THE HIVE

Department of Agriculture Western Australia

Bulletin 3464

THE HIVE

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WESTERN AUSTRALIA
1966

31947—(1)

PREFACE

The hive is the first and most important thing a person needs for keeping bees, and the choice of a hive and its accessories needs careful consideration.

The object of this book is to provide both guidance to the beginner and full information for the established apiarist on hives and their various parts.

Much of the material has been published in the first volume of the journal *Apiculture,* but most of the issues are now out of print. In view of the continuing demand, the articles have been collected together, revised and brought up to date with the most recent useful developments.

The names used for parts of hives are, as far as possible, in accordance with current Australian practice to assist the reader to identify items in manufacturers' catalogues.

The line drawings and the photographs, with the exception of the photograph of an apiary, are by the author. The very fine picture of an apiary in the jarrah forest is from the library of W.A. Newspapers.

F. G. SMITH.

CONTENTS

31947—(2)

THE HIVE

A hive is a man-made nesting place for bees. It is the principal and most essential tool of the beekeeper. As a nesting place it must meet the requirements of the bees for a home. As a tool it must be durable, efficient and convenient to use.

Much information on the requirements of a hive as a home for bees has been obtained from observation of the nesting habits and behaviour of honeybees in the wild state, under a whole range of climatic conditions. Further information has been obtained from observation of the behaviour of bees in hives, and of their reactions to various conditions imposed upon them by the design of the hive.

Nest of honeybees in the crown of a tree.

Although much has been learnt in the past, some of it has been forgotten or is overlooked. As the hive is developed as a tool in new methods of management, further aspects of design in relation to the environment of the nest are brought to light and have to be considered.

The nesting place

In the wild state, honeybees may nest beneath the large branch of a tree or under the overhang of a rock where they are sheltered from the full heat of the sun and protected from rain. But they will only survive in such places if the area is sheltered from high winds and the climate is generally warm.

Usually bees nest in cavities which are cool, dark and dry and which provide protection from their natural enemies. They will select such places in any climate. The most common nesting place is a hollow tree. In hot climates it has been observed that swarms show a distinct

This nest was known to have been here for at least ten years.

preference for nesting places 15 or 20 feet or more above the ground, which are cooler than places nearer the hot surface of the soil. The exceptions are in treeless areas where they will nest underground in the coolness of large termite nests and similar holes, and in totally shaded places such as houses, garages and verandahs where they will occupy boxes and other cavities nearer the ground.

Strong colonies of bees with plenty of food can endure cold for long periods, so long as they are protected from the wind and from dampness. Dampness in the nest causes moulds to develop, may ferment food supplies and leads to the death of bees and eventually of colonies.

If the nesting place becomes too hot, the bees have to waste their energies fanning and collecting water; also they tend to become bad tempered and may abscond.

The colony needs some insulation from extremes of heat and cold, provision for moist air to escape from the nesting place, and sufficient room for the brood nest and for the storage of reserves of food.

Cracks through which the bees cannot pass are generally sealed up with propolis, a resinous mixture with which they varnish the inside of the nesting place. If the entrance to the nest is larger than the bees can guard safely, they block it up with propolis leaving only a number of holes which they can both guard and use to regulate the circulation of air in the hive.

The combs

The combs provide the accommodation for raising young bees and for storing food.

The combs are built of beeswax produced from glands in the bodies of the bees, and are composed of a central vertical midrib with hexagonal cells on both sides. Normally the combs are parallel to each other, but with their midribs about 1 5/16 in. apart in the centre of the colony where they contain the brood. The average thickness of capped brood comb is 31/32 in. with spaces between the combs of 5/16 in. to $\frac{3}{8}$ in.

The outer combs, which are used mainly for the storage of food and sometimes for raising drone brood, are more widely spaced, $1\frac{1}{2}$ in. to $1\frac{3}{4}$ in. or even 2 in.

The combs are built down from the top of the nesting place, and are attached at the top and part of the way down the sides. The bees do not normally attach the combs near or at the bottom, but leave a gap of between $\frac{1}{4}$ in. and $\frac{3}{8}$ in., which may be greater than this directly under the combs at the bottom of the nest. This gap which the bees keep clear is called the bee-space, and is a vital feature in the construction of hives.

In a mature colony brood is reared in the lower parts of the combs. The brood area is more or less spheroidal, with the largest patches of brood in the combs in the centre of the brood nest, and the smallest patches in the outermost combs. Pollen is stored in a band of about two inches wide above and at the sides of the brood area. The combs on each side of the brood nest contain a large quantity of pollen in the parts adjacent to the brood. When there is a sudden abundance of pollen collected after a time of shortage, much of the incoming pollen is stored in the cells normally used for brood rearing. As egg laying gets under way, the pollen in the brood areas is either used up or moved to the outer edges of the brood nest.

Honey is stored above and beyond the pollen band. In a good honey flow, incoming nectar may be stored in empty brood cells during the day, but is moved to cells above or beyond the pollen areas during the night.

Bee-space in hives

In modern frame hives, the bees are induced to build their combs in frames. The hive and frames are constructed to accurate dimensions so that each frame is surrounded by bee-space, and the frames remain free in the hive for easy removal.

Should the space between each frame or between the frames and the hive body be greater than ⅜ in., the bees may fill the gap with burr or brace comb. Any gap less than 3/16 in. will in time be filled with propolis. A space which is between these dimensions will generally be kept free of propolis or comb. It was Langstroth's observation of this fact, and his application of it to the design of hives, that made the modern frame hive possible. In practice the space used in hive construction is between ¼ in. and ⅜ in. The smaller dimension is desirable for the horizontal bee-spaces between the tops of the frames in one box and the bottoms of the frames in the box above, and between the top bars of the uppermost frames and the lid of the hive. A wider bee-space 5/16 in. to ⅜ in. can be used between the end bars of the frames and the walls of the hive. Under the bottom frames there is more latitude, and although the space must not be less than 5/16 in. it can be up to 1 in. If more than this the bees may build comb under the frames.

The hive as a tool

In addition to meeting all the requirements of a nesting place for bees, the hive must also meet the beekeeper's requirements.

The hive must be strong enough to withstand transport and fairly hard usage, light enough to be handled, resistant to decay and insect attack, and as cheap as possible.

The modern commercial beekeeper requires his hives to be easy to move with bees in them, and without killing bees or damaging the colony.

The hive must be easily adjustable in size according to the season, convenient for the collection of the honey crop, and with combs readily available for examination.

It cannot be assumed that any particular type of hive produces bigger crops. It is not the hive, but the nature of the bees in the hive and the management of the hive by the beekeeper that counts. Nevertheless, a well designed and accurately constructed hive adds to the efficiency and pleasure of beekeeping, so making it possible for a beekeeper to manage more hives.

TYPES OF HIVE

There are two main types of modern frame hive in common use. Both of these have been proved in extensive use by successful commercial beekeepers, and meet the requirements of migratory beekeeping. They are the Langstroth and the Dadant types, normally used with only one queen in each hive.

In addition there are other types which are of only fairly local usage, or are of a very specialised nature.

Langstroth type

In the Langstroth type of hive, the individual boxes may be too small at some seasons of the year to provide enough room in one box alone for the brood nest. With this type of hive the queen may be allowed to lay eggs in two or more boxes, at least at certain seasons of the year. Frequently the one size of box is used throughout the hive, for the brood nest as well as for honey storage. This is not always the case however, because shallow supers may be used for the storage of honey. The most common example of this type is the Langstroth hive based on the original design made by Langstroth in America in 1851.

The standard Langstroth hive holds 10 frames which are 9⅛ in. deep, but the boxes used in Australia are ¼ in. narrower than the American standard and usually contain only nine frames.

Originally favoured by the producers of comb honey in sections, the 8-frame Langstroth hive is used by some migratory beekeepers in Australia who find the 10-frame box too heavy to handle when full of honey.

An apiary of Langstroth hives.

TABLE 1.—TOTAL AREA OF COMB IN ONE BOX OF VARIOUS HIVES

Hive	External Dimensions of Frames		Number of Frames in One Box	Total Comb Area in One Box
	Length	Depth		
	in.	in.		sq. in.
Langstroth	17⅝	9⅛	8	2194
			9	2468
			10	2740
			12	3291
Jumbo	17⅝	11¼	10	3420
Modified Dadant	17⅝	11¼	11	3762
British Standard	14	8½	11	2244
British Commercial	16	10	11	3080

Other hives of the Langstroth type are the British National and Modified National hives, the Scottish Smith hive, and the W.S.P. used by some beekeepers in eastern Australia.

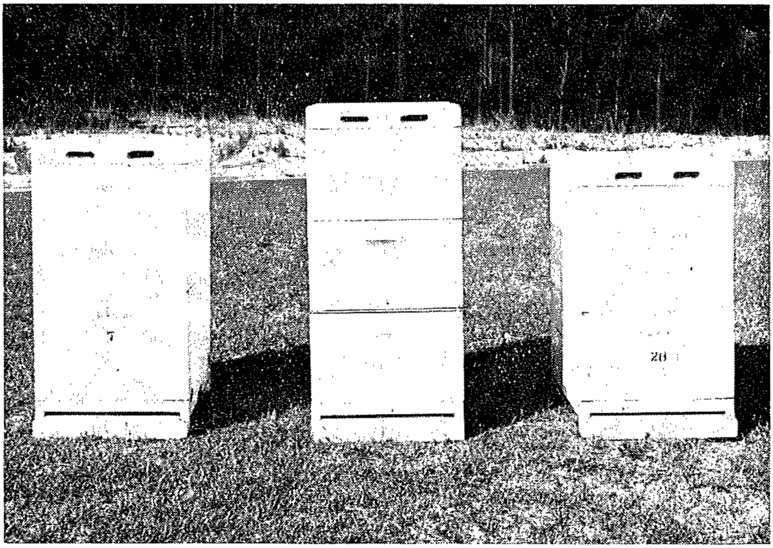
The great advantage of the Langstroth hive, commonly referred to as the full-depth hive, is that it is the standard hive in Australia and so is more readily obtained and more easily sold than any other type of hive. Once a beekeeper has become established in commercial honey production it is extremely difficult for him to make a change to a different type of hive, even when his experience leads him to believe that there is a better tool for his purpose. The tendency is to start with the Langstroth hive and to continue with it.

Dadant type

The Dadant hive was designed to give the queen more room in one box than is provided in the Langstroth hive. The Modified Dadant hive has 11 frames of the same length as the Langstroth frames, but 11¼ in. deep. The Jumbo hive is the same dimensions as the Langstroth hive except for depth; it holds 10 frames 11¼ in. deep.

With this type of hive, the queen is normally confined to one box throughout the year. It has been found that 10 of the 11¼ in. deep frames provide enough room for the brood nest during the build-up period, and there is ample room for food reserves at other times of the year.

The deep box is used only for the brood nest. Shallow supers having 6¼ in. deep frames are used for the storage



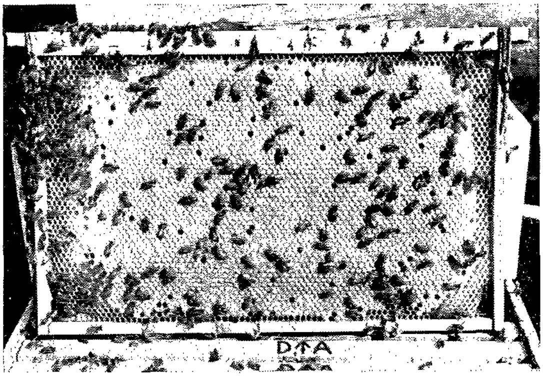
Left. Jumbo hive with two $6\frac{5}{8}$ in. supers. **Centre.** Three-box Langstroth hive. **Right.** Langstroth hive with two $6\frac{5}{8}$ in. supers.

and extraction of honey. Although the Dadant or Jumbo brood box is heavier than the Langstroth box, and would be too heavy to use as a honey super, nevertheless there is little or no difference in weight between a two-box Langstroth hive and a Jumbo hive with one shallow super. A three-box Langstroth hive is heavier than a Jumbo with two supers.

The Modified Dadant hive, with 11 or 10 frames, is used to some extent in North America and England, and a metric version is widely used on the continent of Europe. The 10-frame Jumbo hive is used in very large numbers in Mexico by the Miel Carlota honey producing organization, and is strongly recommended by the founders of this 50,000 colony enterprise. In England a similar hive called the British Commercial hive is used by some beekeepers.

As the brood nest is contained in only one box all through the year, the brood combs can be checked very rapidly. The large combs provide the most natural conditions for the brood nest and egg laying can proceed at the maximum rate. As the brood is on a smaller number of combs, it is much easier to assess the characteristics of the queen and the condition of the colony. This all contributes to a saving in time, labour and cost of production. Against these advantages of the Jumbo hive is the higher initial cost of the Jumbo because it has to be specially made, and the fact that it is not the standard size of hive in Australia.

