.

Bulk Storage

2. Bulk tanks are usually built underground and have a capacity of about 5,000 to 10,000 gallons.

3. *Measuring petrol in bulk.*—For the purposes of stock-taking or checking at any time, the following precaution to ensure an accurate reading is necessary :—

The contents of the tanks should be checked at a definite time daily, the time to be fixed so that as long a period as possible shall have elapsed since the last issue.

4. In dipping the tanks the greatest care should be taken to ensure that an accurate dip reading is obtained.

The dip rod should be lowered gently to the bottom of the tank, and be kept exactly vertical. As soon as it touches the bottom it should be withdrawn quickly.

Two or three dips should be taken before recording a reading. Dipping should not be done until the " wash " of the contents has subsided.

The dipstick should be absolutely dry before use, as any moisture on the stick will cause the petrol to " creep " and give a false reading.

5. Testing for water is carried out by means of litmus paper fixed to the end of the dipstick by two metal clips.

Litmus paper is pink in colour; it turns white in water but is unaffected by petrol and oils.

6. The volume of petrol is considerably influenced by temperature changes. If the temperature of the petrol in the tank is different at one dipping from that of a previous dipping, the volumes in the two cases will not be directly comparable and the difference between the two will not represent the volume of petrol which has been taken out or added in the interval between the two dippings.

7. Variations in volume due to temperature changes are less in the case of tanks well buried than in the case of relatively exposed tanks.

Fire Precautions

8. All motor spirits are highly inflammable at ordinary temperatures, i.e. their flash points are low. Extreme care must therefore be used in handling these products. A mixture of 2 per cent. of motor spirit in air will explode on the application of a flame.

Motor spirit, therefore, should never be handled in proximity to lights (except specially enclosed electric lamps) or fires.

9. In the case of fire, water should on no account be used, as it merely sinks below the oil and may cause the burning material to spread. Recourse must therefore be had to chemical extinguishers, steam, sand, earth or similar inert materials. It should be noted that the products of thermal decomposition of carbon tetrachloride, the most popular chemical extinguisher, are both corrosive and poisonous.

10. All buildings in which motor spirit is stored should be well ventilated on account of the heavy vapours which are readily given off, and for the same reason motor spirits should not be stored in open vessels. Breathing of the vapours given off by motor spirits must be avoided; otherwise gassing may result.

11. For further details regarding storage of motor spirits and fire precautions, *see* Regulations for Army Fire Services.

Storage of Canned Petrol

12. The 4-gallon tin is used in certain stations abroad, but the 2-gallon can is the standard small container most commonly used in the Army.

13. *Petrol in cans*.—Two-gallon cans should be stacked *five* high. (*See* Plate 54, page 263.)

PLATE 54.—STACKING PETROL CANS (2-GALLON)

Fig. 1.—To indicate construction

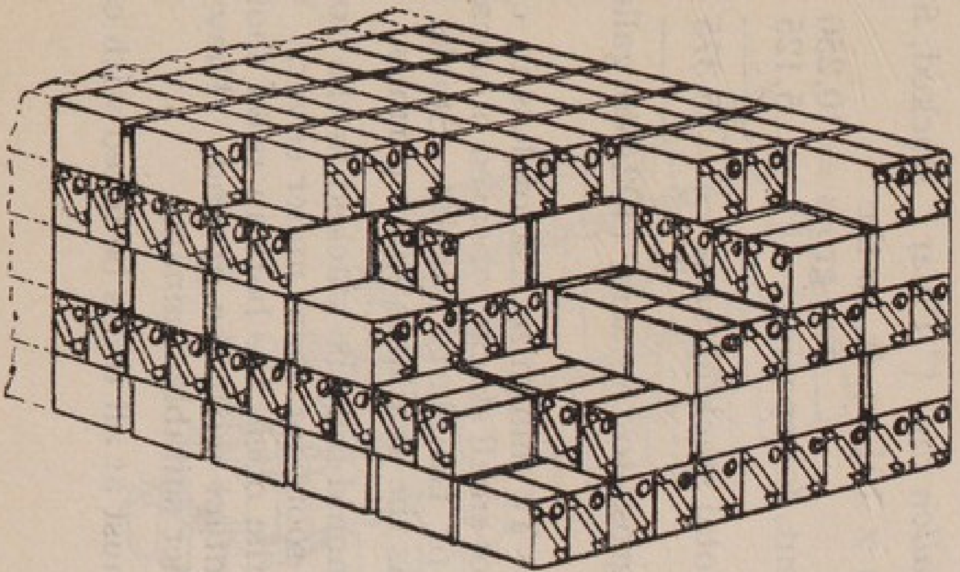
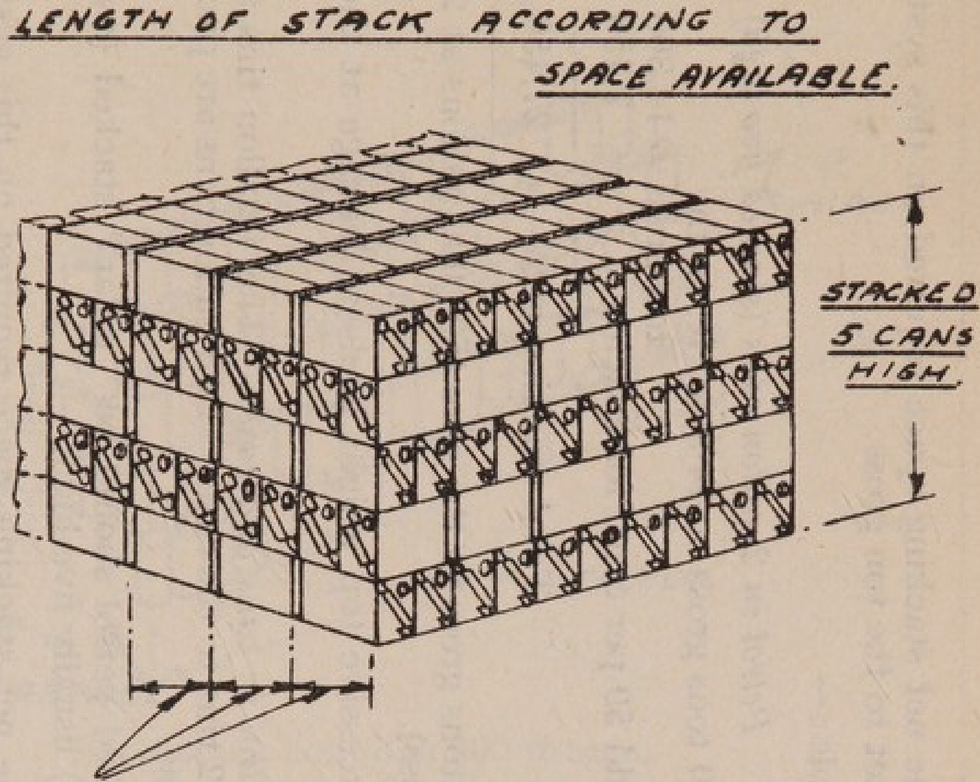


Fig. 2.—The completed stack



Each section contains 50 cans.
Number of sections × 50 = Number of cans.
Number of cans × 2 = Number of gallons.

14. The net stacking space required on this system is 14·3 square feet to the ton gross.

Example :—

Petrol in 2-gallon cans (*stacked five high*)

1,000 tons gross × 14·3 sq. ft. to the ton gross	=	14,300 sq. ft.
Add 50 per cent. for spacing	=	7,150 ,, ,,
Total stacking area		21,450 ,, ,,

or 2,000 tons gross to the acre (500,000 gallons at 250 gallons a ton gross).

15. Excessive top weight leads to leakage at the seams of the cans.

16. *Petrol in cans and cases.*—The 4-gallon tins are packed in cases, 2 tins to the case. Two-gallon cans are packed 4 cans to the case.

17. Cased petrol should be "pillar" stacked (*see* Plate 45, page 250) usually five high.

18. The net stacking space required on this system is 10¼ square feet a ton gross weight.

Example :—

Cased petrol in 2-gallon cans ("Pillar" stacked, five high).

1,000 tons gross × 10¼ sq. ft. to the ton gross	=	10,250 sq. ft.
Add 50 per cent. for spacing	=	5,125 ,, ,,
Total stacking area		15,375 ,, ,,

or, say, 2,800 tons gross to the acre, (492,800 gallons at 176 gallons a ton gross).

19. *Size of stacks.*—To minimize risk of loss in case of fire, etc., a large number of small stacks, of cased or uncased petrol, is better than one or two large stacks. Stacks should be dispersed as widely as the available space permits.

20. Empty cans should only be stacked in the open when it is impossible to find room for them under cover. When they have to be kept in the open, the bottom rows should not be allowed to lie in contact with the ground. They should be laid on boards or other suitable dunnage.

21. Empty cans must at all times be fitted with caps.

PLATE 55.—STACKING OIL DRUMS (5-GALLON)

