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(54) Title:
TEA HARVESTER

(57) Abstract:
Tea harvesting equipment is disclosed herein wherein the equipment is solely supported on the tea bush canopy without any ground contact, the equipment comprising a framework (16) carrying either belts (11, 12) or wheels/rollers (23, 25) which are located at least partially below the framework (16) and engage the tea bush canopy, the belts or wheels/ rollers enabling movement of the equipment over the canopy, a cutter assembly (59) carried by the frame work (16) extending rorwardly of and transversely across the movement direction of the Havester, and a collection duct (64) to receive cut leaves from the cutter assembly (59) and deposit same into collection bins or bags carried by the harvester.

TEA HARVESTER

The present invention relates to apparatus adapted to improve the mechanisation of tea growing activities including but not limited to harvesting, pruning, spraying and fertilising.

Tea is normally grown in rows of bushes and when plucked by hand forms a hedge. Traditionally tea has been plucked by hand and therefore the bushes have to be pruned to a height that enables the person plucking the leaf to reach over the top of the bush and to the centre of the bush, this necessitates the tea bush being pruned at intervals to maintain the plucking height. It is also necessary to have tracks or rows in between the tea bushes. These tracks allow the entry of sunlight which in turn generates weed growth which then must be controlled by herbicides or by hand weeding at high cost.

There have been developed various methods of harvesting the tea crops by mechanised means, the first levels of mechanisation being hand held clippers with a collection device attached to one of the blades. This is all operated by hand and of course supported from the ground by the individual holding the hand clippers. The second generation of harvesters being simple reciprocating blades with two handles on the machine with a leaf collection bag which is generally carried by two people with a further two persons to carry the sack of tea, a four man crew. This unit is still supported by the individuals holding the machinery and the collection device with the operators standing on the ground in every instance. This has required the clearing of paths through the tea, maintaining of the height of the tea and the building of bridges or pathways across drains. Further developments have been made in mechanised tea harvesting by the use of wheeled machines, half tracked machines and tracked machines in an effort to spread the weight across a greater area and reduce the ground pressure. Tea traditionally grows at high altitude close to the equator in the tropics and therefore is subject to frequent tropical rain and the ground condition to grow tea ideally is generally moist and damp and the soils often soft. The combination of the environment and the canopy coverage of the leaves means that the site can deteriorate and over a period of time compaction can take place which can substantially further reduce yields. In every instance it is necessary to keep tracks open in the area between rows of bushes for operators and machines to pass along and substantial civil works are necessary (e.g. construction of bridges over the drains which must be at frequent intervals throughout the tea estate to enable the passage of the machines through the tea to be harvested). In addition, there needs to be sufficient width of head land at the end of the tea rows to allow the machine to be turned and re-enter the crop.

If the tea leaf is to be of value it must be harvested at the correct length therefore, it has been a continual problem to maintain a precise even depth when determining the fresh growth to be plucked. With mechanised means it has been achieved by using the ground as a constant height source and thereby having the picking means attached at a controllable point from the ground, with wheeled machines this has been impracticable where site irregularities and soft patches of ground occur. The tracked machines have been more successful but means the machines are substantially more expensive and to have substantial civil works carried out to enable the support of these machines. The hand carried methods means the plucking device has to be supported by individuals from the ground, with the result that the accuracy of height, control from the ground while the person is walking along is extremely difficult to maintain, this allows the cutting means to be raised and lowered unintentionally causing loss of crop or scalping into the bush which gives poor quality harvested leaf, scalping into the maintenance foliage also reduces the yields.

It is the objective of the present invention to solve the foregoing problems and to produce a low capital cost machine that is capable of carrying out all of the tasks required on a tea estate.

According to the present invention there is provided apparatus for use with a row of tea bushes, said apparatus comprising support frame means which in use is adapted to extend above and generally parallel to a top zone of at least one row of tea bushes, transport means carried by said support frame means and located at least partially below said support frame means adapted to contact and be supported on the top zone of at least one row of tea bushes, and drive means to drive said transport means whereby said support frame means is moved over the top zone of said row of tea bushes while being supported solely by said tea bushes.

By ensuring that the machine does not have any ground support, the traditional problems discussed above with uneven or boggy ground conditions are avoided.

Preferably the support frame means comprises two articulated frame members each having independent transport means whereby the drive means is adapted to selectably drive said independent transport means at differing speeds (or at the same speed, if desired). Advantageously, the support frame means is steerable by selectably varying the relative speed (or direction) of the independent transport means.

Conveniently, the transport means may comprise a wide endless belt, the belt being supported by a plurality of rollers or wheels depending from the or each support frame. Alternatively, an endless belt as aforesaid might be used supported by compressed air injected into a substantially closed zone within the belt. In still further possible arrangements, a plurality of lightweight rollers or wheels might be used to support the support frame directly on the tea bushes.