Jumbo frame filled with brood.



De Layens or horizontal hive

A very simple hive in which all the frames are contained in one single long box is common in parts of Europe. Different sizes of frames are used in different areas.

The brood nest may be maintained at one end or in the middle and the honey stored in the remaining frames. A vertical queen excluder may be used to separate the brood nest from the honey storage combs. To collect the honey the individual combs are removed when full.

This is a very primitive form of frame hive and is being used in some parts of Africa as a transition from simple frameless hives. Hives which are supered vertically, like the Langstroth and Dadant types, are more productive than those in which the honey storage combs are provided at the sides of the brood nest.

Skyscraper hives

Vertical hives, using Langstroth or similar boxes, may be used with two or more queens. Multi-queen hives managed in this way have been called skyscraper hives, and may be built up so high that a ladder is needed to work on them.

Queen excluders and storage supers separate the queens from each other during the build-up period and each queen has an entrance in her own section. Such a system is used in places where the total honey crop for the year comes in only one main flow. Enormous crops have been obtained with such hives, but their use is not applicable to migratory commercial beekeeping.

Collateral hive

This is a two-queen hive which has a bottom box the length of three standard boxes. The bottom box is divided into three equal parts by queen excluder partitions. The

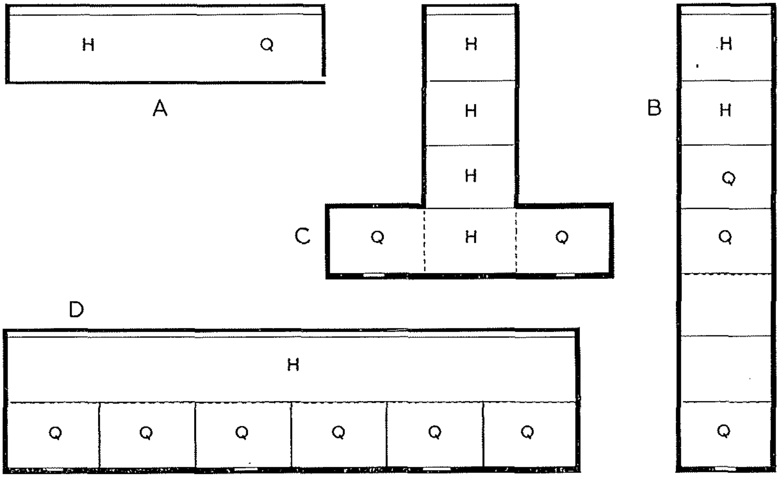


FIG. 1. SOME OTHER TYPES OF HIVE
A. De Layens hive. B. Skyscraper hive. C. Collateral hive. D. Coffin hive.
Q = Brood nest. H = Honey storage.

centre section is used for the storage of honey, and standard honey supers can be placed on top of it. Each of the two side sections is a brood chamber with its own queen and entrance, and its own lid.

Coffin hive

This is a multi-queen hive of horizontal design. The brood nests of the queens are each accommodated in separate compartments along the bottom. The entrances for adjoining brood nests are on opposite sides of the box to reduce drifting. Each brood nest is covered with a queen excluder. A second long box containing the honey storage combs is set on top on the queen excluders, and the bees from all the separate brood nests share the common honey storage super.

These long boxes, which may be up to eight feet long, are a great weight, and can be handled only with special loading equipment.

In two-queen and multi-queen hive systems, a section of the hive which becomes queenless for any reason is likely to remain that way. As the bees obtain queen substance from the other queen or queens in the hive they have no urge to raise another queen.

A two-queen hive or multi-queen hive will produce more honey than a single queen hive. Research has shown, however, that two normal single-queen colonies produce more brood and more honey than one two-queen colony.

PARTS OF THE HIVE

A modern hive is composed of two, three or four hive bodies or boxes, each of which contains a number of frames fitted with comb foundation. In addition there is a queen excluder to separate the box or boxes containing the brood nest from the other boxes used for storing honey, a lid to cover the top of the hive, and a bottom board to act as a base for the hive and to provide an entrance for the bees.

HIVE BODIES

A hive body contains the frames of comb suspended from rabbets in the end walls. A brood box or brood chamber is a hive body which is used to contain the queen and the young and immature forms of bees, eggs, larvae and pupae, and the pollen and honey they require for food. A honey super is a hive body which is placed on the hive above the brood box for the bees to fill with honey.

Hive bodies usually hold between eight and 12 frames. The standard size most widely used throughout the world takes 10 frames at the correct spacing for brood rearing, although only eight or nine frames may be used in bodies of the same width for honey storage. In Australia the standardised width of the 10-frame body is narrower than the American standard by $\frac{1}{4}$ in. This allows less room for manipulation, but has the advantage of decreasing the possible movement of frames when hives of bees are being

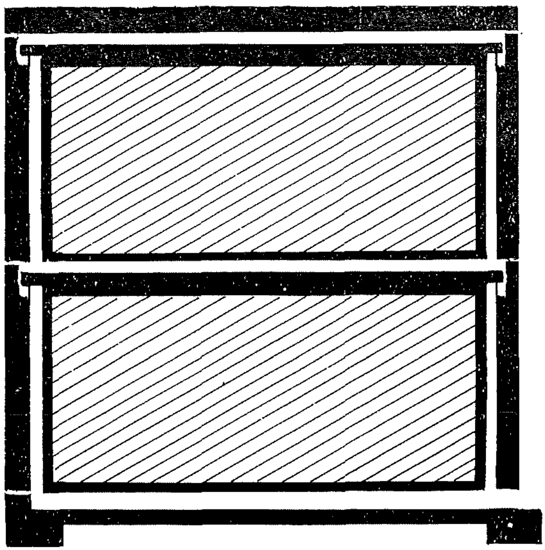


FIG. 2. BEE-SPACE
Showing bee-space above and below frames, and between ends of frames and walls of hive.

moved. It also means that greater attention has to be paid to the accuracy with which the frames are made, and to the allowance for expansion of the wood in the humid atmosphere of the hive, if 10 frames are to be used.

Sizes

The bodies are available in a range of depths to suit the particular size of frame to be used. But in each case the internal and external dimensions in length and width are constant. The thickness of the wood in all hive bodies is normally $\frac{7}{8}$ in., arrived at after planing 1 in. boards on both sides. The internal length of all bodies is $18\frac{1}{4}$ in. and the external length 20 in. As the external dimension of the frames, excluding the top bar lugs, is $17\frac{5}{8}$ in. long, the bee-space between the ends of the frame and the walls of the hive body is 5/16 in.

The internal width of 10-frame hive bodies in Australia is $14\frac{1}{4}$ in. and the external width 16 in. Ten frames, if correctly made to be spaced at $1\frac{3}{8}$ in. occupy $13\frac{3}{4}$ in. leaving $\frac{1}{2}$ in. for manipulation. When the frames are pushed together, this allows $\frac{1}{4}$ in. extra between each of the outer

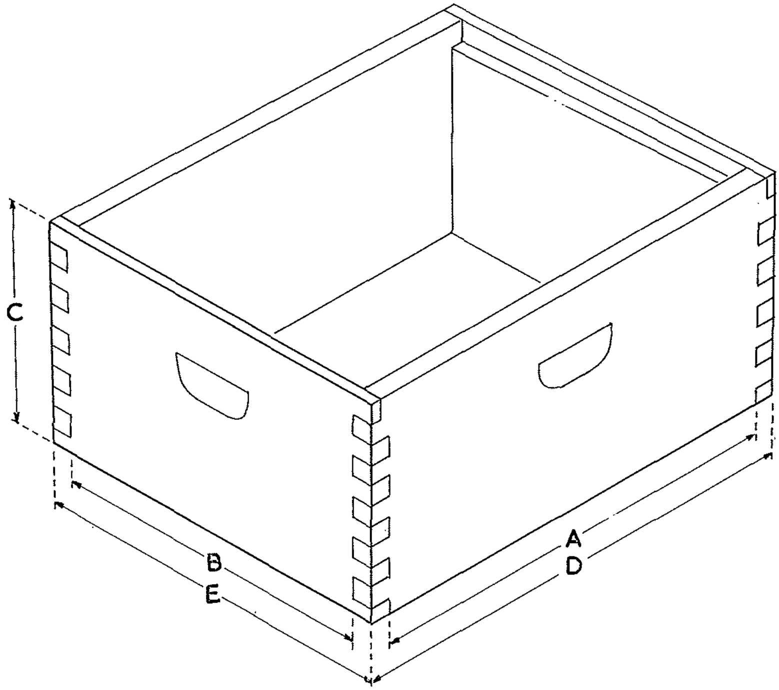


FIG. 3. HIVE BODY
For dimensions of various sizes of hive bodies or supers see Table 2.

frames and the side walls of the hive to permit the bees to use the outer combs fully.

The 8-frame bodies are $12\frac{1}{8}$ in. wide inside, $13\frac{7}{8}$ in. wide outside. They are still being used by some beekeepers but are less popular than they were. The 12-frame hive is square. It is not used in Western Australia, but is being used commercially in the Eastern States.

The depth of hive bodies is between 5/16 in. and $\frac{3}{8}$ in. greater than the depth of the frames contained in them. The bee-space of $\frac{1}{4}$ in. is provided over the frames in each box, between the top of the frames and the top of the walls of the hive body. Thus if a flat lid or queen excluder is placed over a hive body, there is $\frac{1}{4}$ in. bee-space between the tops of the frames and the underside of the lid or queen excluder. The additional 1/16 in. to $\frac{1}{8}$ in. is provided as clearance under the frames and to allow for shrinkage of the timber in the walls of the box when in use.

The dimensions of each of the various hive bodies are given in Table 2.

TABLE 2.—DIMENSIONS OF HIVE BODIES IN INCHES

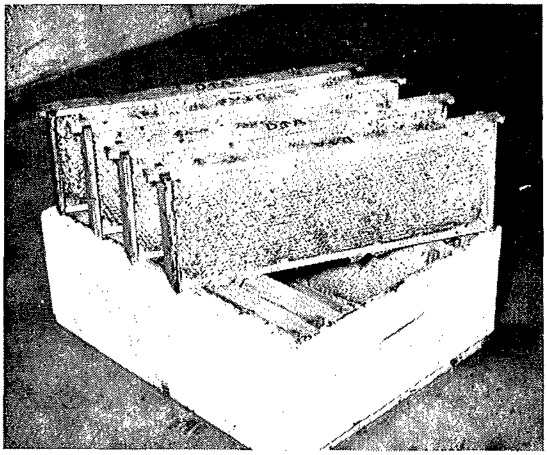
Hive	Depth	Length		Width	
		Internal	External	Internal	External
Symbols in Figure 3	C	A	D	B	E
Modified Dadant	$11\frac{5}{8}$	$18\frac{1}{4}$	20	$16\frac{3}{4}$	$18\frac{1}{2}$
Jumbo	**$11\frac{5}{8}$**	**$18\frac{1}{4}$**	**20**	**$14\frac{1}{4}$**	**16**
Langstroth 12-frame	$9\frac{1}{2}$	$18\frac{1}{4}$	20	$18\frac{1}{4}$	20
Langstroth 10-frame	**$9\frac{1}{2}$**	**$18\frac{1}{4}$**	**20**	**$14\frac{1}{4}$**	**16**
Langstroth 8-frame	$9\frac{1}{2}$	$18\frac{1}{4}$	20	$12\frac{1}{8}$	$13\frac{7}{8}$
W.S.P.	$7\frac{1}{2}$	$18\frac{1}{4}$	20	$14\frac{1}{4}$	16
$6\frac{5}{8}$ in. Super	**$6\frac{5}{8}$**	**$18\frac{1}{4}$**	**20**	**$14\frac{1}{4}$**	**16**
Ideal Super	$5\frac{3}{4}$	$18\frac{1}{4}$	20	$14\frac{1}{4}$	16
Comb Super	$4\frac{3}{4}$	$18\frac{1}{4}$	20	$14\frac{1}{4}$	16

Note:—The internal dimensions must be adhered to if the timber is not exactly $\frac{7}{8}$ in. thick.

Honey supers

A honey super is a box containing frames placed on a hive above the brood nest for the bees to fill with honey.

Many beekeepers have recognised that the Langstroth full-depth 10-frame box is too heavy as a honey super. The weight of these when full may average 80 lb. and occasionally be over 90 lb.



$6\frac{5}{8}$ in. super filled with honey.

Special honey supers, $6\frac{5}{8}$ in. deep, are becoming increasingly popular. These average 55 lb. gross when full, ranging from 50 lb. to 61 lb. and are a reasonable and economic load to lift and carry. The average amount of honey in these supers is 40 lb., ranging from 35 to 45 lb., three-quarters of that held by a Langstroth 10-frame box.