Fig. 1.—To indicate construction

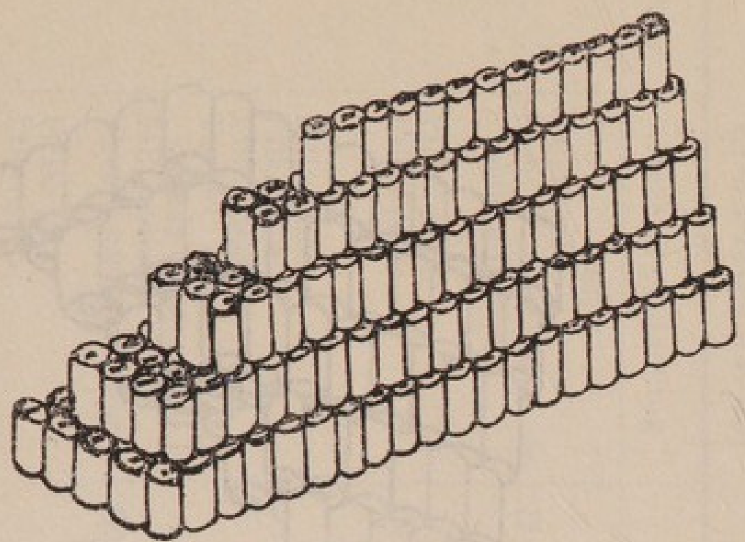
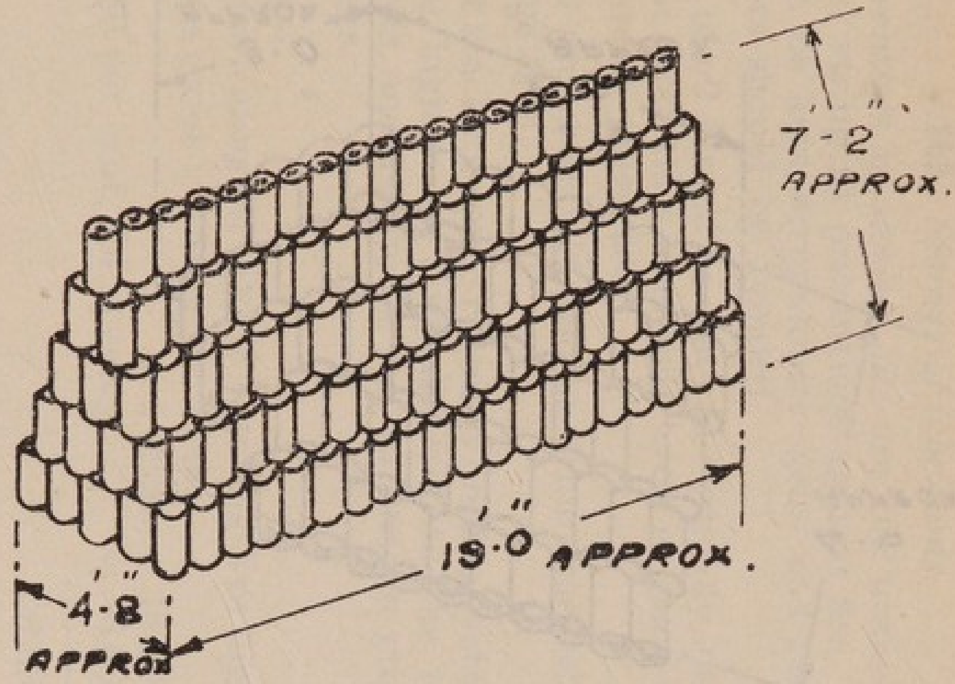


Fig. 2.—The completed stack



Each stack contains 300 drums.
1 drum contains 5 gallons.
Stack contains 1,500 gallons.

PLATE 56.—STACKING GREASE KEG (10-LB.)

Fig. 1.—To indicate construction

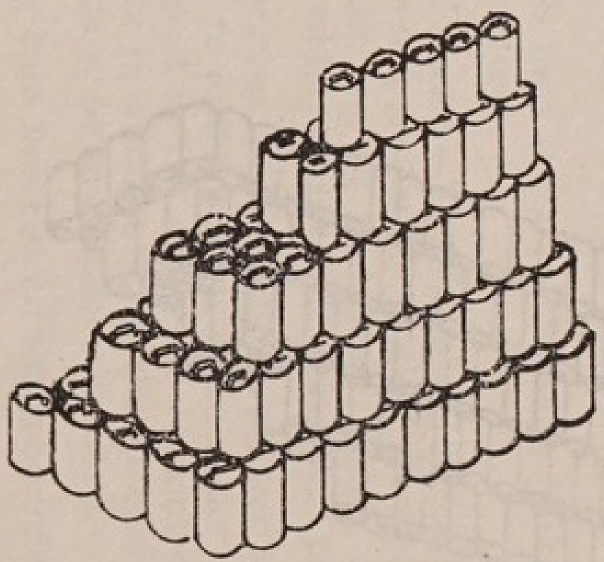
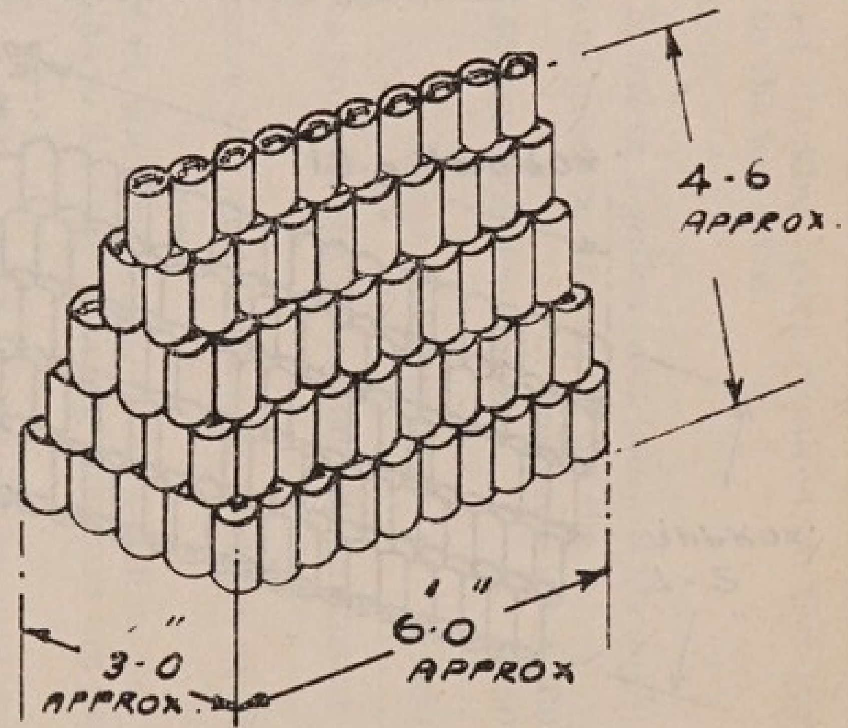


Fig. 2.—The completed stack



Each stack contains 150 kegs.
1 keg contains 10 lb. of grease.
Weight of stack = 1,500 lb.

165. *Storage of lubricants*

1. The essentials in *storing oils* are the utmost cleanliness and the most stringent precautions against fire. Drums and floors should be kept scrupulously clean and the practice of sanding floors should be avoided.

2. Drums of oil should be stacked vertically, preferably four high, and not more than five high, even if space is lacking, as shown in Plate 55 (page 265).

3. Kegs of grease should also be drum stacked as shown in Plate 56 (page 266).

4. The net stacking space required on this system of vertical stacking five high is 13·2 square feet to the ton gross for lubricating oils, and 14 square feet to the ton gross for grease packed in kegs.

Example :—

Lubricating oil (Drum stacking five high)

1,000 tons gross × 13·2 sq. ft. to the ton gross	= 13,200 sq. ft.
Add 50 per cent. for spacing	= 6,600 ,, ,,
	19,800 ,, ,,

or, say, 2,000 tons gross to the acre.

166. *List of supplies and methods of stacking*

(*See* Plates 44–56)

Nature of supplies	Method of stacking	Remarks
(1)	(2)	(3)
Arrowroot	Pillar pile.	
Bacon	Special stacking as shown in plate.	If stock is limited cases to be placed singly on end.
Biscuits	Pillar pile.	
Bran	Pillar pile.	Both 56-lb. and 112-lb. sacks to be stacked thus.
Brandy	Pillar pile.	
Butter	Pillar pile.	
Calves' foot jelly ..	Pillar pile.	
Candles	Tower stacking in threes or sevens.	
Champagne	Pillar pile.	
Cheese	Square case stacking.	Only applies to cheese in cases.
Cornflour	Pillar pile.	
Condensed milk ..	Pillar pile.	

Nature of supplies	Method of stacking	Remarks
(1)	(2)	(3)
Cigarettes	Pillar pile.	
Cocoa powder ..	Pillar pile.	
Flour	Tiers of six.	
Fruits, preserved ..	Square case stacking.	If oblong cases, to be stacked in pillar pile.
Grease, M.T. ..	Drum stacking if in kegs.	
Grocery rations ..	Pillar pile.	
Hay	As shown in plate.	
Iron rations	Pillar pile.	If square cases, to be stacked accordingly.
Jam	Square case stacking.	*See* marmalade.
Lime-juice	Tower stacking in threes or sevens.	
Linseed	Tiers of six.	
M. and V. rations ..	Pillar pile.	If square cases, to be stacked accordingly.
Maize..	Tiers of six.	If short sacks, to be stacked as shown in plate.
Marmalade	Square case stacking.	If oblong cases, to be stacked in pillar pile.
Meat extract ..	Pillar pile.	
Meat, preserved ..	Square case stacking.	If oblong cases, to be stacked in pillar pile.
Mustard	Pillar pile.	
Oats	Tiers of six.	If short sacks, to be stacked as shown in plate.
Oatmeal	Pillar pile.	
Oils, lubricating ..	Drum stacking.	Four or not more than five high.
Pearl barley ..	Pillar pile.	
Pepper	Pillar pile.	
Petrol (in tins) ..	As shown in diagram.	Not more than five high.
Petrol (in tins and cases).	Pillar pile.	
Port wine	Pillar pile.	
Rice	Tiers of six.	
Roast fowl	Pillar pile.	
Rum	Tower stacking in threes or sevens.	
Salt	Pillar pile.	Must not be stacked too high or sacks will burst.
Sago	Pillar pile.	
Stout	Pillar pile.	
Straw	As for hay.	
Sugar..	Tiers of six or pillar pile.	When in large quantities, to be stacked in pillar pile.
Tea	Pillar pile.	
Tobacco	Pillar pile.	
Whisky	Square case stacking.	
Vegetables, preserved	Pillar pile.	