Apparatus as aforesaid may, in one embodiment act as a tea harvesting machine and in such circumstances tea harvesting equipment may be operationally secured to the support frame such that a cutting assembly engages and cuts the new growth tea leaves on the tea bushes as the apparatus moves over the top zone thereof. In one arrangement the cutting assembly may comprise a reciprocating blade with side mounted chains with cross bars, paddles or brushes to slide the cut tea leaf up into container bins or into bags. Alternatively, a rotating cutter mechanism with a vacuum to draw the leaf into a leaf separating device into bags or bulk bins might be employed. In a still further possible arrangement, reciprocating or rotating cutters might be employed with forced air blowing of the leaf off the cutting edge with secondary air inject nozzles to continue conveyance of the leaf through an enclosed duct into bags or into bulk bins.

A number of preferred embodiments and various differing arrangements are disclosed in the annexed drawings, Figs. 1 to 21, and briefly described hereinafter.

Figure 1 shows one such configuration comprising twin variable speed belts which speed variation between the parallel belts can be controlled with a simple belt jockey pulley intermittently engaged in either, forward, neutral or reverse. The same device can be powered by use of hydrostatic drives or by friction drives or such means that would give a variation of speed between the parallel belts which is used for manoeuvring, turning the machine and for forward and reverse (see Fig. 14). The belts would be powered by the friction engagement of the driven roller and supported on the underside by a series of idler rollers with guide strips on the belts to prevent misalignment.

Figure 2 shows the use of air turbines (1) to increase the pressure within the belt track assembly (2), the belting acting as a seal over the top of the tea leaf and with the side skirting (3) the air pressure obtained internally forms a hover track without any rollers on the base of the track other than the end rollers (4), frictionally driving the machine.

The devices can be made in various configurations in two parallel variable speed belts for directional control. Figure 3 shows two full width articulated mobile belt platforms interconnected and steerable.

As described in the foregoing, many activities necessary in a tea estate can be carried out using apparatus according to the present invention.

Figure 4 illustrates a spraying embodiment where platforms can be used to support a tank of spraying solution which is sprayed through booms or nozzles.

Figures 5 and 6 illustrate a pruning activity. When pruning, the machine moves forward being supported by the tea bushes and uses a bandsaw principle (Figure 5) to saw off the underside of the tea bushes or reciprocating cutters or circular saws (Figure 6) for deeper pruning and also for skiffing. A still further activity might be fertilising as shown in Figure 7. The machine can be fitted to carry bulk or bags of fertiliser with a hopper with air inject that will distribute the fertiliser along a boom and blow down through nozzles at a high velocity penetrating through the leaves forming the tea bush canopy and thereby depositing the drilled fertiliser around the base of the tea bushes (Figure 7).

Figure 8 illustrates a different form of transport means where soft rollers (1) supported with a bearing at either end are used. This arrangement spreads the load across the width and over the diameter of the roller. The use of such rollers controls the cutting height of the cutting blade automatically to give precision depth of cut irrespective of the variations of the height of the canopy of the tea bushes. Such a device could be used in advance of the mobile platforms thereby causing a levelling effect between harvesting operations and very accurately controlling the operational height of the cutter (2) relative to the tea bush. Such function being automatic in that the machine rises with the growth of the tea bush canopy thereby still maintaining the precise cutting head.

Figure 9 illustrates the possible use of a series of interconnected rollers to spread the load without any external belting.

Figure 10 illustrates the use of wheels or rollers of suitable material and diameter to give sufficient light loading to convey the machine across the top of the tea bushes without any contact with the ground.

Figure 11 illustrates a device for harvesting and collecting leaf fully supported by the tea bush with no contact with the ground.

Figure 12 illustrates a device for transporting harvested leaf or materials across the top of the tea bushes without contacting the ground.

As previously outlined, this machine has been designed to operate on top of the tea bush canopy (refer to Figure 1), by the means of two independent wide belts Figure 13 (1), driven by a small engine (2) via a transmission (see Figure 14) to final drive rollers (3) (belts are friction driven by rollers).

The one function of the machine is to harvest tea leaves by means of a reciprocating cutter bar (4) (operated by a small independent engine (5)) blow the cut leaf up a collection chute (6) via a high velocity blower (7) (operated by an independent engine (8)) into an air tube (9) and out each blower tube (10).

After leaf has traversed collection chute (6) leaf is deposited into collection bags or bulk bins (11).

After bags are full a tea shuttle (see Figure 12) may be used to come along side and full bags or bins are unloaded onto shuttle ready for transfer to factory.

Figure 14 illustrates a possible transmission arrangement. The transmission consists of a small independent engine (A) V-Belt driven via cone V-Belt pulleys (B) (so speed ratios can be changed) to primary drive shaft (C) on primary shaft (C) are on outside a V-Belt and pulley (D) (on outside to ensure easy replacement of belts). Next to the V-Belt pulley is a roller (2) with a compressible material on the rim, such as polyurethane, rubber or friction material and the same is duplicated on the other end of shaft (F, G).