This more manageable weight increases the speed of handling, lessens fatigue, and eliminates the strain and backache of handling Langstroth boxes.

On the hive, the $6\frac{5}{8}$ in. supers are filled and made ready for extracting more quickly, and they are cleared of bees more quickly and thoroughly by phenol and other repellants.

With the use of special honey supers, frames can be used that are designed for the storage and extraction of honey, instead of for brood rearing. These Manley frames, as they are called, are self spaced at the best spacing for honey storage. The end bars are just under $1\frac{3}{4}$ in. wide, so eight are an easy fit in a super for a 10-frame hive.

The width of the top and bottom bars, a bare $1\frac{1}{8}$ in., enables the cappings to be removed with one sweep of the uncapping knife, and with the minimum of honey passing through the cappings reducer.

Comb section supers

The comb or half-depth super, $4\frac{3}{4}$ in. deep, is used for the production of comb honey in $4\frac{1}{4}$ in. square sections. Each section consists of a strip of thin wood $1\frac{7}{8}$ in. wide which has V grooves cut across it to enable it to be folded to form a square box with bee-way slots in the edges of the top and bottom. The sections are held in rows of four

in slotted section holders each of which consists of a bottom piece with bee-ways cut along the sides, and two plain end pieces. There is no top to the section holder. The holders themselves are supported in the super by metal strips secured under the end walls and protruding a little under the holders. These metal strips must be strong to support the weight of the full sections and should be of 24 gauge galvanised iron. The flimsy bits of tin often supplied are useless.

Between each section holder and the next is provided a bee-way slotted wood separator. This thin piece of wood is necessary to ensure that the comb in the sections is built out evenly. Without the separators some sections will be built too thick and others too thin. The 10-frame width of comb super contains seven section holders, each with four sections, a total of 28 sections. Eight slotted wood separators are needed for each super. The 8-frame width of super holds six section holders, 24 sections, and needs seven separators.

Plain sections, $4\frac{1}{4}$ in. square and only $1\frac{1}{2}$ in. wide, and also 5 in. x $3\frac{5}{8}$ in. x $1\frac{1}{2}$ in. for use in "ideal" supers, may be encountered. These have to be used with fence separators and are not recommended.

Very thin foundation, called "thin surplus" is supplied in sheets $15\frac{1}{2}$ in. x $3\frac{7}{8}$ in. (28 per lb.), to be cut to fit in the sections. It is usually secured in each section by melting the top edge with a heated metal plate. Some sections may have a split top to hold the foundation in position by pinching it in the slit. Generally, however, it is considered easier and neater to use sections without the split, and to secure the foundation with melted wax.

To assist in preparing the sections for use, a section former can be obtained to fold the sections accurately in a square after wetting the sections with water along the back of the grooves. There is also available a section foundation fixer which is used with a small spirit lamp. This speeds up the work of melting the edge of the foundation to fit it accurately in the centre of the section.

As the two outermost rows of sections are seldom completely drawn out and filled, a good idea to save having spoilt sections is to replace the outside section holders with comb super frames. If these are not completed it does not matter, and the honey in them can be extracted.

Construction details

The corners of the bodies may be lock-jointed and nailed through the lugs both ways with $2\frac{1}{4}$ in. by 13 nails, or halved and nailed both ways, or butt-jointed and screwed

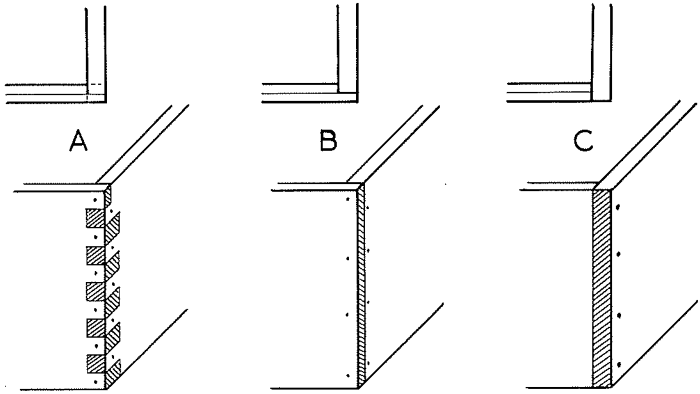


FIG. 4. CORNER JOINTING
A. Lock-jointed and nailed both ways. B. Halved joint nailed both ways.
C. Butt-jointed and screwed.

with 2 in. No. 10 countersunk screws. It is an advantage to apply a weather-proof glue to the corners before assembling halved or butt-jointed boxes.

Corner-locking is generally considered to be the best method, and providing the lugs have been cut accurately in manufacture, correct assembly is easy. To cut the lugs economically requires a rather expensive corner-locking machine. This method is normally confined to hives made by major bee appliance manufacturers.

Halved joints are made easily and cheaply by anyone with a good saw bench, and may be considered superior to corner-locking because less end grain is exposed. However, most commercial beekeepers prefer corner-locked joints. Butt-jointing requires extreme accuracy in cutting and in assembly, and fixing with countersunk screws is laborious.

Rabbets in the walls

The frames are suspended in the bodies by the frame lugs which rest on rabbets cut in the front and rear walls. The depth to which the rabbets are cut provides a bee-space of $\frac{1}{4}$ in. over the top of the frames. A slight clearance is desirable between the bottoms of the frames and the bottom of the walls of the hive body to ensure that the frames do not project below the bottom of the body. The clearance must not be more than $\frac{1}{8}$ in. otherwise there will be too much space between the tops of the frames in one body and the bottoms of the frames in the body above, leading

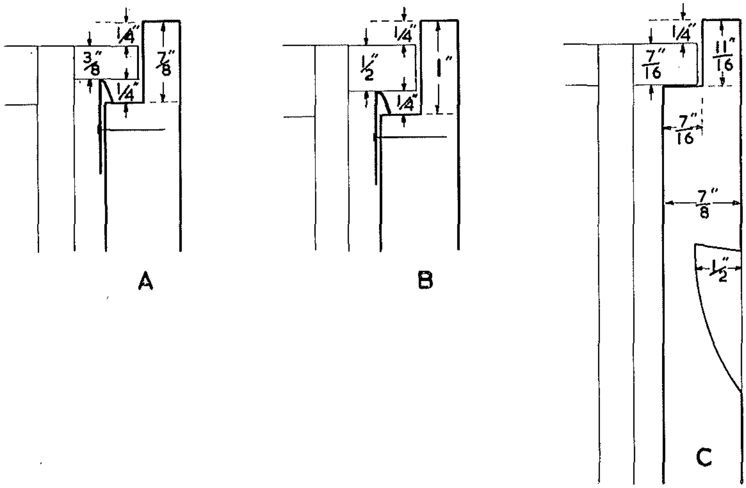


FIG. 5. DETAIL OF RABBETS

A. Langstroth or Full-depth hive with metal runner. B. Jumbo hive with metal runner. C. 6$\frac{5}{8}$ in. Honey Super—no metal runner, also showing hand-hold in section.

to the construction of comb between them. In practice 1/16 in. is the most which is desirable.

Brood boxes have metal runners fitted to the rabbets to make it easier to move the frames, and to prevent loss of top bee-space through a build-up of propolis on the rabbets. The metal runners must be strong to support the weight of the frames when full of honey. The most suitable material is 24-gauge galvanized iron.

The top edge of the runner is bent over 5/16 in. to provide additional support and bee-space of $\frac{1}{4}$ in. under the frame lugs. The metal runner should be $\frac{1}{2}$ in. shorter than the rabbet, so that a space of $\frac{1}{4}$ in. can be left at each end to prevent water being trapped in the rabbets.

Metal runners are not considered necessary in honey supers. To inhibit the use of propolis in rabbets with or without metal runners, they can be brushed over with a thin layer of petroleum jelly (Vaseline).

Hand holds

Hand holds about 3$\frac{1}{2}$ in. long by $\frac{1}{2}$ in. deep are provided in each of the four walls about 2$\frac{1}{2}$ in. below the top. Good hand holds are difficult to cut without special tools. The top should slope upwards slightly towards the inside to prevent the fingers slipping. There must be ample room below the top of the hand hold for the fingers to be able to take the full weight of the super when full of honey.

FRAMES

The frame, as the term is used in beekeeping, is a wooden border, designed to hold the comb of the honeybee in a hive, so that the comb can be removed and replaced in the hive without being damaged. With frames, comb foundation must be used. Comb foundation consists of a sheet of beeswax on which is impressed the pattern of the bases of cells, and which is fitted into the frame to assist the bees in building comb. The foundation is either reinforced with wires embedded in it or has a plastic core.

There are several sizes of frame in use in Australia, but all have one thing in common, their length, which is the original Langstroth length. This dimension is 17⅝ in. The top bars have projecting lugs on the ends, which enable the frames to hang from rabbets in the tops of the hive walls, and are also of one standard length, 19 in.

The main difference between the frames is their depth. That most commonly used in all parts of Australia, and in fact throughout the world, is the Langstroth or Full Depth frame, having a depth of 9⅛ in. For those who like a deeper frame, so that the brood nest can be contained in a single box at all seasons, there is the Modified Dadant or Jumbo frame, having the depth originally used by Quinby, 11¼ in.

The other frames are all shallower than the Langstroth. The W.S.P. is 7⅛ in. deep and is intended as a general purpose frame like the Langstroth. The Dadant shallow frame, intended mainly for honey storage, is 6¼ in. deep. A wide spaced, closed-end variety of this frame, known as the Manley frame, and not unlike the Bolton frame in appearance, is intended purely for the storage and extraction of honey, and is also 6¼ in. deep.

The Ideal and Bolton frames are 5⅜ in. deep and the Half Depth or Shallow frame is 4½ in. deep. The Ideal and Half Depth are normally used only in honey supers and mainly by amateur beekeepers.

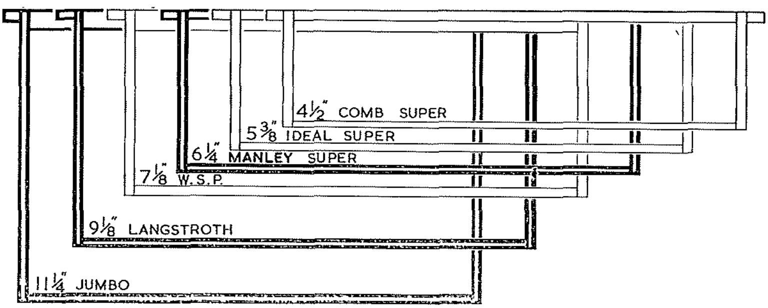


FIG. 6. FRAME SIZES
All frames 17⅝ in. long with 19 in. top bars.

Top bars

The frame top bars have a groove $\frac{1}{8}$ in. wide by $\frac{1}{4}$ in. deep in the underside. The groove is provided for fixing comb foundation to the top bar. Some top bars have a cut-away wedge.

For plain foundation, which is normally used, the single groove top bar is best. The Australian wedge top bar is a very poor thing, the wedge being far too small to serve its purpose of securing the foundation.

With the shallow frames, the thickness (that is, the depth) of the top bar is $\frac{3}{8}$ in. For the deeper frames, a stronger top bar is needed to prevent sagging and this is supplied 7/16 in. deep for Manley frames, $\frac{5}{8}$ in. deep for W.S.P. and Langstroth frames by Australian manufacturers, and 25/32 in. or just over $\frac{3}{4}$ in. by American manufacturers. For the big Jumbo frames, the depth of the top bar is between $\frac{3}{4}$ and $\frac{7}{8}$ in.

The width of the top bars for frames having $1\frac{3}{8}$ in. spacing should be 1 1/16 in. to provide 5/16 in. bee-space between adjacent top bars. This is followed by American manufacturers, while the Australian top bars are made a little narrower, $\frac{7}{8}$ or 1 in. wide.

The importance of these dimensions is not merely a matter of strength. Clearly the top bars must be strong enough not to break or sag under normal commercial bee-keeping conditions. But in addition, the dimensions should be such that the bee-space is maintained between frames to inhibit the building of comb between the top bars. This is achieved in frames with 1 1/16 in. widė top bars, when the frames are pushed together. Of course, if the top bar sags, there is a likelihood of comb being built in the in-creased gap over the frames.