APPENDIX I

SUGGESTED SCALE OF EQUIPMENT FOR A SMALL SUPPLY DEPOT SUPPLYING 7,500 MEN

(Issued as a guide only)

Description of stores		No.
Section E.3.		
Posts, picket, garrison, 5-feet, Mk. III ..		24
Section F.		
Chisels, ripping		1
Hammers, carpenters', claw, 1-lb. 8-oz. ..		1
,, sledge, straight pane, 7-lb. ..		1
Mallets, boxwood		1
Mauls (complete)		1
Nail pullers		1
Saws, tenon, 14-in.		1
Section G.1.		
Nails, assorted	lb.	2
Section H.1.		
Chalk, white	lb.	1
Soap, yellow	,,	10
Section H.2.		
Hessian	yds.	60
Twine, packing	lb.	$1\frac{1}{2}$
Section J.		
Axes, felling (complete)		2
,, ,, helves	(spare)	2
,, pick, $4\frac{1}{2}$-lb. head (complete)		2
Boxes, stationery, field, large		1
Buckets, water, canvas, Mk. V		3
Covers, waterproof, black, G.S., 15-ft. × 20-ft.		10
,, ,, ,, ,, 30-ft. × 30-ft.		20
Flags, distinguishing Supply Depot, Mk. III		1
,, crossbars		1
,, poles, 16-ft.		1
Kettles, camp, Mk. III		3
Panniers, G.S.		1
Posts, picketing, $2\frac{1}{2}$-ft.		24
Ropes, picketing, 66-ft.		6
Screens, latrine..		6
Sheets, ground, Mk. VIII		15
Shovels, G.S.		2
Stools, camp, Mk. IV		2
Stoves, soyers		1
Tables, camp, Mk. III..		2
Tents, C.S., Mk. V (complete)		3
,, store (complete)		2
,, marquee		1

Description of stores	No.
Section K.	
Blankets, brown, single	30
Blocks, chopping, large	1
,, ,, small	1
Chairs, windsor	3
Cloths, wiping . . yds.	10
Steels, butchers'	1
Tables, barrack, 6-ft.	12
Section L.	
Balances, spring, 4-lb.	1
Basins, soup, steel, tinned	16
,, washing, steel, 14-in.	3 (for butchers' use)
Brooms, bass	3
Brushes, scrubbing, hand, union	3
Choppers, meat, butchers'	1
Cleavers	1
Funnels, tin, 2-qt.	1
Hooks, butchers', 9-in.	2
,, ,, 13-in.	2
,, reaping, large	1
Implements, butchers'—	
Cases, wood, empty	1
Sheets, ground, unserviceable	1
Knives, butchers', cutting	2
,, ,, flaying	1
Lamps, hurricane	8
Machines, weighing, 28-lb., spring balance	1
Measures—	
Standard, tin, 1-gal.	1
Tin—	
½-gill	1
1-gill	1
½-pt.	1
1-pt.	1
1-qt.	1
½-gall.	1
Pails, I.G., 3-gall.	4
Plates, dinner, steel, tinned	16
Saws, butchers', bow	1
,, ,, ,, blades . . (spare)	2
Scales, weighing, iron beam with triangles and set of weights, 2½-cwt., Mk. II	1
Scoops, hand, flour, 1-pt.	1
,, ,, ,, 1-qt.	1
Steelyards, 56-lb.	1
Tubs, washing, 8-gall.	4
Section W.1.	
Wire, barbed	In reels. (R.E. will supply on spot)
R.A.S.C. Supply.	
Latrine paper	As required.

List of Army Books, Army Forms and Stationery Required

	Title or purpose	Remarks
Army Book No.		
10	Waybill.	
30	Requisition.	
55A	Ration Indent.	
97	Postage Book.	
121	Register of Correspondence.	
124	Order Book	Shows stock ordered and received.
124	Receipts Book.	Each commodity allotted separate page, showing quantities issued, date, truck No., etc., and any observations.
223	Bill Book.	
298	Petty Cash.	
Army Form No.		
A 2	Proceedings of Boards of Officers.	
A 3091	Jacket for Important Documents.	
B 252	Minor Offence Report.	
B 256	Morning Sick Report.	
C 348	Memo. Form.	
C 2128	Message Pad.	
F 719	Certificate of Issues of F. & L. & Forage.	
F 727A	Camp F. & L. Account.	
F 742	Transfer State of F. & L. Balance.	
F 754	P.S. Account.	
F 755	Petrol and Lubricant Account.	
F 756	Transport Requisition.	
F 783	Discrepancy Report.	
F 3179	Schedule of Issues, Provisions.	
G 973	Camp Equipment Account.	
G 980	Carriers Notes.	
G 1033	Issue and Receipt Vouchers.	For Ordnance Equipment.
N 1487	Requisition for Cash.	If required.
O 1680	Debit Vouchers.	
P 1922	Contractors Bills.	
P 1940	Postage Account.	
P 1964	Conf. List of Bills.	

Regulations

Allowance Regulations.
Equipment Regulations.
Field Service Regulations.
Field Service Pocket Book.
King's Regulations.
Manual of Military Law.
Royal Army Service Corps Training, Vols. I, II and III
Regulations for Supply, Transport and Barrack Services.
Royal Warrant for Pay.

Stationery

Bags, paper.
Buff slips.
Carbon paper.
Clips, wire.
Drawing pins.
Envelopes.
Gum and brush.
Ink.
Inkwells.
Labels, economy.
Labels, tie-on.
Millboards.
Paper, blotting.
,, brown.
,, ruled.
,, typewriting.
,, fasteners.
Pencils.
Pens.
Pins.
Rubbers, ink and drawing.
Ruler.
Sealing wax.
Tape.
Telegraph forms.
Typewriter (if obtainable).

S.O. Books	To be used as	Remarks
124	Daily Summary of Receipts.	Issues and remains to agree with tally boards.
129	Issue Book.	One page for each unit. Issue sheets herein consolidated. One book for two or three commodities, if necessary.
129	Container Account.	One page for each unit. Receipts and issues.
136	Local Despatch Book.	

APPENDIX II

WEIGHTS, MEASURES, MONIES, ETC.

(For additional information, *see* Field Service Pocket Book)

1. *Measures of length*

	Inch	Foot	Yards	Poles	Chains	Fur-longs	Metres
Foot ..	12	1	—	—	—	—	0·30480
Yard ..	36	3	1	—	—	—	0·914399
Rod, pole or perch ..	198	$16\frac{1}{2}$	$5\frac{1}{2}$	1	—	—	5·0292
Chain ..	792	66	22	4	1	—	20·1168
Furlong ..	7,920	660	220	40	10	1	201·168
Mile ..	63,360	5,280	1,760	320	80	8	1·6093 km.

To convert yards to metres multiply by 0·914.
To convert miles to kilometres multiply by 1·609.

2. *Nautical measures*

6 feet = 1 fathom
100 fathoms = 1 cable length
10 cables = 1 nautical mile
60 nautical miles = 1 degree

The assumed length of the cable is 600 feet (182·87 metres), but it is strictly 606·97 feet (185 metres). The conventional nautical mile (the knot in speed measurements) is 10 cables assumed at 6,080 feet (strictly 6069·7 feet), but the nautical mile is strictly the length of a minute of the meridian and differs according to latitude.

3. *Particular measures of length*

Polo ground = 300 × 160 yards
Cricket pitch = 22 yards (1 chain) between the stumps
Football ground (Association) = 120 × 80 yards
League = 3 miles
Fathom = 6 feet (1·8288 metres)
Hand = 4 inches
Halfpenny = 1 inch in diameter

4. *Metric measures of length*

10 millimetres (mm.) = 1 centimetre (cm.)
= 0·39370113 inch
10 centimetres = 1 decimetre (dm.)
= 3·9370113 inches
10 decimetres = 1 metre (m.)
= 1·0936143 yards
10 metres = 1 decametre (dam.)
= 10·936143 yards
10 decametres = 1 hectometre (hm.)
= 109·36143 yards
10 hectometres = 1 kilometre (km.)
= 0·62137 mile

A kilometre is approximately five-eighths of a mile, so that 8 kilometres = roughly 5 miles.

5. *Birmingham gauge (" B.G.") for sheets and hoops*

Descriptive number	Equivalents in parts of an inch	Descriptive number	Equivalents in parts of an inch
No.	inch	No.	inch
15/0 B.G.	1·000	20 B.G.	0·0392
14/0 B.G.	0·9583	21 B.G.	0·0349
13/0 B.G.	0·9167	22 B.G.	0·03125
12/0 B.G.	0·8750	23 B.G.	0·02782
11/0 B.G.	0·8333	24 B.G.	0·02476
10/0 B.G.	0·7917	25 B.G.	0·02204
9/0 B.G.	0·750	26 B.G.	0·01961
8/0 B.G.	0·7083	27 B.G.	0·01745
7/0 B.G.	0·6666	28 B.G.	0·015625
6/0 B.G.	0·625	29 B.G.	0·0139
5/0 B.G.	0·5883	30 B.G.	0·0123
4/0 B.G.	0·5416	31 B.G.	0·0110
3/0 B.G.	0·500	32 B.G.	0·0098
2/0 B.G.	0·4452	33 B.G.	0·0087
1/0 B.G.	0·3964	34 B.G.	0·0077
1 B.G.	0·3532	35 B.G.	0·0069
2 B.G.	0·3147	36 B.G.	0·0061
3 B.G.	0·2804	37 B.G.	0·0054
4 B.G.	0·250	38 B.G.	0·0048
5 B.G.	0·2225	39 B.G.	0·0043
6 B.G.	0·1981	40 B.G.	0·00386
7 B.G.	0·1764	41 B.G.	0·00343
8 B.G.	0·1570	42 B.G.	0·00306
9 B.G.	0·1398	43 B.G.	0·00272
10 B.G.	0·1250	44 B.G.	0·00242
11 B.G.	0·1113	45 B.G.	0·00215
12 B.G.	0·0991	46 B.G.	0·00192
13 B.G.	0·0882	47 B.G.	0·00170
14 B.G.	0·0785	48 B.G.	0·00152
15 B.G.	0·0699	49 B.G.	0·00135
16 B.G.	0·0625	50 B.G.	0·00120
17 B.G.	0·0556	51 B.G.	0·00107
18 B.G.	0·0495	52 B.G.	0·00095
19 B.G.	0·0440		

6. *Square or surface measure*

	Sq. in.	Sq. ft.	Sq. yd.	Pls.	Sq. ch.	R.	Sq. metres, etc.
Square foot	144	1	—	—	—	—	9·2903 sq. decimetres.
Square yard	1,296	9	1	—	—	—	0·836126 sq. metres.
Rod, pole or perch ..	39,204	272¼	30¼	1	—	—	25·293 sq. metres.
Square chain	627,264	4,356	484	16	—	—	—
Rood ..	1,568,160	10,890	1,210	40	2½	1	—
Acre ..	6,272,640	43,560	4,840	160	10	4	0·40468 hectare.

640 acres = 1 square mile = 2·53995 square kilometres.
To convert acres to hectares multiply by 0·405.

N.B.—The term "square feet" must not be confounded with the term "feet square." A piece of cloth measuring 6 square feet consists of 6 squares of a foot each, but a piece measuring 6 feet square is 6 feet along each side, and comprises 36 squares of a foot each. Square measure is computed by multiplying the length by the breadth.