From the primary drive shaft a V-Belt drive is provided to the intermediate shaft. Right hand intermediate shaft drives right hand track, LH intermediate shaft drives, LH track with V-Belt pulley (H) and steel rimmed roller (I) then sprocket (J) the same is duplicated on other intermediate drive shaft. V-Belt pulley (M) steel rimmed roller (L) and sprocket (K).

From the intermediate shafts there is a final drive via chain (N) to final drive shaft (O) which rotates rollers (P) which powers machine. Connected to roller I is a brake to be used a parking brake. The function of the transmission is described in the following.

The transmission is operated by two levers (see (4) linkage Figure 14) with linkage to primary drive shaft. If both levers are pushed forward (as per illustration (4) Figure 14) linkages raises primary drive shaft which engages V-Belts and causes forward movement. This position is maintained via spring tension (see Figure 14 - transmission description item 1) providing forward movement.

If the two levers are both pulled back to a vertical position, V-Belts are disengaged and the machine is in neutral (see 2). If both levers are both pulled back towards the operator this engages the two rollers causing the machine to reverse (see 3) providing reverse motion.

For turning left or right one lever is kept forward keeping V-Belts engaged (causing forward movement) and one lever pulled back, either into neutral or reverse depending on the tightness of the turn. By one lever fully forward (1 track forward) and one lever fully back (1 track reverse), the machine can counter rotate.

Figures 15, 16 and 17 illustrate a preferred form of chassis frame. The frame has been designed to be torsionally strong and very light. Using predominantly high strength lightweight chrome molybdenum tubing or other suitable alloy as discussed previously, each track unit is independent of the other and joined together at assembly on site.

Each track unit has its own chassis or frame (see Figures 15 and 16) each precision jig built using high strength lightweight tubing (see Figure 16) each section is a triangulated truss section, torsionally strong in all directions (17). Fitted to these triangulated frames are the drive roller (rear 1) and front rollers (2) also fitted are the intermediate rollers and belt track (4).

Front and rear rollers may be aluminium tubing or rolled aluminium sheet riveted to circular gussets spaced within the tube.

Intermediate rollers are aluminium or PVC tubing which in turn are fitted to lightweight pressed bearings which are mounted to underside of chassis. When on site, assembly of the two track frames is accomplished by pushing together and joining per detail A (Figure 15) and then bolted together.

Belt (track) is tensioned by means of a take up bearing at front of frames.

A preferred form of cutter head and leaf collection chute is illustrated in Figures 18, 19 and 20. The cutter bar is a reciprocating unit comprising two bars, an off centre crank drive mechanism and an independent small petrol engine directly mounted to the offset crank drive mechanism (see Figure 18). Figure 13 cutter bars (4) are mounted on the leading edge of the collection chute (6). Mounted at the top leading edge of the chute is an aluminium tube (9) connected to a high velocity blower (7). Again power is supplied by an independent small engine (8). High velocity air is directed up the chute via nozzles (10) clamped to aluminium tube for clamping technique (see Figure 19). Construction of a collection chute is shown in Figure 20. The collection chute is constructed from light gauge aluminium. Each panel is pressed with a lip up each side to increase its rigidity and strength to span the 3.4 metre width. Each panel is riveted together and the chute is a separate complete assembly which can be mounted on site quickly and efficiently.

It will be appreciated by those skilled in the art that quite substantial advantages are achieved by use of apparatus as now described in the foregoing text. These advantages include :

(i) that there is no longer any need for passages between tea bush rows and therefore intergrowth of the tea bushes can be permitted to form one continuous interconnecting canopy of tea bushes without any access tracks or opening through to the ground thereby controlling weeds and reducing the need for herbicides.

(ii) A machine supported by tea bushes enables the harvesting of tea in any direction regardless of the rows or placement of the bushes.

(iii) The device enables harvesting of tea on tea estates irrespective of the direction or quantity of drains underlying the tea bushes.

(iv) The device enables very accurate control of cutting heights of the young freshly grown tea leaf and enables automatic adjustment by picking from the top of the bush without contact on the ground.

(v) The device prevents ground compaction because it is supported by the tea bushes and the load is spread across a large area.

(vi) The device increases the quality of leaf by being supported by the top of the tea bush thereby automatically raising the harvesting as the tea bush and leaf canopy grows.

(vii) The device that increases the yield of the tea bushes by being able to pluck long stem length of tea material.

(viii) The device can harvest tea without the necessity of pruning to maintain a reasonable height from the ground.

(ix) The device can harvest tea on steep inclines simply because it is not ground supported. In such situations (see Figure 21), the tea bushes are normally pruned flat on top so that the machine can be supported thereon.

Present mechanical means of harvesting tea can only be carried out on flat or undulating ground. If tracked or wheeled harvesting machines are operated on steep inclines they can slip due to the usually wet conditions and slide into tea bushes causing damage to the tea bush. On plantations in steep country tea bushes are usually terraced, making the use of hand held harvesters extremely difficult and dangerous as one operator is on the down side of the terrace and one operator on the top side of the terrace. Another difficulty in steep terrain is soil erosion. To rectify this problem drains are dug horizontally around the hills joining into vertical down drains to carry away any water. With hand held wheeled or tracked machines, negotiating these drains is difficult.