One unfortunate dimension which has been standardized for a long time is the thickness of the top bar lugs. This is $\frac{3}{8}$ in. and breakage is common, particularly at the point

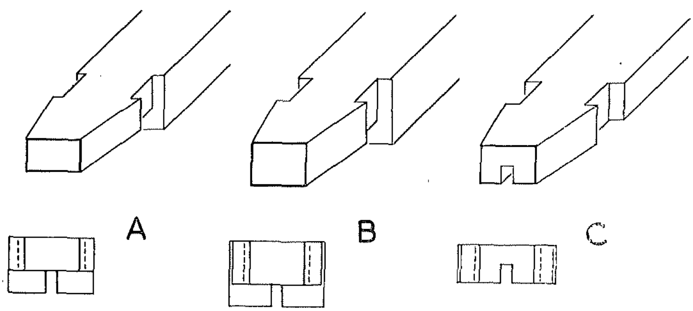


FIG. 7. TOP BARS

A. Langstroth grooved top bar for plain foundation and for Plasticore. B. Jumbo top bar. C. Manley frame top bar grooved for Plasticore or plain foundation.

of junction with the end bar. Some manufactureres try to overcome this by making the lug thicker at this point, but the ideal is for the whole lug to be slightly thicker. In the Manley frames the whole top bar including the lug is now made 7/16 in. thick, and the lugs of Jumbo bars $\frac{1}{2}$ in. thick.

End bars

Frame end bars are made $\frac{3}{8}$ in. thick and 1 to 1 1/16 in. wide except for the upper third which is normally $1\frac{3}{8}$ in. wide. This is the Hoffman type of end bar, which is self-spacing by means of the width of the upper third.

In order that frames with Hoffman end bars be correctly spaced for brood rearing, the frames must be pushed tightly together. This can be made difficult by the accumulation of propolis on the edges. To overcome this, one edge of each end bar can be cut to a blunt "V" edge to cut into the propolis so that the end bars may come into close contact, and maintain the correct spacing.

In Australian 10-frame hives, difficulty is experienced when 10 frames made with $1\frac{3}{8}$ in. spacing are used. When new, the frames fit in easily, but in the humid atmosphere of the hive, the wood of which the frames are made swells and causes them to jam in the hives. Hence only nine frames are usually put into a 10-frame box.

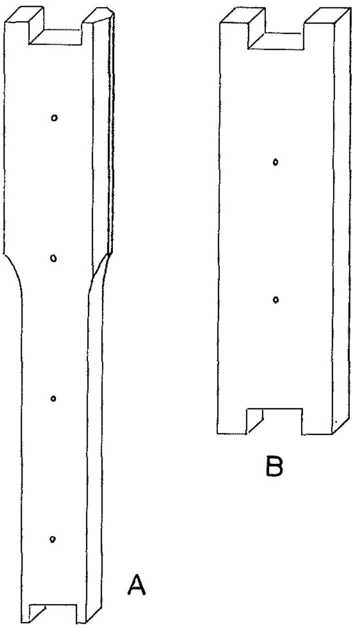


FIG. 8. END BARS
A. Hoffman self-spacing end bar for brood frames. B. Manley end bar for honey extracting frames. Wire holes required only for plain foundation—not needed for Plasticore.

If the end bars are not more than $1\frac{3}{8}$ in. wide when in use, (they can be only 1 5/16 in. wide for brood reading) ten of them pushed together will occupy $13\frac{3}{4}$ in. The internal width of the Australian 10-frame box is $14\frac{1}{4}$ in. so $\frac{1}{2}$ in. is available for manipulation of the frames. In order that 10 frames can be used at the correct spacing for brood rearing they should be made with end bars not more than 1 11/32 in. wide, to allow for swelling in the hive.

In current practice, the nine frames fit very loosely in the box, and the bees use large amounts of propolis to fill the spaces between the end bars, producing a considerable accumulation of the staff. In the circumstances the use of the "V" edge has been dropped, but the frames are not being used as was originally intended and are spaced at over $1\frac{1}{2}$ in. apart. The result is that they are less efficient for the production of brood, and large quantities of propolis and burr comb are produced in the hives. Another feature of this practice is that because the frames are used wider apart than the end bar spacing, they have to be spaced each one by hand, a time consuming operation, not in keeping with modern commercial beekeeping techniques.

The Hoffman shape of end bar, when correctly used, is excellent for frames which are frequently being moved in the hive. But for frames in honey supers, which are used purely for the storage and extraction of honey, a more simple design of end bar can be used. This has end bars the same width for the whole length, and the width corresponds to the spacing of the frames for the most efficient storage of honey. This type of end bar is used on the Manley frames, and it stops the frames from swinging and crushing the bees.

Bottom bars

There are two types of bottom bar in common use. The plain bottom bar is used with plain comb foundation, and the grooved bottom bar is used for plastic cored foundation.

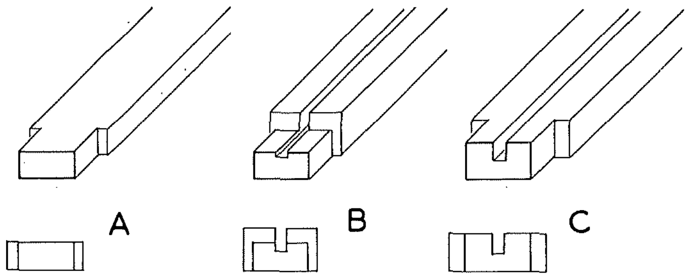


FIG. 9. BOTTOM BARS

A. Plain bottom bars for plain foundation in wired frames. B. Jonel Langstroth bottom bar for Plasticore foundation. C. Manley bottom bar groved for Plasticore foundation.

The dimensions of the bottom bars are generally less vital than those of the top bars. They are usually from 5/16 in. to $\frac{3}{8}$ in. thick by 13/16 in. to $\frac{7}{8}$ in. wide. In the Manley frames, designed for honey storage and extraction, the bottom bars are the same width as the top bars, a bare $1\frac{1}{8}$ in.

TABLE 3.—DIMENSIONS OF FRAMES IN INCHES

See Figure 10

			Top Bar				End Bar			Bottom	
	A	B	C	D	E	F	G	H	I	J	K
Langstroth full-depth—											
Penders	$17\frac{5}{8}$	$9\frac{1}{8}$	19	$\frac{3}{8}$	$\frac{5}{8}$	$\frac{7}{8}$	$\frac{3}{8}$	$1\frac{3}{8}$	1	$\frac{5}{16}$	$\frac{7}{8}$
Jonel	$17\frac{5}{8}$	$9\frac{1}{8}$	19	$\frac{3}{8}$	$\frac{5}{8}$	1	$\frac{3}{8}$	$1\frac{3}{8}$	1	$\frac{1}{2}$	$\frac{13}{16}$
Recommended	$17\frac{5}{8}$	$9\frac{1}{8}$	19	$\frac{3}{8}$	$\frac{5}{8}$	$1\frac{1}{16}$	$\frac{3}{8}$	$1\frac{11}{32}$	1	either of the above	
Jumbo	$17\frac{5}{8}$	$11\frac{1}{4}$	19	$\frac{1}{2}$	$\frac{3}{4}$	$1\frac{1}{16}$	$\frac{3}{8}$	$1\frac{11}{32}$	1	$\frac{3}{8}$	$\frac{7}{8}$
Manley	$17\frac{5}{8}$	$6\frac{1}{4}$	19	$\frac{7}{16}$	$\frac{7}{16}$	$1\frac{1}{8}$	$\frac{3}{8}$	$1\frac{23}{32}$	–	$\frac{7}{16}$	$1\frac{1}{8}$

Brood frames

A frame intended to hold comb in which brood is raised must meet the natural requirements of the honeybees if it is to be efficient for its purpose.

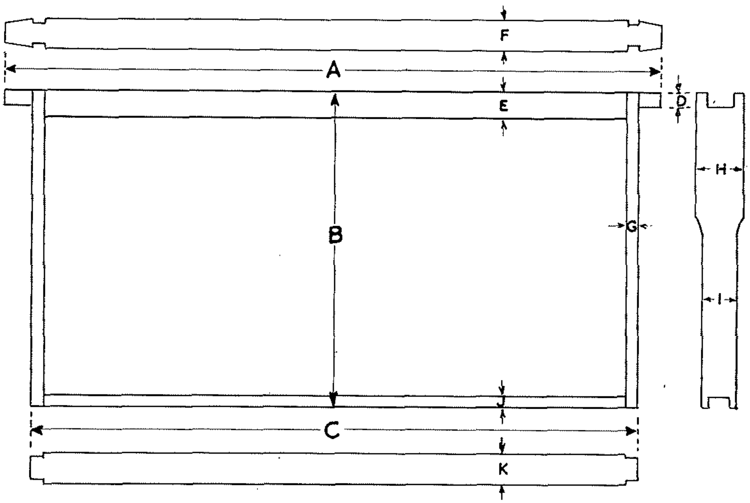


FIG. 10. FRAME DIMENSIONS
See Table No. 3.

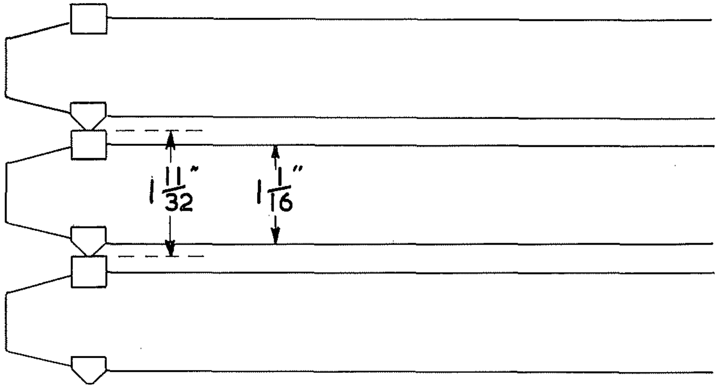


FIG. 11. SPACING OF BROOD FRAMES
Hoffman self-spacing end bars manufactured 1 11/32 in. wide for working with 10 frames in a 10-frame hive. Top bar width 1 1/16 in. gives correct bee-space between frames.

The essential factor is the spacing of the comb. For most efficient brood production the combs should be spaced at little under 1⅜ in. centre to centre. The width of the end bars should be made so that when in use in the hive, the spacing is not more than 1⅜ in. This spacing is maintained by pushing the frames tightly together so there is no gap between the end bars into which the bees will force propolis. This is facilitated by having one edge V-shaped to cut into the small amount of propolis which bees apply to every crack or joint. The convention is for the "V" edge to be on the left when the frame is viewed from the side. This ensures that whichever way round the frames are placed in a hive, the "V" edges always come in contact with flat edges. To allow for the expansion of the wood in the humidity of the hive, the width of the end bars when cut from dry timber should be no more than 1 11/32 in.

The other parts of the frame should be designed so that when in use the principal of the bee-space is maintained between adjacent frames. The spaces should be no less than ¼ in. and no more than ⅜ in. for them to be kept clear of propolis and comb.

Honey storage frames

Bees tend to space the combs used for the storage of honey wider apart than the brood combs, often 1½ to 1¾ in. apart.

The beekeeper can make use of this by spacing the frames wider apart in the honey supers. This is more economical, as fewer frames are required, and more honey can be stored in a box as there are fewer spaces between

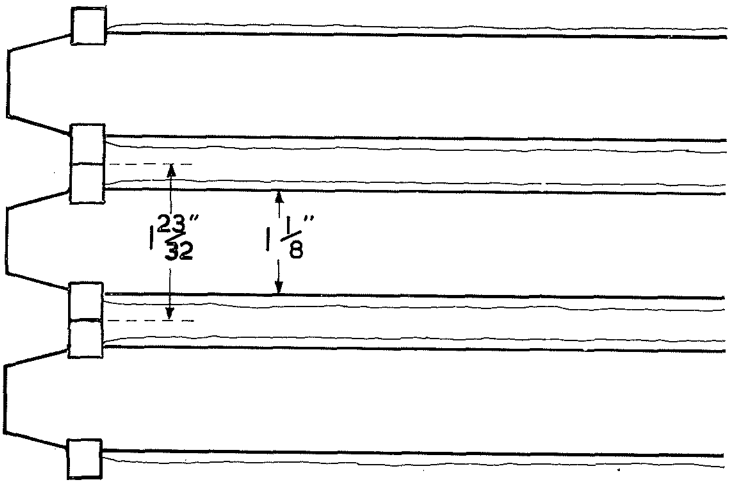


FIG. 12. SPACING OF MANLEY HONEY SUPER FRAMES
End bars 1 23/32 in. wide with 1⅛ in. wide top and bottom bars provide space for easy uncapping. Eight Manley frames fit easily in 10-frame width super.

combs. For this reason it is usual for only eight frames to be used in a 10-frame box, with a spacing of a little under 1¾ in.

Usually ordinary brood frames are used for this purpose, and are spaced by eye, a time wasting operation.

Frames have been specially designed for the storage and extraction of honey, and such frames are not intended for use in brood rearing. In fact, their wide spacing tends to inhibit the bees from using them for this purpose. These frames are simple in design, with straight sided end bars, 1 23/32 in. wide for use in Australian 10-frame Langstroth hives. The top and bottom bars are made the same width as each other, a bare 1⅛ in. so that when the uncapping knife is drawn along in contact with the top and bottom bars, it takes off all the cappings in one slice.