7. *Cubic or solid measure*

A cube is a solid body, and contains length, breadth and thickness, having six equal sides. A cube number is produced by multiplying a number twice into itself, thus: 64 is a cube number, the cube of 4. $=4 \times 4 \times 4 = 64$.

1,728 cubic inches	= 1 cubic foot = 0·028317 cubic metre
27 cubic feet	= 1 cubic yard = 0·764553 cubic metre
40 cubic feet of rough, or 50 cubic feet of hewn timber	= 1 ton or load
108 cubic feet	= 1 stack of wood
128 cubic feet	= 1 cord of wood
16 cubic feet of wood	= 1 "fort" of wood
40 cubic feet	= 1 ton shipping

In marine circles cubic feet and cubic inches of shipping tonnage are expressed as feet and inches. The method of calculation adopted is taken from "The Merchant's and Ship Master's Ready Calculator and Complete Pocket Assistant."

The following is an example :—

Dimensions of case $= 11 \times 15 \times 22$ inches $= 2{,}630$ cubic inches.

$$\begin{array}{l} \text{Divide by } 1728)3630(2 \text{ feet} \\ \qquad\qquad\qquad\;\; \underline{3456} \\ \tfrac{1}{12} \text{ of } 1728 = 144)\ 174(1 \text{ inch} \\ \qquad\qquad\qquad\;\; \underline{144} \end{array}$$

Therefore the cubic measurement of the case is 2 feet 1 inch.

Assuming that 26 cases go to the ton gross weight, the cubic measurement of 1 ton gross weight will be 54 feet 2 inches.

Details of dimensions of packs, cubic measurement, etc., for all supply commodities are given in Appendix III.

8. *Liquid measure*

		Gals.		*Qts.*		*Pts.*	*Litres.*
4 gills, 1 pint	=	—		—		—	0·568
Quart	=	—		1	=	2	1·136
Gallon	=	1	=	4	=	8	4·5459
Firkin or quarter-barrel	=	9	=	36	=	72	—
Kilderkin or half-barrel	=	18	=	72	=	144	—
Barrel	=	36	=	144	=	288	—
Hogshead of ale ($1\frac{1}{2}$ barrels)	=	54	=	216	=	432	—
Butt of ale (3 barrels)	=	108	=	432	=	864	—

Practically the only measures in use are gallons and quarts, the others are merely nominal, e.g. the hogshead of 54 gallons, old measure, contains but 52 gallons, 1 quart, 1 pint and 3·55 gills imperial measure, and of wine 6 nominal quart bottles go to the gallon.

The customary glass bottle of wine or spirits should contain one-sixth of a gallon = $26\frac{2}{3}$ fluid ounces.

To convert gallons to litres multiply by 4·54.

9. *Dry or corn measure*

4 quarts	=	1 gallon
2 gallons	=	1 peck
4 pecks	=	1 bushel
3 bushels (4 of corn)	=	1 sack
12 sacks	=	1 chaldron
8 bushels	=	1 quarter
5 quarters	=	1 load

A quarter of wheat measures, roughly, 10 cubic feet.

A quartern loaf = 4 lb.

A quarter is a heaped measure of 8 bushels. A quarter of English wheat is reckoned at 504-lb. weight.

10. *Hay and straw*

Truss of straw	= 36 lb.
Truss of old hay	= 56 ,,
Truss of new hay (to September 1)	= 60 ,,

Load, 36 trusses = straw, 11 cwt. 2 qrs. 8 lb.; old hay, 18 cwt.; new hay, 19 cwt. 1 gr. 4 lb.

An acre of grass should yield 1 to 2 tons of hay.

A cubic yard compressed hay	= about 225 lb.
A cubic yard hay in stack	= ,, 126 ,,
A cubic yard compressed straw	= ,, 145 ,,
A cubic yard straw in stack	= ,, 90 ,,
A cubic yard grain	= ,, 20 bushels

11. *Measures of weight*

Avoirdupois Weight

$27\frac{11}{32}$ grains	= 1 drachm
16 drachms	= 1 ounce = 28·350 grammes
16 ounces	= 1 pound = 0·45359 kilogramme
8 pounds	= 1 stone of butcher's meat (Smithfield stone)
14 pounds	= 1 ordinary stone = 6·350 kilograms
28 pounds	= 1 quarter (qr.) = 12·70 kilograms
4 quarters (112 lb.)	= 1 hundredweight (cwt.) = 50·8022 kilograms
20 cwt. (2240 lb.)	= 1 ton = 1016·0 kilograms (1·0160 tonnes)

This weight is used in almost all commercial transactions and common dealings.

To convert lb. avoirdupois to kilograms multiply by 0·454.

The Short Ton of 2,000 lb. is used in Canada, South Africa and the U.S.A.

12. *Troy weight*

24 grains	= 1 pennyweight = 1·5552 grammes
20 pennyweights	= 1 ounce = 31·1035 grammes

13. *Stationery table*

24 sheets of paper	= 1 quire
20 quires	= 1 ream
10 reams	= 1 bale

14. *Other useful weights and measures*

1 sovereign = 2 drams; 1 half-crown, $3\frac{1}{2}$ drs.; 1 florin, 3 drs.; 1 shilling, $1\frac{1}{2}$ drs.; 1 threepenny piece, $\frac{1}{3}$ dr.; 1 tablespoon holds 1 oz.; 1 dessert spoon, $\frac{1}{2}$ oz.; 1 teaspoon, $\frac{1}{4}$ oz.

Trade

Miscellaneous Weights and Measures

Apples (bushel)	=	37 to 43 (average 40 lb.)
Bread (gallon)	=	8 lb.
Butter (firkin)	=	56 lb.
Butter (barrel)	=	4 firkins (224 lb.)
Butter (tub)	=	84 lb.
Claret (hogshead)	=	46 gals.
Coal (sack)	=	224 lb.
Coal (bushel)	=	80 lb.
Coal (ton)	=	10 sacks
Cocoa (bag)	=	112 lb.
Coffee (bag)	=	140 to 168 lb.
Coffee (bale of Mocha)	=	224 to 280 lb.
Coffee (tierce)	=	5 to 7 cwt.
Flour (peck)	=	14 lb.
Flour (bag)	=	140 lb.
Flour (sack)	=	280 lb.
Gross	=	12 doz.
Hock (aum)	=	30 gals.
Hops (bag)	=	280 lb.
Madeira (pipe)	=	92 gals.
Marsala (pipe)	=	93 gals.
Meat (stone)	=	8 lb.
Port (pipe)	=	115 gals.
Potatoes (sack)	=	112 lb.
Rice (bag, East India)	=	168 lb.
Rice (cask, America)	=	6 cwt.
Sugar (bag)	=	112 to 196 lb.
Wood (cord)	=	128 cubic feet

15. *Weight of coal stored in the usual way*

Anthracite, a cubic yard	1,550 lb.
Other broken coal (household, bituminous, cannel, steam, etc.) average a cubic yard	1,350 lb.

16. *Specific gravities*

Weight of any volume of the following substances compared with the weight of the same volume of water.

Alcohol	= 0·79	Petroleum	= 0·88
Aluminium	= 2·67	Platinum	= 21·45
Brandy	= 0·84	Silver	= 10·51
Brass	= 8·00	Steel	= 7·75
Copper	= 8·94	Tin	= 7·29
Cork	= 0·24	Water	= 1·00
Glycerine	= 1·26	Woods—	
Gold	= 19·32	Ash	= 0·84
Ice	= 0·92	Beech	= 0·85
Iridium	= 22·38	Mahogany	= 1·06
Iron	= 7·20 to 7·79	Oak	= 1·17
Lead	= 11·35		
Mercury	= 13·60	Zinc	= 7·19

Note.—To find the weight of a cubic foot of a substance multiply the specific gravity by 62·321 lb.

To find the number of cubic feet in 1 ton divide 35·943 by the specific gravity.

17. *Measures of heat*

The following scales are used :—

Fahrenheit
Centigrade
Réaumur

Conversion table F = Fahr., C = Cent., R = Réaum.

$$F = \frac{9C}{5} + 32$$

$$C = \frac{5(F - 32)}{9} = \frac{5R}{4}$$

$$F = \frac{9R}{4} + 32$$

$$R = \frac{4(F - 32)}{9} = \frac{4C}{5}$$

$$F = C + R + 32$$

Freezing Point = 32° F. = 0° C. = 0° R.
Boiling Point = 212° F. = 100° C. = 80° R.

18. *Humidity*

The amount of moisture in the air equals the degree of humidity. The amount of moisture which air can hold or retain varies with its temperature. Thus, at 32° F. a cubic foot of dry air can take up 2·10 grs. of water, while at 100° F. it can take up as much as 19·84 grs.

When air is so full of moisture that it can contain no more, it is said to be saturated. In the United Kingdom the air contains on an average about three-fourths of the amount of water needed to saturate it, i.e. a humidity of about 75 per cent.

19. *Power and heat equivalents*

1 *Horse-power-hour* = 0·746 kilowatt-hour = 1,980,000 foot-pounds = 2550 B.Th.Us. = 2·64 pounds of water evaporated at 212° F. = 17 pounds of water raised from 62° to 212° F.

1 *Horse-power* = 746 watts = 0·746 kilowatt = 33,000 foot-pounds per minute = 550 foot-pounds per second = 2550 B.Th.Us. per hour = 42·5 B.Th.Us. per minute = 0·71 B.Th.Us. per second = 2·64 pounds of water evaporated per hour at 212° F.

1 *Kilowatt-hour* = 1000 watt-hours = 1·34 horse-power hour = 2,653,200 foot-pounds = 3,600,000 joules = 3420 B.Th.Us. = 3·54 pounds of water evaporated at 212° F. = 22·8 pounds of water raised from 62° to 212° F.

1 *Kilowatt* = 1000 watts = 1·34 horse-power = 2,653,200 foot-pounds per hour = 44,220 foot-pounds per minute = 737 foot-pounds per second = 3420 B.Th.Us. per hour = 57 B.Th.Us. per minute = 0·95 B.Th.Us. per second = 3·54 pounds of water evaporated per hour at 212° F.

1 *Watt* = 1 joule per second = 0·00134 horse-power = 0·001 kilowatt = 3·42 B.Th.Us. per hour = 44·22 foot-pounds per minute = 0·74 foot-pounds per second = 0·0035 pounds of water evaporated per hour at 212° F.