DATED THIS 26TH DAY OF JULY, 1991

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AUSTRALIA

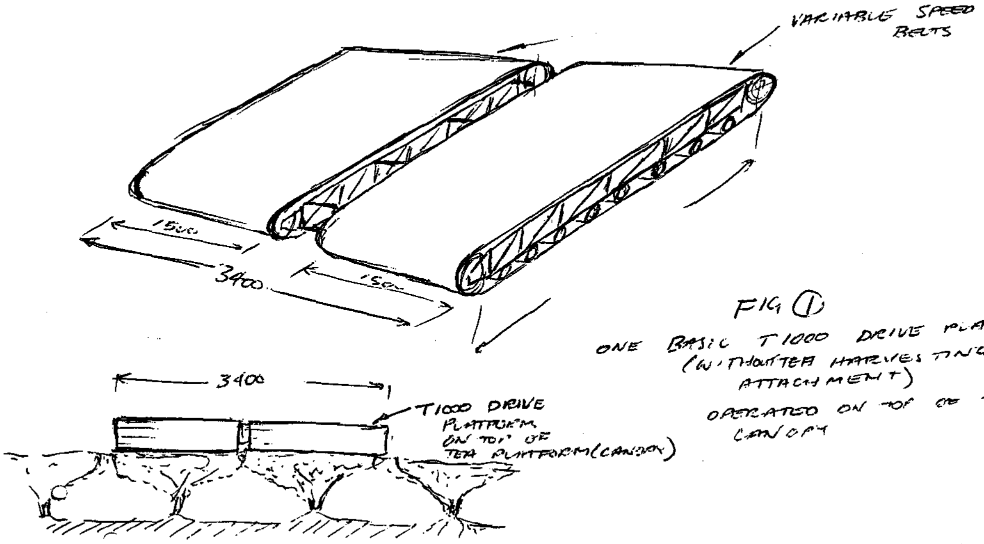


FIG 1
ONE BASIC T1000 DRIVE PLATFORM
(WITHOUT TEA HARVESTING ATTACHMENT)
OPERATED ON TOP OF TEA CANOPY

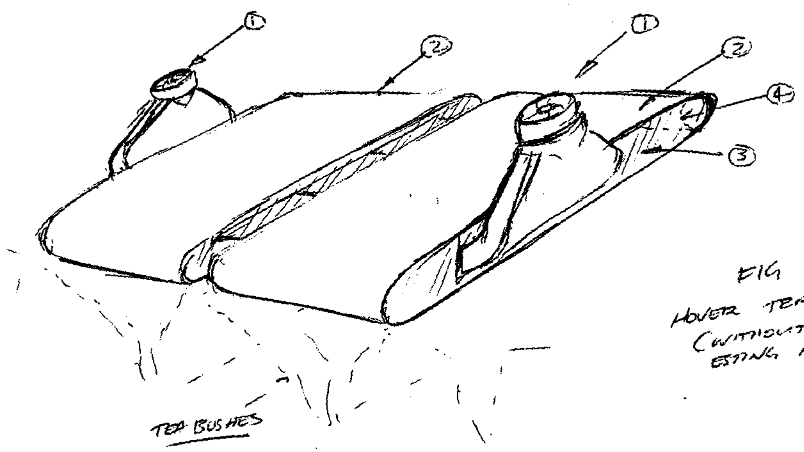


FIG 2
HOVER TRACK CONCEPT
(WITHOUT TEA HARV-
ESTING ATTACHMENT)

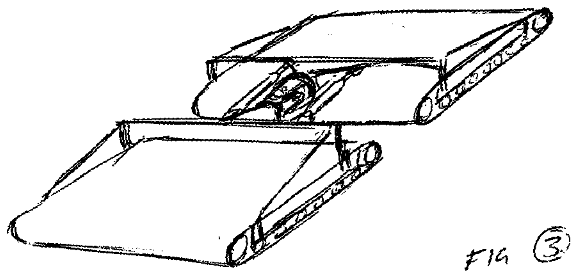
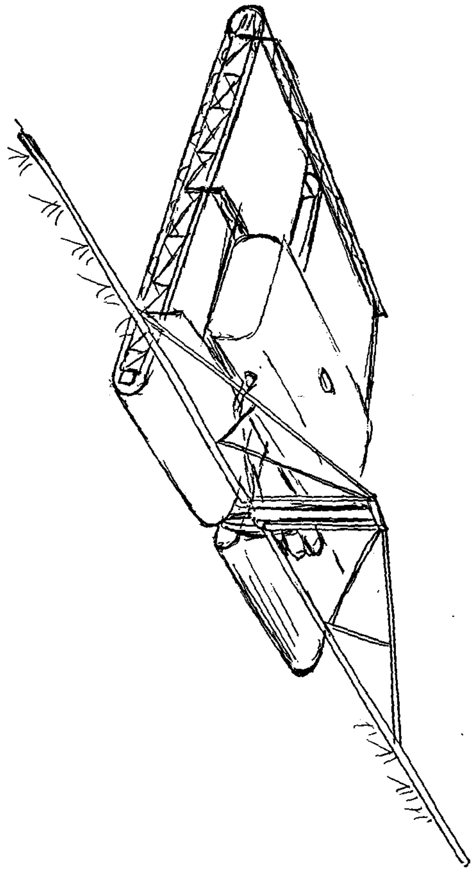
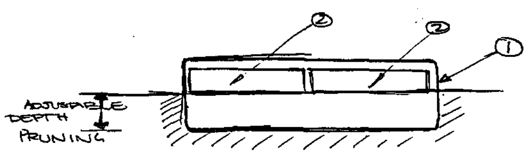