This type of frame is the Manley honey super frame, and is usually used in the 6¼ in. deep size.

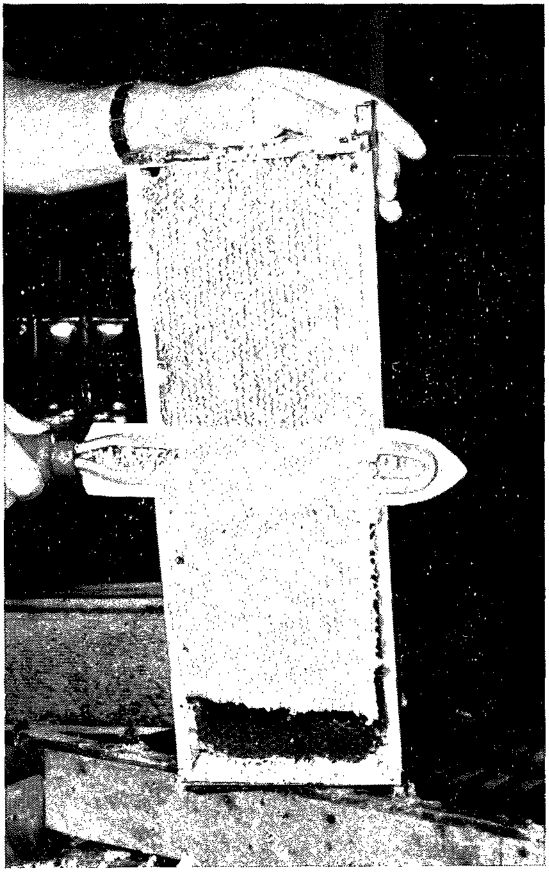
General purpose frames

Beekeepers using Langstroth or Full Depth hive bodies for all purposes want frames which can be used for both both brood rearing and for honey storage and extraction. Owing to the difference in spacing required for the two uses, perfection for both cannot be achieved. It is, however, possible to make frames which meet the essential requirements of brood frames and which are also good extracting

frames. The spacing for honey storage remains unsatisfactory as it has to be done by eye or by means of special spacers fitted to the honey super.

End bar width of 1 11/32 in. gives the best spacing and enables 10 frames to be used in a 10-frame box for brood rearing. Top bar width of 1 1/16 in. gives the proper bee-space between frames to minimize burr comb, and gives a good level for uncapping combs which have been spaced eight in a 10-frame box, without putting too much strain on the cappings melter.

All these deails of frame design may appear to some to be too meticulous. But attention to these details makes the hives easier to work and speeds up all management operations, by reducing the accumulation of propolis and burr comb, which otherwise fouls up the hives. Also, more bees



Uncapping a Manley frame.

are free to forage and bring in honey, instead of wasting their time collecting propolis and stuffing it between the frames, using up honey and time in building burr comb, and hanging around filling the too wide spaces between the brood combs.

COMB FOUNDATION

The use of comb foundation in frames has been accepted as good practice by beekeepers for many years.

It is generally agreed that the advantages of using foundation are:—

(a) the combs are built correctly in the frames;

(b) the combs are composed almost entirely of worker cells, and the construction of drone cells is reduced to the minimum;

(c) combs are built more quickly;

(d) there is an increase in honey production because the bees do not have to consume so much honey to produce wax, and because more bees are available for foraging.

The advantage (d) holds mainly for combs used for storing honey; in the brood nest, wax is produced extremely economically when brood is being reared.

Foundation is made with various sizes of cell bases, to suit European, African and Indian varieties of worker bees, and also in drone cell size. We are concerned only with the size for European bees.

It is also made in different thicknesses and weights. The most satisfactory is called Medium Brood, and works out at seven Langstroth sheets, five Jumbo sheets, or 10 sheets for 6¼ in. frames to one pound weight. The thinner grades of foundation should be used only for the production of comb honey, where the whole comb is eaten and no wires are embedded in the foundation. Medium Brood foundation is drawn into comb more quickly than Light Brood or Thin foundation, and has fewer pop holes and fewer cells lacking brood due to the presence of embedded wires.

Plain foundation is used most commonly. To support it in the centre of the frames, and to prevent the combs from collapsing when moving hives or extracting honey, wires about two inches apart are threaded through the end bars, and embedded in the foundation.

The holes are usually drilled by the manufacturer, but it is important that metal eyelets be fitted tightly into the

TABLE 4.—COMB FOUNDATION SIZES IN INCHES

Frame	Type	Size in.	Sheets per lb. (approx.)
Langstroth full-depth	Plasticore	$16\frac{3}{4} \times 8\frac{3}{8}$	6
	Plain	$16\frac{3}{4} \times 8\frac{1}{8}$	7
Jumbo	Plasticore	not available	....
	Plain	$16\frac{3}{4} \times 10\frac{1}{4}$	5
Manley	Plasticore	$16\frac{3}{4} \times 5\frac{3}{4}$	9
	Plain	$16\frac{3}{4} \times 5\frac{1}{2}$	10
Comb and Sections	Thin surplus	$15\frac{1}{2} \times 3\frac{7}{8}$	28

holes on the outside of the end bars to prevent the wires from cutting into the wood and to keep the wires tight. Individual beekeepers have their preferences for different methods of wiring frames, but the basic method is to have horizontal wires, pulled tight so that they twang when plucked, but not so tight as to bend the end bars inwards. The neatest way of embedding the wires is by passing a low voltage current through the wire so that it heats and sinks into the middle of the sheet of foundation. It is usual to fit the top of the foundation into the groove in the underside of the top bar, and to secure it by running melted beeswax into the groove, or by applying a few drops of glue in the groove.

The wiring of frames and embedding of wires into the foundation is a slow and tedious job. To overcome this some beekeepers use ready wired foundation. But as most forms of reinforced foundation still need some frame wires to keep the foundation central and to prevent damage in extraction, there is no real saving obtained from its use. There is, however, considerable saving in labour in the use of foundation with a plastic central core.

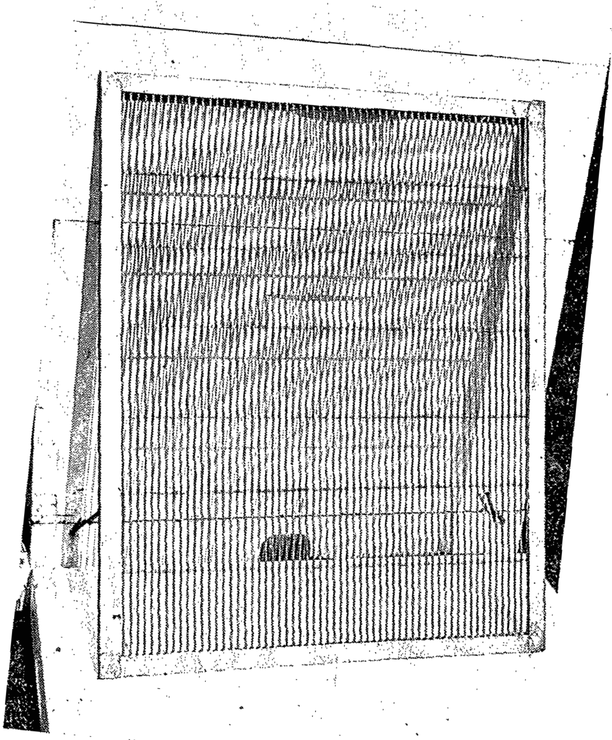
This last, marketed in Australia as "Plasticore", has a metal strip down each side, and is secured into the grooves in the top and bottom bars by metal strips. Extensive tests have shown this foundation to be hightly satisfactory from all practical aspects. It is more expensive than plain foundation with eyelets and wire, but as it reduces the time taken to assemble frames ready for use to less than half, the additional cost is cancelled out by the saving in labour expenses. Also it has a very much longer useful life than ordinary foundation.

QUEEN EXCLUDER

The queen excluder is an essential part of every honey producing hive. It is placed on top of the brood box to keep the queen from going up into the honey supers and laying eggs in them. The excluder is a wire grid in which the holes are of such a size as to permit worker bees to pass through, but to prevent the passage of the queen and drones. With excluders of the wire type, the space between the wires is specified as 0.168 in. plus or minus 0.003 in. (4.27 mm. plus or minus 0.07 mm.).

The type of queen excluder recommended is the metal-bound welded-wire queen excluder. This is a great improvement on the wooden framed excluder, being stronger and easier to clean.

The queen excluder keeps the brood out of the combs in the upper boxes. The beekeeper can then remove the boxes for extracting without handling the frames or without taking combs of brood into the extracting plant. By stopping the movement of brood combs from one hive to another the danger of spreading brood diseases is greatly



All metal welded wire queen excluder.

reduced. The honey extracted from combs which have not been used for brood is of better quality, both in colour and flavour, than that from combs darkened by brood rearing.

Some beekeepers find that they obtain more honey when they use queen excluders. Without queen excluders, the queen is tempted to go up into an empty super and use it for brood rearing, neglecting the bottom box. But with a queen excluder in position, the queen is forced to utilise fully the bottom box and the bees are stimulated to fill the super with honey.

A queen excluder can always be put between two boxes in which the bees are already working. But do not put a queen excluder on top of a box which is not fully occupied by bees. If the bees are not ready to occupy a super, then the addition of a queen excluder may delay the use of the super when the bees are ready. If you must give the bees a super before they are ready for it, wait until they have started work in the super before putting the queen excluder under it.

A point to note when using a welded-wire excluder: put the excluder in position with the cross wires uppermost. This ensures that there is only a bee space between the excluder and the top bars of the frames underneath, and that there is sufficient space to stop propolising between the queen excluder wires and the bottoms of the frames in the box above.

HIVE LIDS

The lid, or roof, covers the top of the hive. It protects the bee colony from the weather and from enemies, and is readily removable to give the beekeeper access to the interior of the hive.

The lid must be strong enough to permit the hives to be stacked, a man to stand on top of it, and for the hives to be lashed on a vehicle. The materials of which the lid is made must be sufficiently durable to withstand the effects of the weather, the full heat of the sun, rain and damp. The lid is required to keep the hive cool in summer and dry at all times. It must stay in position in a gale. And it must not provide a nesting place for ants or other pests.

Telescopic cover

The telescopic cover consists of a wooden rim, which fits loosely round the hive body and is covered on top with boards or tempered hardboard (Masonite). It is made rain-proof with a sheet of galvanized iron over the top and folded down to cover the joint between the top and the rim.

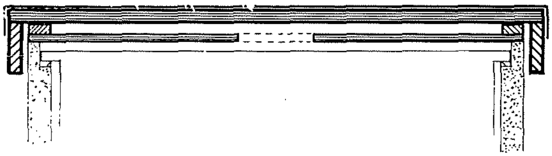
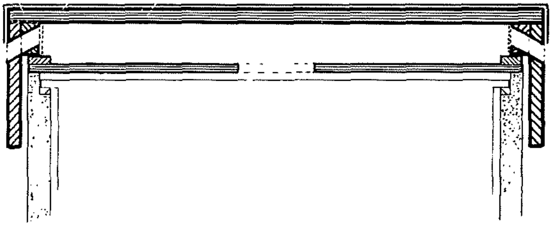


FIG. 13. TELESCOPIC COVER

A. American cover with separate inner cover.



B. British version with top ventilation and deep storm-proof rim.

As the rim of the telesecopic cover comes down over the top of the hive body, it is not possible to insert a hive tool to separate the cover from the body. So a flat piece of strong plywood, having a rim ⅜ in. deep by ⅞ in. wide round the upper side, is placed on top of the hive body. This is known as an inner cover and is usually provided with a central hole 1 3/16 x 3 in. for ventilation and for taking a Porter bee escape. The inner cover can be used as a super clearer.

The standard American type of telescopic cover has a rim only 2 or 3 in. deep, and is liable to be blown off in a strong wind. In the United Kingdom, where gales are not uncommon, this is overcome by having the rim about 6 in. deep. With this depth of rim, the cover catches on the hive when lifted on one side by the wind.

Ventilation is normally provided in the telescopic cover to permit the escape of hot or moist air from the top of the hive.

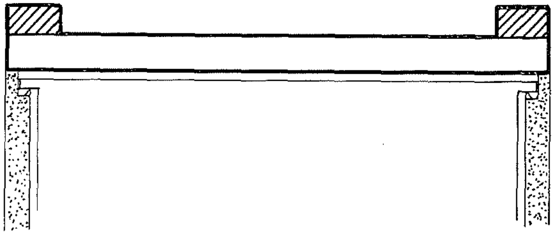
Cleated lid

A very simple type of lid is made of tongued and grooved boards, secured by a wooden cleat along the top of each end. To be serviceable such a lid must be made of a stable timber, such as Western Red Cedar *(Thuya plicata)* and be of fairly thick boards, 1 to 1½ in. If made of inferior timber the lid will warp, and if of thin material, too much heat will be transmitted in hot weather.