1 *B.Th.U.*—British Thermal Unit is the amount of heat required to raise one pound of water 1° F. = 1052 watt-seconds = 778 foot-pounds = 0·252 calorie = 0·000292 kilowatt-hour = 0·000391 horse-power-hour = 0·00104 pound of water evaporated at 212° F.

1 *Foot-pound* = 1·36 joule = 0·000000377 kilowatt-hour = 0·00129 B.Th.U. = 0·0000005 horse-power-hour.

1 *Joule* = 1 watt-second = 0·000000278 kilowatt-hour = 0·00095 B.Th.U. = 0·74 foot-pound.

Gas therm = 100,000 B.Th.Us.

If V = cubic feet consumed.
H = declared heat value of the company's gas (in B.Th.Us. per cubic feet).
P = cost of therm in pence.
B = total bill in pence.

Then $B = \dfrac{V \times H \times P}{100{,}000}$ Whence equivalent cost (in pence) per 1,000 cubic feet $= \dfrac{B \times 1000}{V} = \dfrac{H \times P}{100}$

20. *Foreign weights and measures*

Metric weights and measures.—In the metric system, the standard of length is the metre, the standard of weight is the kilogram and the standard of capacity is the litre. The use of the metric system was permitted in Great Britain in 1897.

The metric system has been adopted by all European countries (except Great Britain) and is permissive in all countries.

The following list gives some of the weights and measures in common use in certain countries.

China	Ko	=	2 pints (approx.).
	Shêng	=	20 pints (approx.)
	Liang weight	=	1·33 ozs. av.
	Chin ,,	=	1·33 lb. av.
	Picul ,,	=	133·33 lb. av.
	Ts'un	=	1·41 inches
	Ch'ih	=	1·175 feet
	Chang	=	11·75 feet
	Li	=	21·15 feet

Egypt and Sudan	Rotl	=	0·99 lb. av.	The metric system of weights and measures is legal in Egypt and Sudan, but is little known and rarely used outside the large towns.
	Oke	=	2·75 lb. av.	
	Kantar (=100 Rotls)	=	99·05 lb. av.	
	Ardeb of wheat	=	150 kilogrammes	
	,, barley	=	120 ,,	
	,, beans	=	155 ,,	
	,, maize	=	140 ,,	
	Qasaba (land)	=	11·65 feet	
	Pic	=	29·53 inches	
	Qirat	=	209·3 sq. yards	
	Feddan (24 Qirats)	=	1·038 acres	
	Kêla	=	0·454 bushel	
	Ardeb (12 kêlas)	=	5·444 bushels	

Greece	Ocque	= 2·84 lb.	
	Livre	= 1·1 lb.	
	Drachma	= 0·11 oz.	
	Quintal	= 132·2 lb.	
India	Tola (rupee weight)	= 180 grains	
	Chittak	= 2·0571 oz.	
	Seer (16 chittak or Botolas)	= 2·0571 lb.	
	Maund (40 Seers)	= 82·284 lb.	
	,, (Bombay)	= 27·864 lb.	
	,, (Madras)	= 24·68 lb.	
	Seer (liquid)	= 1·760 pints	
Japan	Ken	= 1·9884 yards	The metric system was adopted in Japan from July 1, 1929.
	Ri	= 2·4403 miles	
	Ri (square)	= 5·9553 sq. miles	
	Chō	= 5·423 chains	
	Chō (square)	= 2·4507 acres	
	Tsubo	= 3·9538 sq. yards	
	Kokou (liquid)	= 39·7033 gallons	
	,, (dry)	= 4·9629 bushels	
	Sho (liquid)	= 1·5881 quarts	
	,, (dry)	= 0·1985 pecks	
	Shêng	= 20 pints (approx.)	
	Kwan	= 8·2673 lb. av.	
	Kin	= 1·32 lb. av.	

(Old Maltese Measures)

Malta	Piede	= 11·166 inches	The metric system is used in Malta.
	Canna	= 2·2283 yards	
	Libbra = (12 Oncia)	= 4886 qr. Troy	
	Rotolo	= 1·745 lb. av.	

(Old Russian Measures)

Russia	Sajen	= 7 feet	Russia adopted the metric system from January 1, 1927.
	Funt	= 0·90282 lb.	
	Verst (500 Sajen)	= 1166·66 yards	
	Sq. Verst	= 0·4394 sq.miles	
	Zolotnik	= 65·8306 grains	
	3 Zolotnik	= 1 loth	
	32 Loth	= 1 funt	
	40 Funt	= 1 pood (36·1128 lb.)	
	Tcharka	= 0·2164 pint	
	10 Tcharkas (1 Shtoff)	= 1·0822 quarts	
	1 Vedro (10 Shtoffs)	= 2·705 gallons	

British Dominions	Australia and New Zealand—Same as British.
	Canada—Same as British, but with short ton of 2,000 lb. as in U.S.A.
	Newfoundland—Same as British.
	South Africa—Metric system is compulsory in the case of chemists and is permissible together with British Weights and Measures in other cases. The short ton of 2,000 lb. is used.

21. *Foreign money*

Country and monetary unit	Gold coins	Silver coins	Nominal value of unit in British currency (gold standard)	Par value
(1)	(2)	(3)	(4)	(5)
Austria—			£ s. d.	
Schilling ..	100 and 25 Schilling.	½, 1, 2 Schilling.	0 0 6·939	34·58½
Belgium—				
Franc of 100 Centimes.	20 Francs.	1, 2, 5 Francs and 50 Centimes.	0 0 6·858	35
China—				
Tael of 100 Cents. Dollar of 100 Cents. Taels 72=Dollars, 100. (Nominal)	—	1 Dollar or Yuan 5, 10, 20, 50 Cents.	1 6	Varies with price of silver.
Egypt—				
Gold pound of 100 Piastres	Egyptian pound, 50 Piastres.	2, 5, 10, 20 Piastres.	1 0 6¼	97½
France—				
Franc of 100 Centimes.	10, 20 Francs.	Nickel 1, 2, 5 Francs 20 and 50 Centimes.	0 0 1·932	124·21
Germany—				
Reichsmark of 100 Pfennige.	10, 20 Mark.	1, 2, 3, 5, Mark 50 Pfennige.	0 0 11·7483	20·43
Italy—				
Nominal Lira of 100 Centesimi.	10, 20, 50, 100 Lire.	1, 2, 5 Lire 50 Centesimi.	—	92·46
Japan—				
Gold Yen of 100 Sen.	5, 10, 20 Yen.	10, 20, 50 Sen.	0 2 0½	24·58*d.* (Pence to Yen).
Mexico—				
Nominal gold Peso of 100 Centavos.	2, 2½, 5, 10, 20 Pesos.	2, 1 Peso 10, 20, 50 Centavos.	0 2 0½	9·76
Russia (*U.S.S.R.*)—				
Nominal Gold Rouble of 100 Kopecks.	—	1 Rouble 50 Kopecks or half-rouble = Poltinnik.	0 2 8⅗	7·35

Country and monetary unit	Gold coins	Silver coins	Nominal value of unit in British currency(gold standard)	Par value
(1)	(2)	(3)	(4)	(5)
Spain— Peseta ..	—	1, 2, 5 Pesetas 20, 50 Centimos.	0 0 9·516	25·22½
Switzerland— Franc of 100 Centimes.	10, 20 Francs.	1, 2, 5 Francs 50 Centimes.	0 0 9·516	25·22½
Turkey— Turkish Lira of 100 Piastres Gold Piastre of 40 Paras.	20, 50, 100, 250, 500 Piastres.	½, 1, 2, 5, 10, 20 Piastres.	0 18 0	110
U.S.A.— Gold Dollar of 100 Cents.	1, 2½, 5, 10, 20 Dollars.	¼, ½, 1 Dollar 1 Dime.	0 4 1·32	4·866

22. *Currencies of British Dominions, Colonies, etc.*

(The English equivalent at the par of exchange is shown, where possible, in parenthesis)

Aden.—Indian rupees (1*s.* 6*d.*).

Australia.—Notes and coins of similar denominations to those issued in Great Britain.*

Bermuda.—Same as Great Britain.

British Guiana.—British and American coins and notes issued locally in denominations of \$2 and \$1 (\$4·86⅔=£1).

British Honduras.—Local coins of similar denominations to those of the American coinage. American notes circulate freely (\$4·86⅔=£1).

British North Borneo.—Same as Straits Settlements.

Canada.—Notes and coins issued by the Dominion Government of similar denominations to those of the American currency (\$4·86⅔=£1).

Ceylon.—Indian rupees (1*s.* 6*d.*), but subsidiary coins are in cents (1 rupee =100 cents).

Cyprus.—The monetary unit is the British sovereign, which is equivalent to 180 piastres (local coinage).

Falkland Islands.—Same as Great Britain. Notes are issued locally.

Gibraltar.—Same as Great Britain.

Hong-Kong.—The monetary unit is the British silver dollar, but notes issued by the European banks are largely in circulation.*

India.—Rupee notes and coins issued by the Government of India (1 rupee =1*s.* 6*d.*).

Iraq.—Same as India.

Jamaica.—Same as Great Britain and notes issued locally.

* The rates of exchange vary.

KENYA.—The monetary unit is the silver shilling of 100 cents (20 shillings =£1 sterling). Notes and coins are issued locally.

MALTA.—Same as Great Britain.

MAURITIUS.—The Indian rupee (1*s*. 6*d*.) and notes and coins issued locally ; the smaller coins being cents (1 rupee=100 cents).

NEWFOUNDLAND.—Same as American currency. Notes and coins are issued by the Government and notes by the banks.

NEW ZEALAND.—Same as Great Britain. Notes and coins are issued locally.*

NIGERIA.—The West African florin (2*s*.). Notes and coins are issued by the West African Currency Board.

PALESTINE.—The Palestine pound=1,000 mils=£1 sterling.

SHANGHAI.—Silver dollar is the currency, but the tael is the money of account. Notes and coins are issued locally.*

SIERRA LEONE.—Same as Nigeria.

SOUTH AFRICA.—Same as Great Britain. Notes and coins are issued by the Government.*

ST. HELENA.—Same as Great Britain. Both British and South African currency are legal tender.

STRAITS SETTLEMENTS.—The Straits Settlements dollar=100 cents=2*s*. 4*d*. Notes and coins are issued by the Government.

SUDAN.—Same as Egypt.

TANGANYIKA.—Same as Kenya.

TIENTSIN.—Silver dollar. Notes and coins are issued locally.*

UGANDA.—Same as Kenya.