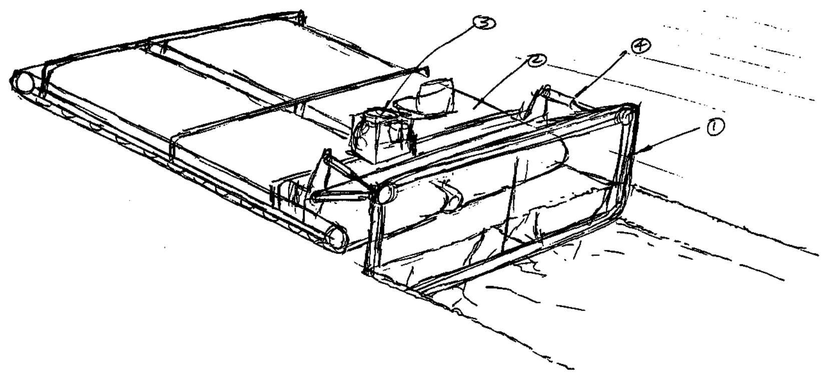
FIG ③

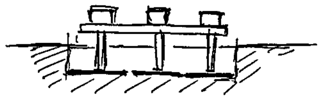
ARTICULATED MOBILE TEA PLATFORM (WITHOUT TEA HARVESTING ATTACHMENT)