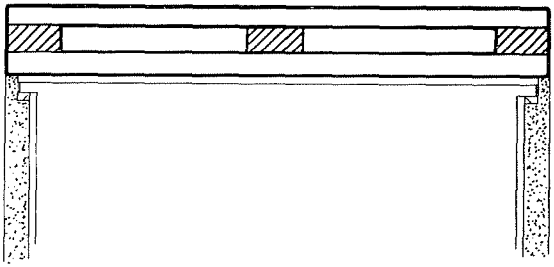
The dimensions are the same as the length and breadth of the hive body. The lid lies flat on top of the hive, and

FIG. 14. CLEATED LIDS

A. Simple cleated lid.



B. Shade-board lid.



is stuck to the top box by the propolis. This prevents it blowing off, and keeps out the rain.

Additional protection from the weather is sometimes given to the cleated lid by securing a piece of galvanized iron sheet, or tongued and grooved boards, over the top of the cleats, thus forming a shade board lid. This is not popular in Western Australia as the gap between the shade board and the lid proper forms an excellent nesting place for poisonous red-backed spiders.

Migratory lids

The migratory lid looks very much like the telescopic cover. It consists of a 2 in. high rim, with boards or tempered hardboard on top, covered with galvanized iron sheet, and with ventilation holes in the rim. The rim is made to exactly the same dimensions as the hive body; it rests on top of the hive, and does not telescope down round it.

The migratory lid, like the cleated lid, is securely attached to the hive by propolis and does not blow off in a gale. It provides a ventilated air space over the frames which protects the colony from overheating and severe damp. Being of the same external dimensions as the hive bodies, it simplifies the packing of hives on a truck.

The inner cover under a telescopic lid, and also the cleated lid, both provide a flat top to the interior of the hive, giving ¼ in. bee-space over the top bars of the frames. But

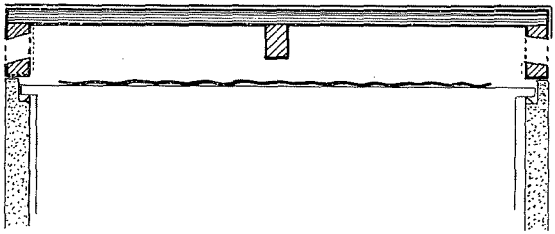
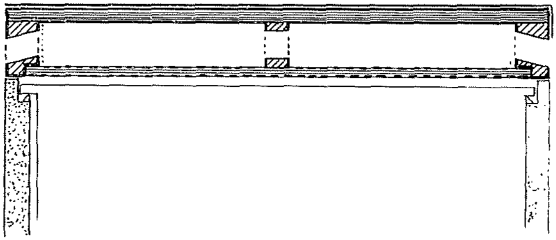


FIG. 15. MODERN AUSTRALIAN LID

A. Migratory lid, ventilated and with mat on frame top bars.



B. Cavity lid, ventilated at the ends and with built-in inner cover with ventilation slots along the sides of the inner cover.

in the migratory lid, the space is about 2 in. If there is insufficient room in the hive for the storage of honey, the bees build comb in the lid, making it more difficult and messy to open.

To try to prevent the building of comb in the lid, a piece of rubber insert, ripple plastic sheet, ripple leather or heavy canvas is placed on top of the frames. This mat, as it is called, is cut rather smaller than the inside of the hive to leave a gap of about 1 in. all around for ventilation.

Cavity lid

The cavity lid is very similar to the migratory lid in appearance. Instead of having to use a separate mat, an inner cover is built into the lid, thus halving the time and work required to open and close the top of the hive.

The inner cover consists of a piece of waterproof plywood or tempered hardboard, fitted into and flush with the bottom of the lid. The inner cover is narrower than the inside of the lid to provide a ½ in. wide gap along each side for ventilation.

The ventilation holes are provided in the rim at the ends of the lid. In this position the wire screens on the inside of the holes are not blocked up by propolis. Some strains of bees, particularly Caucasians, may propolise the ends of the ½ in. wide slots at the sides of the inner cover, but they still leave plenty of room for ventilation.

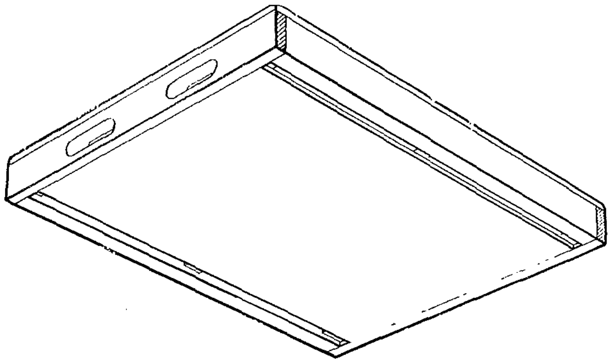


FIG. 16. CAVITY LID
Showing ventilation holes in the ends and ½ in. wide ventilation slots along the sides of the built-in inner cover.

Ventilation

All hive lids should be ventilated. Hot air, or damp air, must be able to escape from the top of the hive.

If no top ventilation is provided in summer, the air in the top of the hive can reach very high temperatures, much higher than the air temperature outside the hive. The heat can be sufficient to cause the wax to melt in the top of the hive. It causes more bees to be employed in fanning and in collecting water instead of nectar. Weak colonies and nuclei may not be able to keep the temperature under control, and may be lost through over-heating. Other colonies may abscond.

The provision of a shade board over the lid helps, but does not prevent the absorption of heat by the sides of the hive. This heat originates from the direct rays of the sun, radiation from the sky and from the hot ground around the hive. Painting the outside of the hive white is a very great help in keeping out the radiated heat. Shade over the hives and the surrounding ground is valuable in summer, but is not readily available in commercial apiary sites. In fact, the heavy shade of forest trees in areas where there is a big range in temperature each day, as in the Karri forest, is detrimental to honey production.

The most simple and effective answer to high temperature is adequate top ventilation. This also speeds up the ripening of honey by permitting the more rapid escape of moisture from the hive.

In cool damp winters top ventilation permits the escape of the damp air which rises from the bee colony. If there is inadequate top ventilation this moisture will condense on the inside of the lid and on the walls of the hive, which

are colder than the air rising from the cluster. This condensation results in a damp hive, the growth of fungi on the wood and on the combs, rotting of the wood, damage to the paint, and unhealthy conditions for the bees which become liable to a number of disorders. Top ventilation may make the top of the interior of the hive slightly cooler in winter but it is a healthy dry condition, not a destructive damp clammy atmosphere.

Protective covering

The most commonly used covering for hive lids is galvanized iron sheet, fitted over tempered hardboard or boards. The metal should be of a reasonably substantial gauge to resist damage; 26 gauge is most suitable. The sheet is cut 2 to 3 in. larger than the top of the lid so that it can be folded down round the rim 1 to 1½ in.

The galvanized iron is secured to the lid with flat-headed galvanized nails. These are driven through the turned down edges into the sides of the rim. They must never be driven into the top of the lid which must be kept perfectly smooth and water tight.

Galvanized iron absorbs heat very rapidly. It can be painted white to reflect the heat, but while this is quite satisfactory for static beekeeping the paint soon gets scratched off the metal when much migration is practised. Protection of the lid from heat can be provided by having boards of substantial thickness, ⅞ in. or more, under the iron. If tempered hardboard is used under the iron, insulation can be provided by having a sheet of ceiling board (Caneite) or a wad of newspapers between the metal and the hardboard.

An alternative to galvanized iron is to cover the top of the lid with a hard waterproof plywood. A very serviceable and reasonably priced plywood for this purpose is 5/16 in. thick Karri Aquatite. To prevent splinters, the edges and corners should be rounded by sanding, and the whole lid, inside and out, should be painted thoroughly with red lead, two layers of undercoat and best quality hard gloss top coat.

BOTTOM BOARDS

The bottom board or floor board is the base on which hive bodies stand. It provides an entrance for the bees to pass in and out of the hive.

The bottom board is required to protect the bee colony from the weather and from enemies and to protect the hive from damage, particularly that caused by fungi and termites.

A good bottom board assists in the management and handling of hives. It should be easy to attach to and detach

from hive bodies. The nose or forks of a barrow or hive loader should go under it. It should be easy to slide across the platform of a truck and to stack on top of other hives. It may be required to fit on a pallet for loading several hives at once. The entrance should be easy to shut and open.

Dimensions

Essential dimensions are the length and width, which are the same as those of the hive bodies. The space between the floor and the bottoms of the frames in the hive body is important.

This space should never be less than 5/16 in. It can be as much as 1 in. If more than this, the bees may build comb under the frames.

Protection from decay

The bottom board is more subject to decay than any other part of the hive. Damp is the main cause of the trouble because it provides suitable conditions for the growth of fungi. The damp comes up from the ground, from condensation within the hive, and from rain splashing in the entrance.

If the hive cannot be placed on a stand, the bottom board is fitted with cleats to raise it off the ground. In the case of flat floor boards, it is usual to set the hive so that it is tipped forward slightly to allow any condensation or rain to run straight out of the entrance. Some bottom boards are designed so that the floor slopes down towards the entrance. This arrangement sheds water when the hives are set down in normal apiary sites, without the need to incline the hives forward.

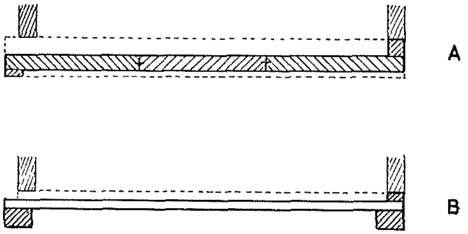
To provide further protection, the wooden parts are made of fungus-resistant timber, or are treated with wood preservative.

In the warmer areas, termites readily destroy unprotected bottom boards and travel up into the hive bodies. To provide protection against this sort of damage, bottom boards in Australia are often made of galvanized iron sheet. The cleats and frame or risers are made of terminate resistant timber.

Because the galvanized iron sheet is shaded by the hive body, the floor does not become any hotter than the air surrounding it.

Designs

The standard American design of bottom board, which is also used in Britain, has tongued and grooved boards running across the width of the hive. The ends of these boards fit into grooves cut in the 2 in. high side rails.



A. American bottom board, section.

B. Australian bottom board, section.

FIG. 17. STANDARD BOTTOM BOARD TYPES

The American floor is reversible, providing a full width entrance $\frac{7}{8}$ in. high on one side, and $\frac{3}{8}$ in. high on the other. The $\frac{7}{8}$ in. side is the one normally used, and the entrance can be reduced, or closed, with a wooden block.

The normal Australian type of bottom board has the floor boards running from the back to the front of the hive. The boards are fixed to cleats under the back and front. Risers, $\frac{3}{8}$ in. high by $\frac{7}{8}$ in. wide, are fitted along the sides and back to provide the space between the floor and the bottom of the frames.

Some beekeepers use tempered hardboard (Masonite) instead of timber but galvanized iron sheet is becoming increasingly popular and is more durable.

Landing board

Some bottom boards have a projection of the floor under the entrance. This is called a landing or alighting board, and as such it is of doubtful value. The disadvantage of the projecting landing board is in wet weather, when it causes rain to splash into the hive and holds water in the

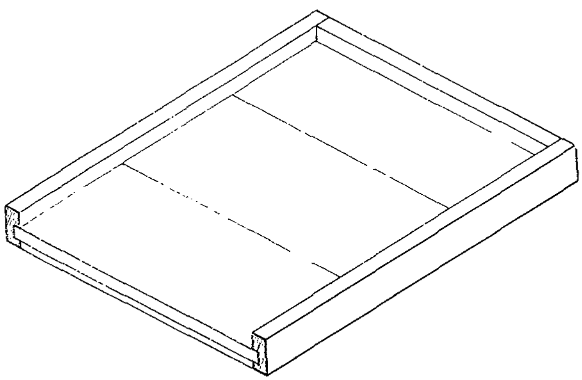


FIG. 18. STANDARD AMERICAN BOTTOM BOARD

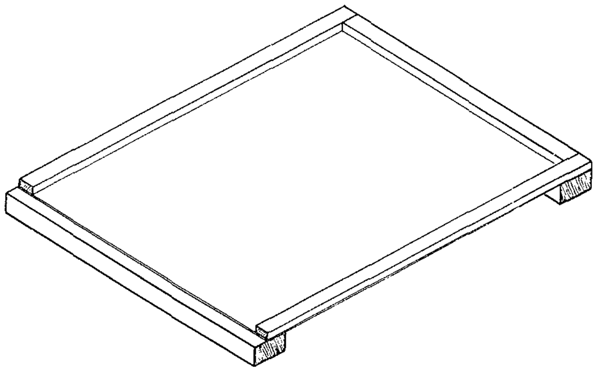


FIG. 19. COMMON TYPE OF AUSTRALIAN BOTTOM BOARD

path of the bees. If such a projection is used, it should be as short as possible and slope away from the entrance.