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* The rates of exchange vary.

APPENDIX III

LIST SHOWING THE PATTERN OF PACKAGES IN WHICH ROYAL ARMY SERVICE CORPS SUPPLIES ARE PACKED FOR FIELD SERVICE

Commodity	Pack	Gross weight of pack	Approximate exterior measurement of pack (case, etc.)			Cubic measurement of pack	Packages		Quantity of commodity (when packed)		Cubic measurement of 1 ton gross weight
			Length	Breadth	Height		No. to ton gross weight	No. to ton space	To ton gross weight	To ton space	
(1)	(2)	(3) lb.	(4)	(5)	(6)	(7) ft. in.	(8)	(9)	(10)	(11)	(12) ft. in.
Ale	Cases, 48 Imp. ½-pts.	85	22	15	11	2 1	26	19	1,248 bottles	912 bottles	54 2
Alum	Cases, 30 lb.	49	21½	12¼	9¼	1 7	45	25	1,350 lb.	750 lb.	71 3
Alumina, sulphate of.	Bags, 224 lb.	230	33	23	12	5 3	9¾	7½	2,184 lb.	1,680 lb.	51 2
Ammonia ..	Drums, 100 lb.	112	17	17	25	4 2	20	10	2,000 lb.	1,000 lb.	83 4
Anchovy paste..	Cases, 40 lb., 160 4-oz. tins.	52	17	14	11	1 6	43	27	6,880 tins (1,720 lb.)	4,320 tins (1,080 lb.)	64 6
,, essence	Cases (40 bottles).	96	27	17	12	3 5	23	12	920 bottles	480 bottles	78 7
Arrowroot ..	Cases, 40 lb. (2 20-lb. canisters).	54	20	11	10	1 3	41	32	1,640 lb.	1,280 lb.	51 3
Atta	Bags, 140 lb.	142	34	20	8	3 2	16	13	2,000 lb.	1,820 lb.	50 8
Anti-fly spray ..	Drums, 5 gals.	60	11	11	17	1 2	37	34	185 gals.	170 gals.	43 2
Baking-powder	Cases, 40 lb. (1-lb. tins).	62	22	17	9	1 11	36	20	1,440 lb.	800 lb.	69 0
Bacon—Salt pack	Cases, av. 120 lb.	av. 216	31	17	14	4 3	10	9	1,200 lb.	1,080 lb.	42 6
Barley, pearl ..	Cases, 40 lb. (2 20-lb. canisters).	53	21	11	9	1 2	42	34	1,680 lb.	1,360 lb.	49 0

Biscuits, fancy	Cases, av. 70 lb.	110	21	21	19	4	10	20	8	av. 1,400 lb.	av. 560 lb.	96	8
,, Service	Cases, 50 lb. (2 25-lb. canisters).	av. 74	24	17	12	2	10	30	14	1,500 lb.	700 lb.	85	0
Bran	Bags, 112 lb.	114	42	23	11	6	2	19	6½	2,128 lb.	728 lb.	117	2
Brand's essence	Cases, 63 lb. (252 4-oz. tins).	112	26	14	11	2	4	20	17	1,260 lb. (5,040 tins)	1,071 lb. (4,284 tins)	51	9
Brandy	Cases, 12 bottles	50	20	17¾	7¾	1	8	45	24	540 bottles	288 bottles	75	0
Bread	Sacks, 33 2-lb. loaves.	69	28	27	13	5	11	32	7	2,112 lb.	462 lb.	189	4
Beans, haricot ..	Bags vary from 160 lb. to 240 lb.	—	—	—	—	—		—	—	—	—	—	
Benger's food ..	Cases, 20 3-lb. tins.	92	27	16	11	2	9	24	15	1,440 lb. (480 tins)	900 lb. (300 tins)	66	0
Bicarbonate of soda	Kegs, 112 lb.	125	19	16	16	2	10	18	14	2,016 lb.	1,568 lb.	51	0
Burgundy ..	Cases, 12 bottles	55	19	15	8	1	8	41	24	492 bottles	288 bottles	68	4
Candles—													
Magazine ..	Cases, 60 lb.	78	26	15	10	2	3	28½	17½	1,710 lb.	1,050 lb.	64	1
Paraffin ..	Cases, 72 lb.	94	21	18¾	13	3	0	23½	13	1,710 lb.	936 lb.	71	3
Stearine ..	Cases, 72 lb.	88	21	19	13	3	0	25	13	1,800 lb.	936 lb.	75	0
Siege	Cases, 48 lb.	65	27¾	14	8¼	1	10	34¼	21	1,656 lb.	1,032 lb.	63	3
Carriage ..	Cases, 60 lb.	75	26¼	13½	10½	2	4	29¾	17	1,785 lb.	1,020 lb.	69	5
Calcium chloride	Drums, 110 lb.	112	25	15	15	3	3	20	12	2,200 lb.	1,320 lb.	60	0
Carbide, coarse	Drums, 112 lb.	130	25	15	15	3	3	17	12	1,904 lb.	1,344 lb.	55	3
,, fine ..	Cases, 72 lb. (36 2-lb. tins).	98	27½	13½	10	2	3	22¾	18	1,638 lb.	1,296 lb.	51	2
Cake, tinned ..	Crates, 56 lb.	75	31	14	9	2	3	30	18	1,680 lb.	1,008 lb.	67	6
Capers	Cases, 30 lb. (80 6-oz. bottles).	95	22	18	15	3	5	24	12	720 lb. (1,920 bottles)	360 lb. (960 bottles)	82	0
Carbolic acid (Zotal).	Drums, 5 gals.	ap. 60	11	11	17	1	2	37	34	185 gals.	170 gals.	43	2
Carbolic bottoms	Drums, 5 gals.	ap. 60	11	11	17	1	2	37	34	185 gals.	170 gals.	43	2
	Barrels, 40 gals.	560	24	24	34	11	4	4	3	160 gals.	120 gals.	45	4
Caustic soda ..	Drums, 112 lb.	125	16	16	18	2	8	18	12	2,016 lb.	1,344 lb.	48	0
Champagne ..	Cases, 24 ½-bottles	74	22	15½	10	1	11	30	21	720 bottles	504 bottles	57	6

APPENDIX III—*continued*

Commodity	Pack	Gross weight of pack	Approximate exterior measurement of pack (case, etc.)			Cubic measurement of pack	Packages		Quantity of commodity (when packed)		Cubic measurement of 1 ton gross weight
			Length	Breadth	Height		No. to ton gross weight	No. to ton space	To ton gross weight	To ton space	
(1)	(2)	(3) lb.	(4)	(5)	(6)	(7) ft. in.	(8)	(9)	(10)	(11)	(12) ft. in.
Cheese	Crates, average 162 lb. (2 cheeses in crate).	av. 175	27½	16	16	4 2	12¾	9½	av. 2,065 lb.	1,539 lb.	52 8
Chicken essence	Cases, 320 2-oz. tins	71	21	16	8	1 7	31½	25	1,260 lb. (10,080 tins)	1,000 lb. (8,000 tins)	49 9
,, broth ..	Cases, 56¼ lb. (30 30-oz. tins).	84	23	15	10	1 10	26	22	1,462½ lb. (780 tins)	1,237½ lb. (660 tins)	47 8
Chloride of lime	Cases, 60 lb. (2 30-lb. canisters).	78	11	13	22	1 10	28½	22	1,710 lb.	1,320 lb.	52 3
Clarifying powder	Cases, 30 lb.	55	18	14	11	1 7	40¾	25	1,222 lb.	750 lb.	64 6
Claret	*See* Port Wine.										
Cocoa powder ..	Cases, 40 lb. (1-lb. tins).	70	20½	15¾	13¾	2 6	32	16	1,280 lb.	640 lb.	80 0
Coffee	Cases, 40 lb. (2 20-lb. canisters).	63	21	16	10¾	2 1	35	19	1,400 lb.	760 lb.	72 11
,, with milk	Cases, 42 lb. (48 14-oz. tins).	56	20	13	8	1 2	40	34	1,680 lb. (1,920 tins)	1,428 lb. (1,632 tins)	46 8
Cocoa and milk	Cases, 42 lb. (48 14-oz. tins).	56	20	13	8	1 2	40	34	1,680 lb. (1,920 tins)	1,428 lb. (1,632 tins)	46 8
Chocolate ..	Cases, 60 1-lb. slabs	70	21	10	9	1 1	32	36	1,920 lb.	2,160 lb.	34 8
,, ..	Cases, 60 lb. (1-oz. bars).	70	18	15	12	1 11	32	21	1,920 lb.	1,260 lb.	61 4

Charcoal ..	Bags, average 49–50 lb.	51–52	36	24	24	12 0	43	3	2,150 lb.	150 lb.	516 0
Cigarettes ..	Cases, 30 lb.	72	20	18	18	3 10	31	10	930 lb.	300 lb.	118 10
Cornflour ..	Cases, 40 lb.	57	22¼	12	11	1 8	39	24	1,560 lb.	960 lb.	65 0
Cresoli	Drums, 5 gals.	av. 59	11	11	17	1 2	38	34	190 gals.	170 gals.	44 4
Creosote ..	Drums, 5 gals.	60	11	11	17	1 2	37	34	185 gals.	170 gals.	43 2
Curry powder ..	Cases, 40 lb.	66	23	17	9	2 0	34	20	1,360 lb.	800 lb.	68 0
Custard powder	Cases, 40 lb. (1-lb. tins).	66	22	16	11	2 3	34	18	1,360 lb.	720 lb.	76 6
Dried fruits—											
Rasins ..	Average, 26 lb.	30	15½	10½	6	0 7	74	68	Av., 1,924 lb.	Av., 1,768 lb.	43 2
Plums	Average, 50 lb.	57	15½	13	10	1 2	39	34	Av., 1,950 lb.	Av., 1,700 lb.	45 5
Currants ..	Average, 48 lb.	54	19½	10	10	1 2	42	34	Av., 2,016 lb.	Av., 1,632 lb.	49 0
Floor polish ..	Cases, 50 lb.	73	17½	16¼	13	2 2	30½	18½	1,525 lb.	925 lb.	61 0
Fly papers ..	No standard pack.										
Flour	Bags, 140 lb.	142	36	21	8	3 6	15¾	11	2,205 lb.	1,540 lb.	55 1
Formaldehyde ..	Cases, 6 ½-gallon bottles.	70	13	19	15	2 2	32	18	192 bottles (96 gals.)	108 bottles (54 gals.)	69 4
Fruits, tinned—											
Apricot ..	Cases, 24 tins, average 1¾ lb. each.	av. 62	18	13	10¼	1 4	36	30	1,512 lb. (864 tins)	1,260 lb. (720 tins)	48 0
Peaches ..	Cases, 24 tins, average 1¾ lb. each.	av. 58	17	13	10¼	1 4	37	30	1,554 lb. (888 tins)	1,260 lb. (720 tins)	49 4
Pineapple ..	Cases, 36 tins, average 1¾ lb. each.	av. 80	24½	13	10¼	1 11	28	21	1,484 lb. (1,008 tins)	1,113 lb. (756 tins)	53 8
Pears	Cases, 24 tins, average 1¾ lb. each.	av. 62	18	13	10¼	1 6	36	27	1,512 lb. (864 tins)	1,134 lb. (648 tins)	54 0
Gas oil	Barrels, 40 gals.	av. 428	33½	26	26	13 4	5	3	200 gals.	120 gals.	66 8
Golden syrup ..	Cases, 60 lb.	80	22	13	9	1 6	28	27	1,680 lb.	1,620 lb.	42 0
Grocery rations	Cases, 100 rations in tins										
Tea	At ½ oz. .. 3⅛ lb.										
Sugar	At 2 oz. .. 12½ lb.	39	18	15½	9½	1 7	57	25	5,700 rations	2,500 rations	90 3
	15⅝ lb.										