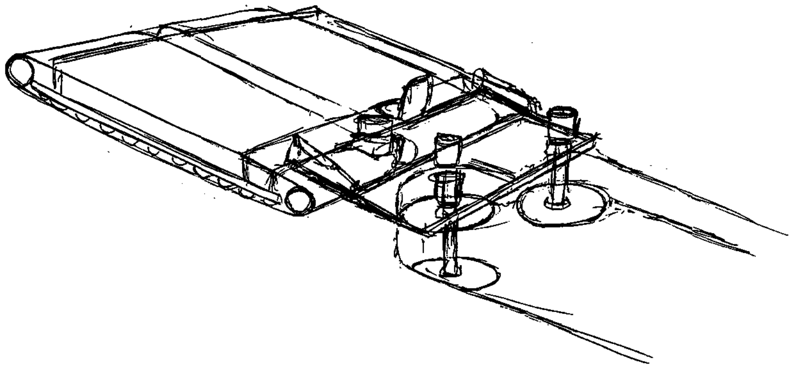


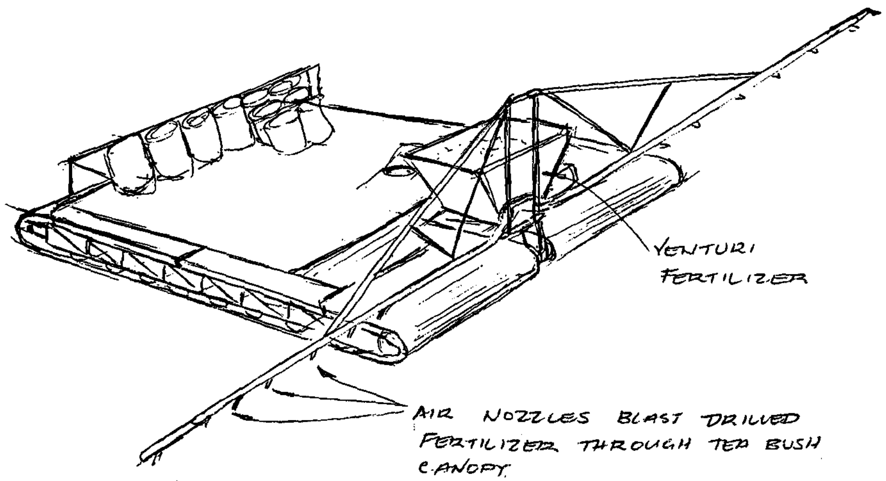
REAR VIEW
PRUNING

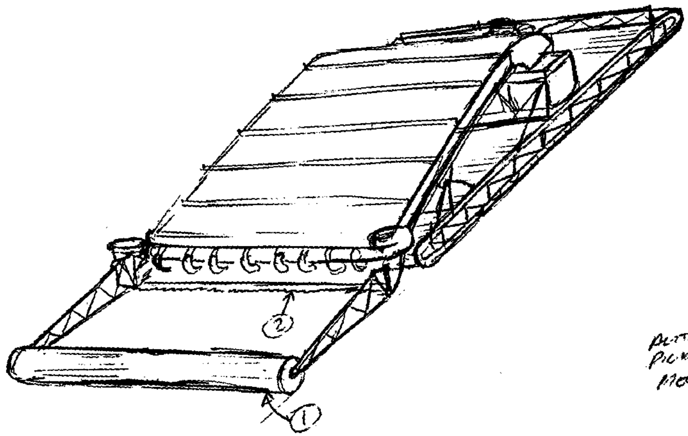




REAR VIEW



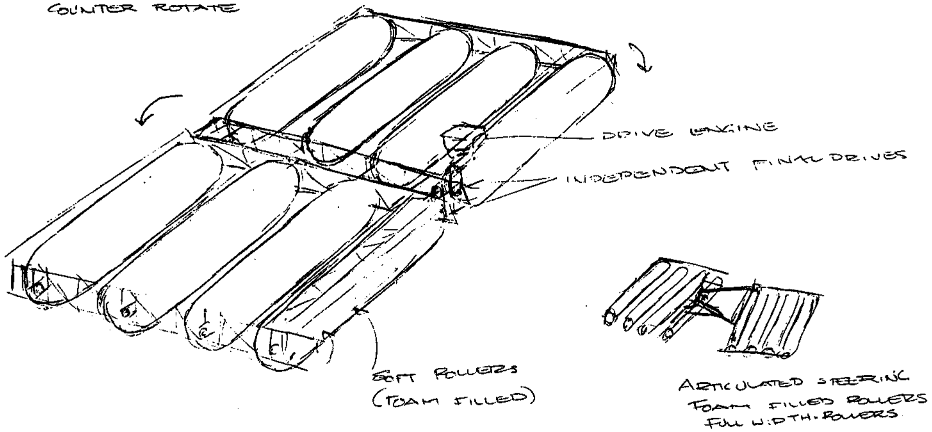

VENTURI
FERTILIZER
AIR NOZZLES BLAST DRILLED
FERTILIZER THROUGH TEA BUSH
CANOPY



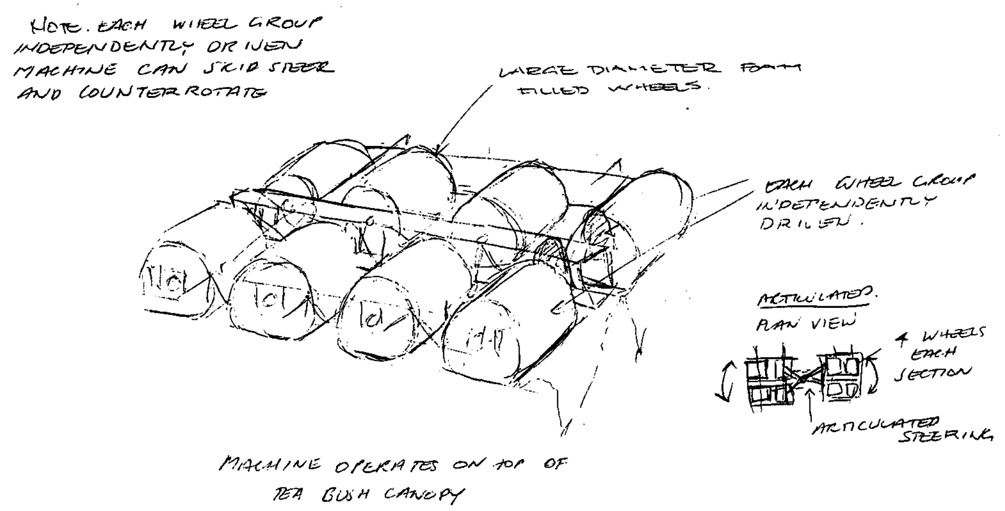
AUTOMATIC HARVESTER PICKING HEAD LEVELING MECHANISM.

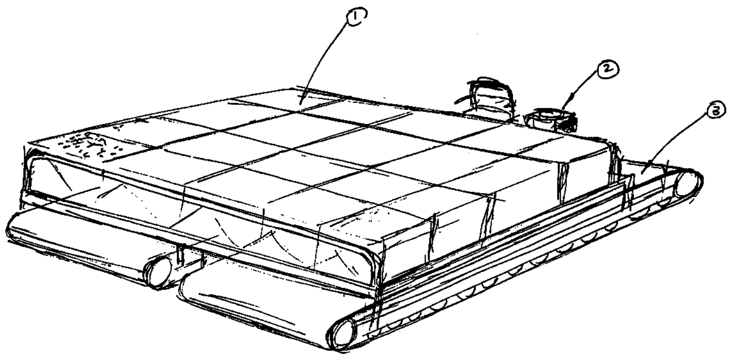
WORK PLATFORM. (TEA BUSH SUPPORTED)