When fasteners are used on the fronts and backs of the hive bodies, a projecting landing board acts as a spacer between hives when loaded for moving. Only ¾ in. is needed for this. The space so formed permits the circulation of air between the rows of hives, and is most useful when moving hives with open entrances.

For these reasons, a short strong landing board is incorporated into the design of bottom boards used by many migratory beekeepers.

Entrances

The entrance must be large enough for the free passage of workers, drones and occasionally queens. The minimum height is 5/16 in. but if it is ½ in. high the bees are able to fan in the entrance itself. The width of the entrance ranges from about 5 in. to the full width of the hive.

If the entrance is too big, the bees may reduce it with propolis. If it is too small, they chew away at the wood around the entrance. Hives with no top ventilation need large entrances in the bottom boards, but hives with well-ventilated lids need only small bottom entrances.

The hive entrance has to be small enough for the bees to be able to defend the colony against pests such as ants, mice and lizards, and in some places against wasps and beetles. The longer the passage way through which intruders have to pass, the easier it is for the bees to defend.

The floor should not contain any cavity into which the bees cannot enter; it could become a nesting place for ants and other pests.

Baffle or tunnel entrance

Bees appear to avoid having comb near the entrance to the hive. Frequently they will remove large pieces from the corner of combs in the bottom box when the common types of American and Australian floor boards are used.

This loss of comb space can be overcome by providing a baffle or false floor between the entrance and the combs. In nature bees often provide their own baffle or tunnel in the form of a sheet or wall of propolis.

Dr. Miller designed a slatted floor with a baffle over the entrance which was very successful in preventing wastage of comb space, and provided additional clustering space under the frames. This arrangement has been found very satisfactory in the production of honey in sections where the bees are kept in an overcrowded condition in the hive.

Dr. Anderson provided even more protection for the bottom of the Glen hive for use in the north of Scotland. Although too cumbersome for commercial use, the Glen hive was, and still is, an excellent home for bees.

The baffle or tunnel type of floor offers the following advantages:—

(1) The colony is better protected from the effects of winds, both hot and cold.

(2) The hive is more easily defended against enemies.

(3) The ventilation of the hive can be controlled by fewer bees.

(4) Full use is made of the comb space provided in the frames in the bottom box.

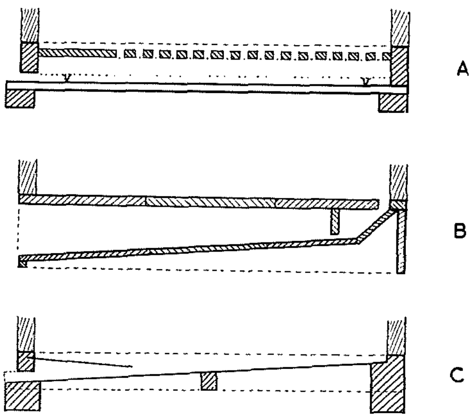


FIG. 20. BAFFLED BOTTOM BOARD
A. Miller baffled and slotted bottom board. B. Protected entrance in the Glen hive. C. Tunnel entrance bottom board.

A design of bottom board has been developed, which incorporates the advantages of the tunnel entrance with a combination of the best features of the American and Australian types.

The floor is of 24 or 26 gauge galvanized iron sheet, sloping down from the back of the hive to the entrance. The sides of the sheet fit into saw cuts in the side rails. A smaller sheet of galvanized iron slopes back for 6 in. from the front of the bottom board, forming the baffle and tunnel entrance. The frame is designed to be cut from 6 x 2 in. bulk timber with the minimum of waste.

The result is a strong, light and durable bottom board which keeps dry and clean, and gives the colony all the necessary protection from weather and enemies.

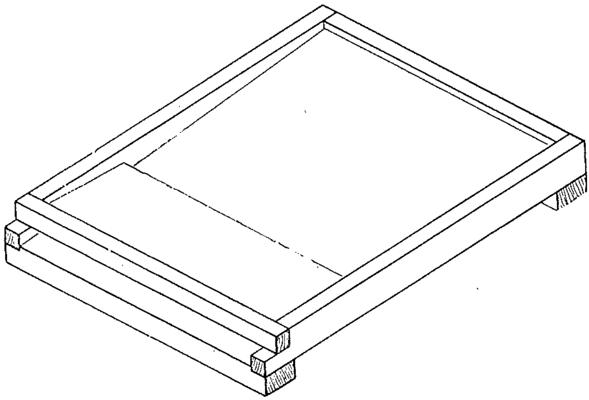


FIG. 21. TUNNEL ENTRANCE BOTTOM BOARD

ASSEMBLING HIVES

Timber for hive making

The timber from which hives are made should be light in weight, stable (free from expansion and contraction or warping with changes of moisture content), easy to work with tools, easy to nail without splitting, durable and resistant to fungal and insect attack. The timber should have been properly air dried and selected for reasonably straight grain and for freedom from knots.

The best timber in the world for hive making is Western Red Cedar, *Thuya plicata,* from British Columbia. It excells in its lightness (22 lb./cu. ft. at 12 per cent. moisture content), freedom from movement, and resistance to insects and fungus. However, it has the disadvantage of being twice as expensive as other timbers locally available.

Hoop pine, *Araucaria cunninghamii,* and Radiata Pine, *Pinus radiata,* are the two timbers most commonly used for hives in Australia. They are both about 50 per cent. heavier than Western Red Cedar (32.5 lb./cu. ft. and 31.6 lb./cu. ft. respectively), but only slightly heavier than Scots Pine or Baltic Redwood, *Pinus sylvestris* (30 lb./cu. ft).

Hoop Pine, which occurs in Queensland, is fairly durable and stable, moving only slightly with changes in moisture content, and appears to be the best native Australian timber for hives. Radiata Pine, which is being extensively cultivated, works and nails well but must be treated properly with preservative for a good working life. The main disadvantage of Radiata is its movement which is considerable with changes of moisture content. Adequate allowance must be made during manufacture from dry timber to provide for the subsequent expansion of the frames in the moist atmosphere of the hive. For this reason we have found it necessary to reduce the specified width of end bars of frames manufactured from dry timber by 1/32 in. to allow for this expansion.

Beekeepers are not recommended to try to make their own frames. This job is done economically and accurately only with expensive woodworking machines, and the main beekeeping appliance manufacturers are well equipped to be able to make and sell frames at the lowest price possible.

Hive bodies can be made with simple woodworking tools provided that butt jointing or rabbet jointing at the corners is acceptable. But if cornerlocking is required then special machines are necessary to do this work economically. Hand holds are also difficult to cut in a proper manner without special tools.

Lids and bottom boards can be made with the aid of a simple circular saw bench.

Wood preservatives

In temperate climates hives made of Western Red Cedar require neither paint nor preservative, so the high cost of the timber is offset by savings in the cost of paint and labour. Other soft woods in such climates need be treated only with a non-insecticidal wood preservative. It is an advantage for the wood to be able to absorb some heat from the sun in cool damp climates. But in the tropics and sub-tropics, where hives may be subjected to very high temperatures, it is desirable to use white paint to reflect the radiated heat away from the hives.

The timbers with which hives are made in Australia are subject to fungal and insect attack. This makes it necessary for the wood to be treated with a preservative to give the hives a good working life. The traditional preservative, which has stood the test of time and which is best for use on hives which are to be painted, is red lead primer.

An alternative preservative, which is easier to apply because the parts can be dipped in it, is copper naphthenate. Paint does not appear to adhere to the wood so well after copper naphthenate treatment as it does if red lead primer is used. Hot wax treatment of the wood is used by some beekeepers, but this requires special equipment for its application and is best suited for use by commercial apiarists or hive manufacturers.

Before assembling the boxes, bottom boards and lids, apply red lead primer to all the various joints, working it well into the end grain of the timber. While the primer is still wet assemble the parts and nail them.

Brood boxes and supers

The brood boxes and supers are composed of four pieces of timber, two of which are longer than the other two. The two shorter pieces have a rabbet cut along the inside of the top. In addition to the four pieces of wood, brood boxes and full-depth supers have two metal runners which fit in the rabbets. The $6\frac{5}{8}$ in. honey super does not have metal runners.

To assemble the boxes, fit the corners together immediately after applying primer. Making sure that the hand holds are on the outside, knock the sides into place with a mallet or piece of wood. Then make sure that you have the box square. Drill an $\frac{1}{8}$ in. hole in the thin lugs at the ends of the rabbets, and nail the pieces together, using a $2\frac{1}{4}$ in. x 13 or $2\frac{1}{2}$ in. x 12 gauge cement-coated or galvanized nail through each lug. After nailing all four corners, make sure that the box is square, and sandpaper any roughness off the corners.

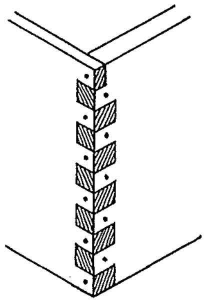


FIG. 22. NAILING BOXES
Drive nail through each lug.

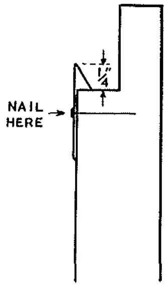


FIG. 23. FITTING FRAME SUPPORTS
Correct method of fitting metal runners in rabbet.

Before painting, mark each box with your registered hive brand. The brand consists of a combination of letters and numerals at least half an inch high and set in alignment. The brand may be burnt in, stamped, carved or scored so it is distinctively impressed below the level of the surface of the box.

Paint the box inside and out with red lead primer, working it well into the corners, joints and end grain. Allow at least two days for the primer to dry thoroughly and then paint inside and outside with white undercoat. For a good finish, sand the undercoat on the outside lightly with fine sandpaper, brush off the dust and apply a second undercoat.

Finally, paint the inside and outside with the best quality hard gloss enamel. Cheaper paints do not last as well and no one wants the work of sanding down and repainting more often than is absolutely necessary.

In the case of brood boxes and full-depth supers, fit the metal runners in position in the rabbets, using at least five $\frac{5}{8}$ in. or $\frac{3}{4}$ in. x 17 or 18 gauge cement-coated nails for each runner. The purpose of the runners is to provide a $\frac{1}{4}$ in. bee-space under the lugs of the frames, to make it easier to manipulate the frames in the brood box.

Lids and bottom boards

Follow the same procedure as with the boxes, applying red lead primer to all joints immediately before assembly. Particular care must be taken to work the primer well into all corners, end grain, grooves and ventilation holes. With lids, complete all painting before fitting the wire gauze or grids to the inside of the ventilation holes with $\frac{1}{2}$ in. staples or small nails.

If the lids are to be covered with galvanised iron, finish painting the wood and masonite before putting on the metal. There should be some insulation under the metal; this can be a sheet of caneite or a wad of newspapers. The joints at the corners of the metal cover can be soldered.

If the metal comes down partly covering the ventilation holes, dent the metal a little into the holes with a ball pein hammer. This will keep the metal on without the need for nail holes. If this cannot be done, drive about five short stout nails into the rim at each side and end. Never drive nails into the top of the metal cover.

Most of the moisture in a lid comes from within, from the bees themselves. Adequate ventilation of the lid together with insulation of any metal cover are the best ways of reducing moisture in the hive.

Assembling frames for Plasticore foundation

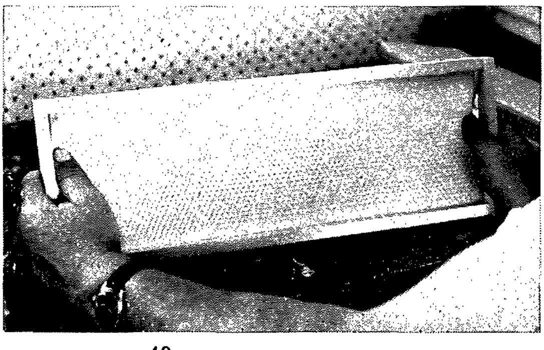
To assemble Jonel full-depth frames or Manley frames modified for Plasticore foundation, place the top bar of the frame on a bench, groove uppermost. Put some synthetic resin or P.V.A. glue in the slots at the top and bottom of the end bars and push the end bars into position in the lugs of the top bar. Put the bottom bar in position.

Drive one 1 in. x 18 gauge cement-coated nail into each end of the bottom bar, punching it just below the surface of the wood.