APPENDIX III—*continued*

Commodity	Pack	Gross weight of pack	Approximate exterior measurement of pack (case, etc.): Length	Breadth	Height	Cubic measurement of pack	Packages: No. to ton gross weight	No. to ton space	Quantity of commodity (when packed): To ton gross weight	To ton space	Cubic measurement of 1 ton gross weight
(1)	(2)	(3) lb.	(4)	(5)	(6)	(7) ft. in.	(8)	(9)	(10)	(11)	(12) ft. in.
Glycerine ..	Drums, 64 lb.	74	11	11	17	1 2	31	34	1,984 lb.	2,176 lb.	36 2
Gelatine ..	Cases, 48 × 1-lb. tins	70	24	16	12	2 8	32	15	1,536 lb.	720 lb.	85 4
Grease, M.T. ..	Cases, 60 2-lb. boxes	178	26	19	19	5 5	12	11	1,512 lb.	1,320 lb.	65 0
,, ,, ..	Cases, 22 5-lb. boxes	153	25	18	17	4 5	14	13	1,606 lb.	1,430 lb.	61 10
,, ,, ..	Kegs, 10 lb.	14	7	7	11	0 4	160	120	1,600 lb.	1,200 lb.	53 0
Hay, compressed	Bales, 80 lb.	80	26	15	13	2 11	28	13¾	2,240 lb.	1,100 lb.	81 8
,, ,,	Trussed, av. 56 lb.	56	36	24	18	9 0	40	4½	2,240 lb.	252 lb.	360 0
Hops	Cases, 30 lb. (2 15-lb. canisters).	52	20	15	14	2 5	43	17	1,290 lb.	510 lb.	103 11
Honey	Cases, 40 lb. (20 2-lb. jars).	82	25	14¾	11½	2 7	27¼	15½	1,000 lb. (545 jars)	620 lb. (310 jars)	70 4
Herbs	Cases, 25 lb. (100 4-oz. packets).	38	25	21	20	6 1	59	6	1,475 lb. (5,900 pkts.)	150 lb. (600 pkts.)	358 11
Hexamine ..	Cases, 112 lb.	140	19	19	21	4 5	16	9	1,792 lb.	1,008 lb.	70 8
,, ..	Kegs, 112 lb.	125	16	16	20	3 0	18	13	2,016 lb.	1,456 lb.	54 0
Herrings—											
In tomatoes ..	Cases, 48 lb.	72	17	16	12	1 11	31	22	1,488 lb.	1,056 lb.	59 5
Izal	Drums, 5 gallons	50	11	11	17	1 2	45	34	225 gals.	170 gals.	52 6
Jam	Cases, 60 lb. (30 2-lb. tins).	80	21	12	11	1 7	28	25	1,680 lb.	1,500 lb.	44 4

Jelly, calves' foot	Cases, 160 ¼-lb. pkts.	58	21	13	10	1	7	38½	25	6,160 pkts.	4,000 pkts.	60	11
,, assorted ..	Cases, 180 ¼-lb. pkts.	64	24	12	10	1	8	35	24	6,300 pkts.	4,320 pkts.	58	4
Lard, refined ..	Cases, 56 lb. (2 28-lb. tins).	75	21¼	10¾	13½	1	10	30	22	1,680 lb.	1,232 lb.	55	0
Latrine paper ..	Bales, 5 reams	44	19	16	13	2	3	50	18	250 reams	90 reams	112	6
Lefroy's fluid ..	Drums, 5 gals.	60	11	11	17	1	2	37	34	185 gals.	170 gals.	43	2
Lemon juice ..	Cases, 2 1-gal. jars.	52	30	9	9	1	6	43	27	86 jars	54 jars	64	6
,, essence	Cases, 90 4-oz. bottles.	76	21	15	14½	2	9	29½	14½	2,655 bottles	1,305 bottles	81	1
Lentils	Bags, 98 lb.	100	28	16	7	1	10	22½	22	2,205 lb.	2,156 lb.	41	3
Liquid chlorine—													
For temperate climate.	Cases, 66 lb. (1 cylinder).	194	50¼	11¾	11	3	10	10½	10	693 lb.	660 lb.	40	3
For tropical climate.	Cases, 60 lb. (1 cylinder).	188	50¼	11¾	11	3	10	11	10	660 lb.	600 lb.	42	2
Liquid "C" ..	Drums, 5 gals.	60	11	11	17	1	2	37	34	185 gals.	170 gals.	43	2
Linseed ..	Bags, 168 lb.	170	30	21	13	4	9	13	8½	2,184 lb.	1,428 lb.	61	9
M. & V. rations	Cases, 48 16-oz. tins	88	20	18	11	2	4	25¼	17	1,212 tins	816 tins	58	11
Maple peas ..	Bags, 100 lb.	103	24	22	9	2	9	21½	15	2,150 lb.	1,500 lb.	59	1
Malt	Cases, 50 lb.	65	17	16	12	1	11	34½	21	1,725 lb.	1,050 lb.	66	1
Margarine ..	Cases, 28 lb.	35	20	12	6½	1	0	64	40	1,792 lb.	1,120 lb.	64	0
Marmalade ..	Cases, 60 lb. (30 2-lb. tins).	80	21	12	11	1	7	28	25	1,680 lb.	1,500 lb.	44	4
Matches ..	Cases, 20 gross.	105	20	20	26	6	0	21	6½	420 gross	130 gross	126	0
Macaroni ..	Cases, 24 lb.	40	19	14	13	2	0	56	20	1,344 lb.	480 lb.	112	0
Meat extract ..	Cases, 320 2-oz. tins	71	21	16	8	1	7	31½	25	1,260 lb.	1,000 lb.	49	10
,, Solid, in cubes.	Cases, 1,000 cubes	25	18½	9½	6½	0	8	89½	60	89,500 cubes	60,000 cubes	59	8
Meat, frozen ..	—	—	—	—	—	—		—	—	—	—	100	0
,, preserved	Cases, 36 lb. (48 12-oz. tins).	56	21	11	9	1	2	40	34	1,440 lb. (1,920 tins)	1,224 lb. (1,632 tins)	46	8
,, wrappers	Bales, 1,000–1,500.	70	—	—	—	64	0	—	—	—	—	—	
Methylated spirit	Drums, 5 gals.	50	11	11	17	1	2	45	34	225 gals.	170 gals.	52	6

APPENDIX III—*continued*

Commodity	Pack	Gross weight of pack	Approximate exterior measurement of pack (case, etc.) Length	Breadth	Height	Cubic measurement of pack	Packages No. to ton gross weight	No. to ton space	Quantity of commodity (when packed) To ton gross weight	To ton space	Cubic measurement of 1 ton gross weight
(1)	(2)	(3) lb.	(4)	(5)	(6)	(7) ft. in.	(8)	(9)	(10)	(11)	(12) ft. in.
Milk, condensed, unsweetened.	Cases, 36 lb. (48 12-oz. tins).	53	19	13	8	1 2	42	34	1,512 lb. (2,016 tins)	1,224 lb. (1,632 tins)	49 0
Milk, condensed, sweetened.	Cases, 48 14-oz. tins	59	19	13	8	1 2	38	35	1,596 lb. (1,824 tins)	1,470 lb. (1,680 tins)	44 4
Mustard ..	Cases, 40 lb.	78	19	16	12	2 1	28½	18	1,140 lb.	720 lb.	59 4
Mosquito pomade	Cases, 48 lb. (in 3-oz. tins).	45	19	13	8	1 2	50	34	1,350 lb.	918 lb.	58 4
Mutton broth ..	Cases, 56¼ lb. (30 3-oz. tins).	70	22	14	12	2 2	32	18	1,800 lb. (960 tins)	1,012½ lb. (480 tins)	69 4
,, extract	Cases, 320 2-oz. tins	71	21	16	8	1 7	31½	25	1,260 lb.	1,000 lb.	49 10
Naphthalene paste	Cases, 32 2-lb. tins	84	18	19	11	2 2	23½	18	1,504 lb.	1,152 lb.	50 11
Oatmeal ..	Cases, 40 lb.	54	22	11	10	1 5	41½	28	1,660 lb.	1,120 lb.	58 9
Oats	Bags, 80 lb.	82	27	20	9	2 10	27¼	14	2,180 lb.	1,120 lb.	77 2
,, ...	Bags, 160 lb.	163	36	26	10	5 5	13¾	7¼	2,200 lb.	1,160 lb.	74 5
Oil—											
Mineral burning	Drums, 5 gals.	50	11	11	17	1 2	45	34	225 gals.	170 gals.	52 6
Kerosene ..	Drums, 5 gals.	50	11	11	17	1 2	45	34	225 gals.	170 gals.	52 6
Lubricating ..	Drums, 5 gals.	av. 54	17¼	11½	11¼	1 3	41	31	210 gals.	156 gals.	53 4
Rape	Drums, 5 gals.	52	11	11	17	1 2	43	34	215 gals.	170 gals.	50 2
Mineral Signalling }	Drums, 5 gals.	52	11	11	17	1 2	43	34	215 gals.	170 gals.	50 2
Fuel	Drums, 5 gals.	49	11	11	17	1 2	45½	34	227½ gals.	170 gals.	53 1
Tangyes ..	Drums, 5 gals.	50	11	11	17	1 2	45	34	225 gals.	170 gals.	52 6
Pan	Drums, 5 gals.	50	11	11	17	1 2	45	34	225 gals.	170 gals.	52 6
Pan	Barrels, 40 gals.	av. 448	24	24	33½	11 4	5	4	200 gals.	160 gals.	56 8