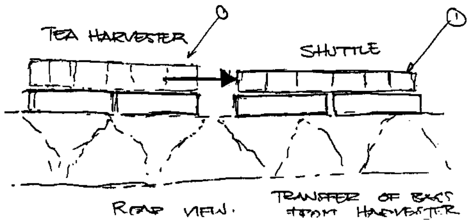
NOTE. SEPERATE ROLLER GROUPS (DRIVEN INDEPENDENTLY)
ENSURE MACHINE CAN
SKID STEER AND
COUNTER ROTATE



WORK PLATFORM ('TEA-BUSH SUPPORTED)

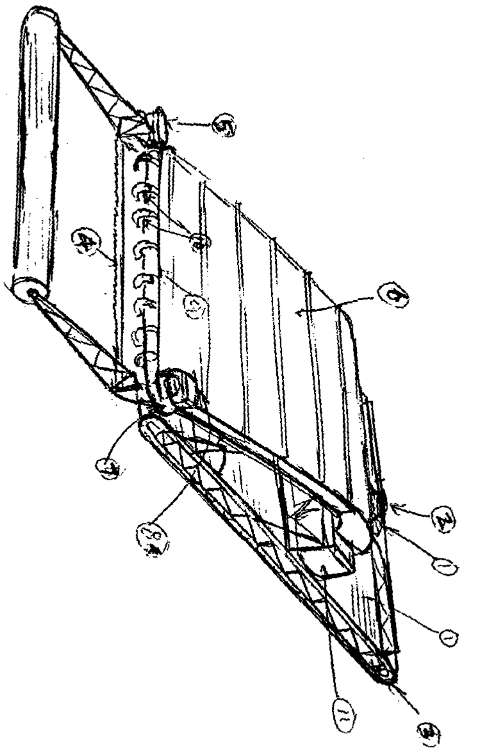






WILLIAMSTER TEA SHUTTLE

FIG 12



T.1000 TRANSMISSION. FIG (14)

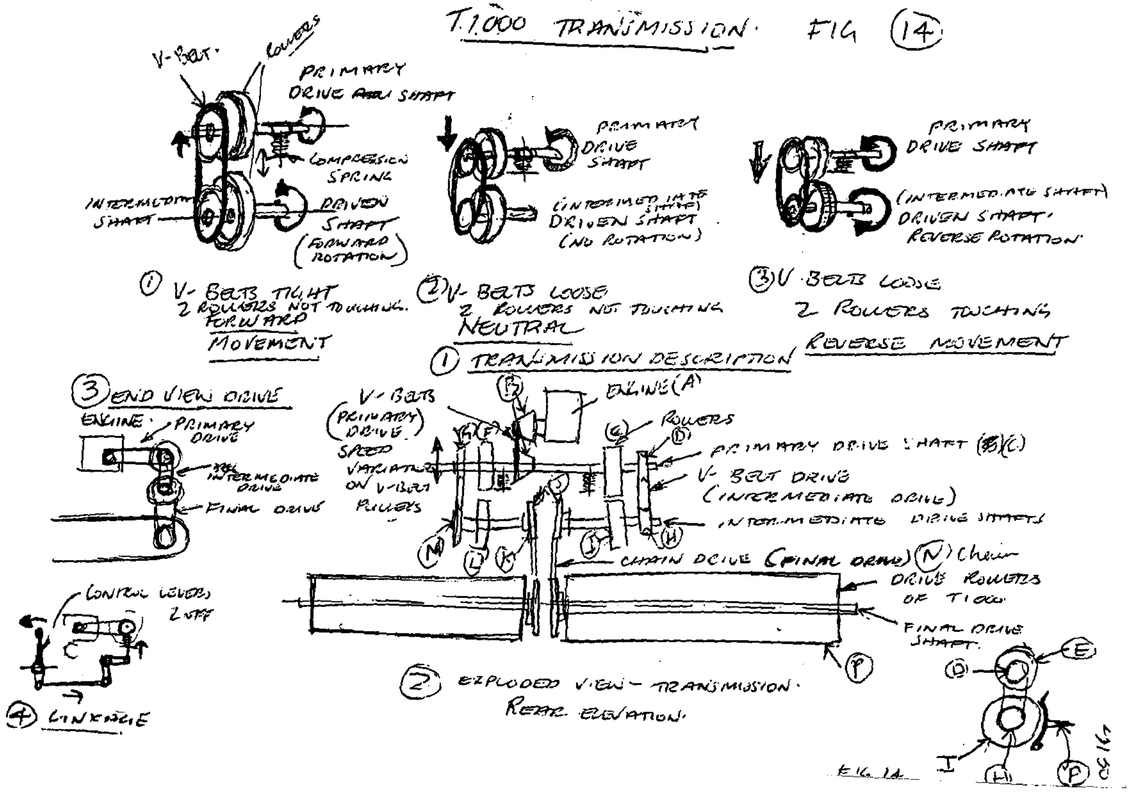
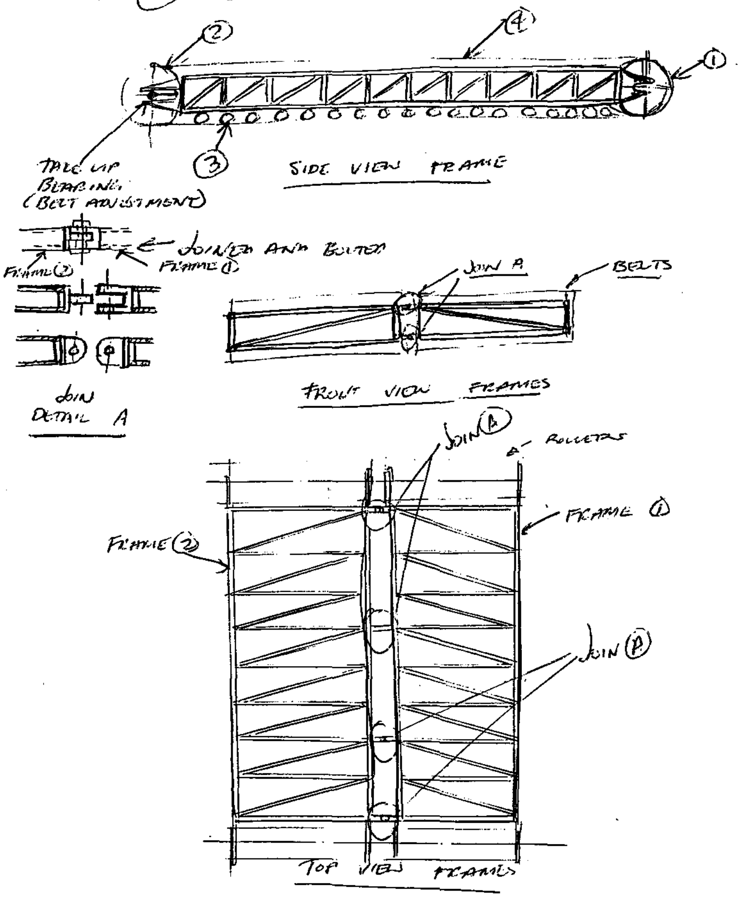
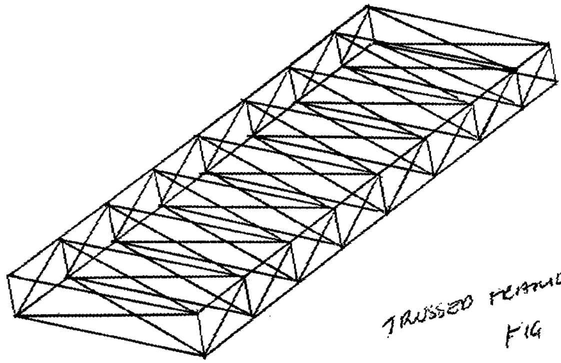