Turn the frame the right way up and drive one $1\frac{1}{4}$ in. x 17 gauge cement-coated nail in each end of the top bar. If glue is not used, two nails are needed at each corner of the frame.

If the end bars of the frame are provided with a "V" edge, this should be facing you on the left of the assembled frame when it is held the right way up.

Fitting Plasticore foundation into a Manley frame.



Fitting Plasticore insertion strips with machine.

Fitting the Plasticore foundation

The bound Plasticore foundation has a metal binding at each end. With the frame upside down resting on its top bar, put the edge of the Plasticore foundation into the top bar groove. Hold the frame by the end bars and press the metal edges of the Plasticore with your thumbs, bending the metal slightly. This will bring the top edge of the foundation into the bottom bar groove. Straighten out the metal binding if you happen to bend it.

Place a metal insertion strip in the top bar groove, with the wider side of the strip against the foundation. Press the metal insertion strip into the groove with a paint scraper or similar tool, or with the special Plasticore inserting machine. Turn the frame round and the other way up and press another strip into the bottom bar groove. The frame is now ready for use.

Assembling frames for plain foundation

Before assembling the frames, the end bars must be fitted with eyelets in the wiring holes. The wire holes are already drilled by the manufacturer along the centre of the end bars about 2 in. apart.

Lay the end bars of the frames on the bench. If one edge of the end bar has a "V" edge, lay the end bars down so that the wide or top end is away from you and the "V" edge is on the right. It is important to put the eyelets in the correct side of the end bars when "V" edges are used. Eyelets are put in only on the outside of each end bar.

Insert the eyelets in the holes. An awl is a useful tool for this. Several eyelets are threaded on the awl and then the point is put in the hole and the awl pushed until the first eyelet is in place. After withdrawing the awl, tap the

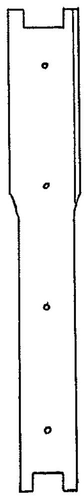


FIG. 24. FITTING EYELETS
Lay end bar on bench with V edge on right as shown.

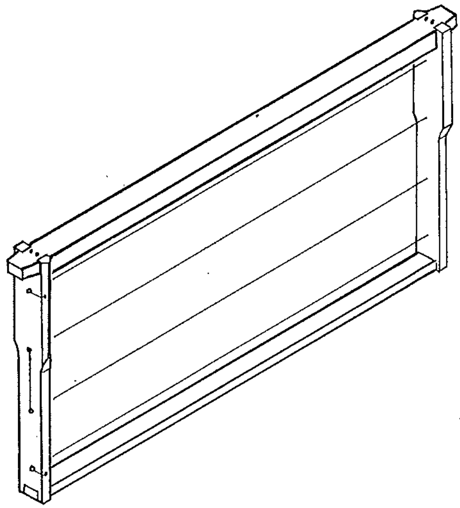


FIG. 25. WIRING FRAME
Wired frame showing method of wiring and position of V edges.

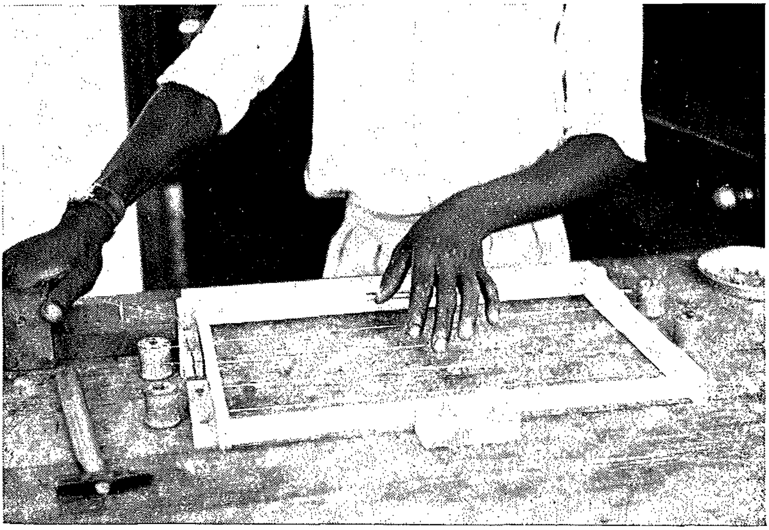
eyelet lightly with a pin hammer so that it lies flush in the wood.

Having fitted the eyelets, assemble the frames in the manner described above for Plasticore foundation.

Wiring the frames for plain foundation

For wiring, a jig should be prepared to hold the frame firmly on the bench. A block should press the bottom bar inwards in the centre. The wire is threaded through the holes nearest the top bar, and back through the next pair of holes and so on until it has been passed through the last pair nearest the bottom bar. A fine nail is driven partly into the edge of the end bar nearest the last hole, and the end of the wire wound round it. The nail is then tapped flush into the wood. The wire is pulled tight, each strand in turn, and the other end wound round a nail in the edge of the end bar by the hole nearest the top bar. After making sure that each strand of the wire is quite tight, the nail is driven into the wood. Any protruding ends of wire should be broken off close to the nails and tapped into the wood.

On removing the frame from the jig, the release of the pressure on the bottom bar ensures that all the wires remain tight.



Wiring a frame with a simple bench-top jig.

Fitting plain foundation

For the next stage, fixing the foundation and embedding the wires, a slab of wood the size of the inside of the frame, $\frac{3}{4}$ in. thick, is used to support the foundation while the wires are being embedded.

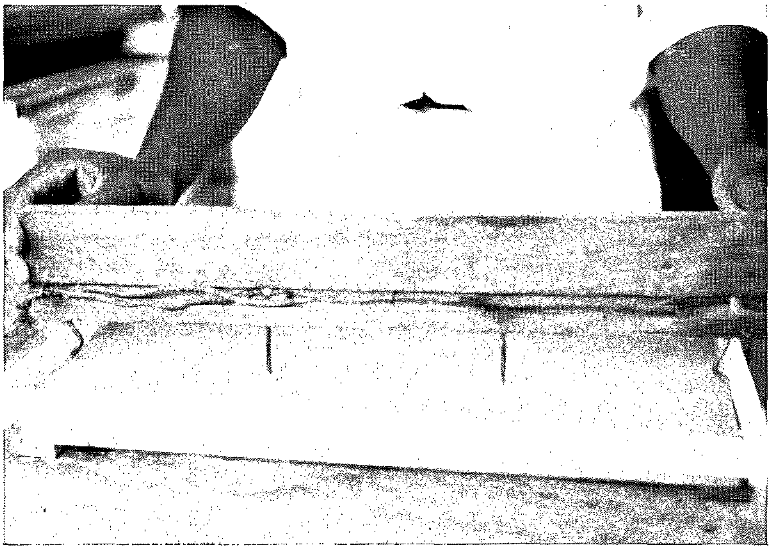
Hold the frame upside down, with the top bar resting on the bench. Insert one edge of the sheet of foundation into the groove in the top bar. Put a few drops of glue along the groove to hold the foundation in position, or run melted beeswax along the groove.

Hold the embedding board against the sheet of foundation so that the wax is pressed against the wires and lay the frame and board on the bench, wires uppermost.

To embed the wires, a 4-volt current from a battery is passed through each wire in turn so that it heats and sinks into the foundation. Alternatively, a special toothed embedding wheel, heated in a flame, can be run along the wires. After the wires have been embedded in the foundation, the frame is ready for use.

The most efficient tool for embedding consists of a strip of wood about the same length as the top bar. Four nails are driven into the wood so that the points of the centre two project further than the points of the outer two. The battery is connected so that each terminal is joined to alternate nails. The current will then pass along the section

of the frame wire touched by any neighbouring pair of nails. Thus each strand of wire is embedded in three sections. This method is very quick and makes a neat job. The points of the nails need to be cleaned occasionally, to free them from wax, so that proper electrical contact is made each time.



Embedding wires in foundation electrically.

RECOMMENDED HIVES

Many beginners go to buy their first hive with very little idea of what they want. As a result they are supplied with whatever is ready to hand in the shop, and frequently with goods that experienced beekeepers reject. It is only after beginners have a few hives of bees established and have met some experienced beekeepers that they begin to realise that their equipment is unsuitable, or at the best, inconvenient.

Essential hive parts

The parts of the hive that have to be considered are the bottom board, one or more brood boxes with frames and comb foundation, a queen excluder, additional boxes or supers with frames and foundation for the storage of honey, and a lid.

The first decision which a beekeeper has to make is whether to use 10-frame or 8-frame equipment. We have no hesitation in recommending the use of 10-frame equipment. The 8-frame size has been a useful stop-gap for those who wanted lighter honey supers when there was nothing between the too-light half-depth super and the full-depth super. But we would not recommend the 8-frame size to anyone today. The 10-frame size brood box provides sufficient room for a queen in one box throughout most of the year, and under some conditions throughout the whole year, whereas the 8-frame size requires the use of two boxes for the brood nest during most of the year, thereby increasing costs of equipment and adding to the labour of hive management.

Having made it clear that we recommend only the 10-frame width of hive, we will proceed to the individual components.

BOTTOM BOARD

Recommended—

Metal (galvanized iron) bottom board

or for those who want a refinement in the bottom board design we recommended—

Bottom board, tunnel entrance

BROOD BOX

Recommended for brood box—

Full-depth body, 10-frame width,

with dovetailed corners and with strong galvanized iron frame supports; or

for those who need a brood box with more room in it than the full-depth Langstroth box, then we recommend:—

Jumbo brood box, 10-frame, 11⅝ in. deep,

with galvanized frame supports.

HONEY SUPERS

Recommended for the storage and extraction of honey—

Honey super, 6⅝ in. deep (two or three to each hive)

These do not require metal frame supports.

COMB SECTION SUPERS

Recommended—

Half-depth super, 10-frame width, 4¾ in. deep with 24 gauge galvanized iron metal strips and—

7 slotted section holders for 4¼ x *4½* x *1⅞ in. sections.*
8 slotted wood separators, 18 in. x *4¼ in.*
28 one-piece sections, 4¼ x *4¼* x *1⅞ in., slotted.*
7 thin surplus comb foundation, sheets 15½ x *3⅞ in.*

QUEEN EXCLUDER

Recommended—

Metal-bound welded-wire or all-wire queen excluder.

LID OR COVER

Recommended—

Migratory metal cover or lid (ventilated)

These lids require, on the frames in the top box, the addition of a mat which is a piece of thick plastic or rubber cut smaller than the inside of the hive to leave a gap of about one inch all round for ventilation.

For those who would like to use a migratory lid with a built-in inner cover, which saves messing about with mats, we recommend—

Cavity lid, ventilated.

FRAMES AND COMB FOUNDATION (FOR BROOD BOX) (9 or 10 per box)

Recommended—

Full-depth frames with grooved top and bottom bars (Jonel frames) with bound Plasticore foundation and metal insertion strips;

OR

Full-depth frames with grooved top bar and end bars with eyelets, 28 gauge frame wire, and medium brood full-depth comb foundation (7 sheets per lb.)

For Jumbo brood box—

Jumbo Brood frames, 11¼ in. deep with eyelets for end bars, 28 gauge frame wire and medium brood comb foundation, 16¾ in. by 10¼ in (5 sheets per lb.)

FRAMES AND COMB FOUNDATION (FOR HONEY SUPERS) (8 per super)

Recommended—

Honey Super frames, 6¼ in. deep Manley type with grooved top and bottom bars with 16¾ in. by 5¾ in. bound Plasticore foundation and metal insertion strips;

OR

Honey Super frames, 6¼ in. deep, Manley type with eyelets for end bars, 28 gauge frame wire, and medium brood comb foundation 16¾ in. by 5½ in. (10 sheets per lb.).

Summary

In brief, the list of the basic requirements for one hive is as follows:—

1 Metal (galvanized iron) bottom board, or tunnel-entrance bottom board.

1 Full-depth body, 10-frame, with galvanized iron frame supports.

2 Honey supers, 6⅝ in. deep.

1 Queen excluder, metal-bound welded wire.

1 Migratory metal covered lid, or cavity lid.

9 or 10 full-depth frames with grooved top and bottom bars, Jonel type.

9 or 10 sheets bound Plasticore full-depth foundation with metal insertion strips.

16 Honey Super frames, 6¼ in. deep, Manley type, with grooved top and bottom bars.

16 sheets 16¾ in. x 5¾ in. bound Plasticore foundation with metal insertion strips.

Nails 2¼ in. x 13 gauge for assembling boxes, 1¼ in. x 17 gauge nails for assembling frames and ¾ in. x 18 gauge nails for fixing frame supports.

If Plasticore foundation is not available, the plain foundation of medium brood weight is required, with metal eyelets for the end bars of the frames, and frame wire.

ALEX. B. DAVIES, Government Printer, Western Australia 31947/12/66—2M