Peat moss litter	Bales, various	av. 234	20	20	46	10 8	$9\frac{1}{2}$	$3\frac{3}{4}$	Av., 2,223 lb.	Av., 877 lb.	101 4
Pea soup ..	Cases, 40 lb. (160 4-oz. packets).	64	17	12	12	1 5	35	28	1,400 lb. (5,600 pkts.)	1,120 lb. (4,480 pkts.)	49 7
,, ,, ..	Cases, 56 lb. (4 14-lb. packets).	76	21	16	9	1 9	29	23	1,624 lb. (116 pkts.)	1,288 lb. (92 pkts.)	50 9
Peas, dried ..	Bags, vary from 160 to 240 lb.	—	—	—	—	—	—	—	—	—	—
Pepper	Cases, 56 lb. (1-lb. tins).	90	26	14	14	2 11	25	$13\frac{3}{4}$	1,400 lb.	770 lb.	72 11
Permanganate of potash.	Cases, 120 $\frac{1}{2}$-lb.	85	19	14	14	2 2	26	18	1,560 lb.	1,080 lb.	54 6
Petrol	Cans, 2 gals. (full)	18	10	6	13	0 5	125	83	250 gals.	166 gals.	60 0
,, ...	Cases, 4 2-gal. cans	100	$22\frac{3}{4}$	15	$13\frac{3}{4}$	2 10	22	14	176 gals.	112 gals.	62 4
,, cans (empty).	—	$3\frac{5}{16}$	10	6	13	0 5	676	96	—	—	281 8
Petrol cases with empty cans.	Cases, 4 2-gal. cans	32	$22\frac{3}{4}$	15	$13\frac{3}{4}$	2 10	70	14	—	—	198 4
Petrol (Eastern Pack).	Cases, 2 4-gal. tins	$79\frac{1}{2}$	21	$11\frac{1}{2}$	$14\frac{3}{4}$	2 1	28	19	224 gals.	152 gals.	57 8
Petrol tins (empty) (Eastern Pack).	—	$2\frac{3}{4}$	$13\frac{3}{4}$	$9\frac{1}{2}$	$9\frac{1}{2}$	0 9	815	56	—	—	578 4
Petrol cases with empty tins (Eastern Pack).	Cases, 2 4-gal. tins	18	21	$11\frac{1}{2}$	$14\frac{3}{4}$	2 1	124	19	—	—	255 5
Petrol	50-gal. barrels	482	34	26	—	13 4	$4\frac{3}{5}$	3	245 gals.	147 gals.	61 8
Petrol barrels (empty).	50-gal. barrels	112	34	26	—	13 4	20	3	—	—	266 8
Pork and beans	Cases, 48 16-oz. tins	70	22	16	10	2 0	32	20	1,536 lb.	960 lb.	64 0
Potted meat ..	Cases, 40 lb. (160 tins).	72	19	12	12	1 7	31	26	1,240 lb.	1,040 lb.	49 1
Port wine ..	Cases, 12 bottles	53	$20\frac{1}{4}$	$17\frac{3}{4}$	$7\frac{3}{4}$	1 8	42	24	504 bottles	288 bottles	74 0
Pickles	Cases, 40 lb. (16 $2\frac{1}{2}$-lb. jars).	112	24	23	10	3 2	20	$12\frac{1}{2}$	800 lb.	500 lb.	63 4
,, ...	Cases, 40 lb. (4 10-lb. jars).	98	19	17	13	2 5	$22\frac{3}{4}$	$16\frac{1}{2}$	910 lb.	660 lb.	54 11

APPENDIX III—*continued*

Commodity	Pack	Gross weight of pack	Approximate exterior measurement of pack (case, etc.)			Cubic measurement of pack	Packages		Quantity of commodity (when packed)		Cubic measurement of 1 ton gross weight
			Length	Breadth	Height		No. to ton Gross weight	No. to ton space	To ton gross weight	To ton space	
(1)	(2)	(3) lb.	(4)	(5)	(6)	(7) ft. in.	(8)	(9)	(10)	(11)	(12) ft. in.
Rice	Bags, 224 lb.	226	36	24	13	6 6	9¾	6	2,183 lb.	1,344 lb.	63 4
,, cones ..	Bags, 140 lb.	142	31	19	13	4 5	15¾	9	2,205 lb.	1,260 lb.	69 7
Roast fowl ..	Cases, 40 1-lb. tins.	72	22	11	11	1 6	31	26	1,240 lb.	1,040 lb.	46 6
,, rabbit ..	Cases, 48 lb. (24 2-lb. tins).	72	23	12	11	1 7	31	25	1,488 lb. (744 tins)	1,200 lb. (600 tins)	49 1
,, ,,	Cases, 48 1-lb. tins	76	18	18	10	1 11	29	21	1,392 lb.	1,008 lb.	55 7
Rum	Cases, 2 1-gal. jars	51	30¼	9	9	1 5	44	28	88 jars	56 jars	62 4
,, ...	Cases, 4 ½-gal. jars	64	26¼	16	9	2 2	35	18½	140 jars (70 gals.)	76 jars (38 gals.)	75 10
,, ...	Cases, 1 2-gal. jar	53	20¾	11½	11¾	1 9	42	23	42 jars (84 gals.)	23 jars (46 gals.)	73 6
Sacks—											
Bread	Bundles of 50	75	34	15	9	2 8	29	15	1,450 sacks	750 sacks	77 4
Oat	Bundles of 50	56	24	18	9	2 3	40	17	2,000 sacks	850 sacks	90 0
Bran	Bundles of 50	56	30	20	9	2 0	40	20	2,000 sacks	1,000 sacks	80 0
Salt—											
Table	Bags, 80 lb.	81	22	15	9	1 9	27½	23	2,200 lb.	1,840 lb.	48 1
Coarse ..	Bags, 80 lb.	81	25	17	6	1 6	28	27	2,200 lb.	2,160 lb.	42 0
Rock	Bags, 80 lb.	81	Variable			—	—	—	—	—	—
Sago	Cases, 40 lb.	53	19	12	10	1 4	42	30	1,680 lb.	1,200 lb.	56 0
Salad oil ..	Cases, 50 bottles (reputed pints).	106	23¼	17	13¾	3 2	21	12½	1,050 bottles	625 bottles	66 6

Salmon, tinned	Cases, 48 tins	70	20½	13	10¼	1 6	32	27	1,536 tins	1,296 tins	48 0
Sardines ..	Cases, 100 tins	54	23¼	11¼	7¼	1 1	41½	37	4,150 tins	3,700 tins	44 11
Sauce	Cases, 30 lb. (24 20-oz. bottles).	84	24	16	13	2 11	27	14	810 lb. (744 bottles)	420 lb. (624 bottles)	78 9
Semolina ..	Cases, 40 lb.	53	19	12	10	1 4	42	30	1,680 lb.	1,200 lb.	56 0
Sodium arsenite	Drums, 112 lb.	120	13	13	16	1 7	19	26	2,100 lb.	2,912 lb.	30 1
,, ...	Drums, 56 lb.	62	9	9	15	0 8	36	23	2,016 lb.	1,288 lb.	24 0
,, carbonate	Kegs, 112 lb.	120	16	16	20	3 0	19	13	2,100 lb.	1,456 lb.	57 0
,, nitrate..	Bags, av. 184 lb.	186	24	19	6	1 7	12	26	2,200 lb.	4,784 lb.	19 0
Spices, mixed ..	Cases, 28 lb. (in 1-lb. tins).	48	25	14¾	7½	1 9	46¾	23	1,309 lb.	644 lb.	81 10
Stout	Cases, 48 bottles	85	11	15	22	2 1	26	19	1,248 bottles	912 bottles	54 2
Sherry	As for Port Wine.										
Sugar	Bags, 80 lb.	82	23	19	8	2 0	27¼	20	2,180 lb.	1,600 lb.	54 6
Sulphur, rolled..	Bags, av. 190 lb.	196	22	20	8	2 0	11½	20	2,185 lb.	3,800 lb.	22 6
Tapioca ..	Cases, 40 lb.	54	22	11	10	1 5	41½	28	1,660 lb.	1,120 lb.	58 9
Tic beans ..	Bags, av. 125 lb.	128	29	19	9	2 10	17½	14	2,187 lb.	1,750 lb.	49 7
Tea	Original chests, av. 125 lb.	av. 140	25	19	19	5 3	16	7½	2,000 lb.	937 lb.	84 0
Tobacco, various	Cases, 50 lb.	95	26	13	16	3 2	23	12	1,150 lb.	600 lb.	72 10
Tin plates ..	Boxes, 110 lb. (124 sheets a box).	118	22	16	2½	0 7	19	68	2,090 lb.	7,480 lb.	11 1
,, ,, ..	Boxes, 108 lb. (112 sheets a box).	117	22½	16	2½	0 8	19	68	2,052 lb.	7,344 lb.	12 8
Vermicelli ..	Cases, 28 lb.	38	24½	12	10	1 8	59	24	1,652 lb.	672 lb.	98 4
Vinegar ..	Cases, 20 bottles	68	22	14½	11½	2 2	33	18½	660 bottles	370 bottles	71 2
,, ...	Cases, 30 bottles	101	31	16	10¾	3 2	22	13	660 bottles	390 bottles	69 8
Water sterilizing powder (chlorine).	Cases, 120 ¼-lb. tins	59	11	12	20	1 6	38	27	1,140 lb.	810 lb.	57 0
,, ,,	Cases, 2 30-lb. canisters.	78	10	14	22	1 9	28¾	22½	1,725 lb.	1,350 lb.	50 3
Whisky ..	Cases, 12 bottles	48	18½	12¼	9¾	1 3	47	32	564 bottles	384 bottles	58 9

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