FIG (15) FRAMES T1000





TRUSSED FRAME

FIG (16)

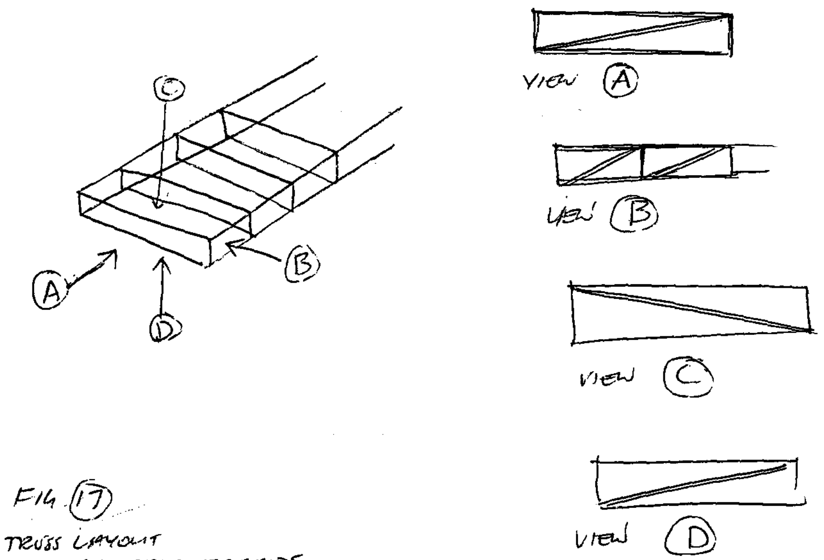
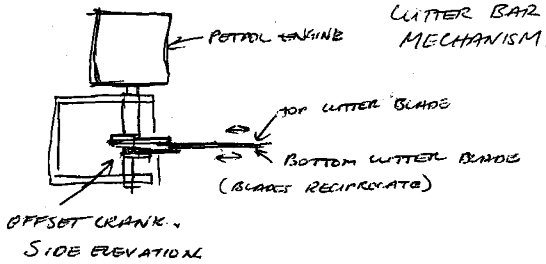
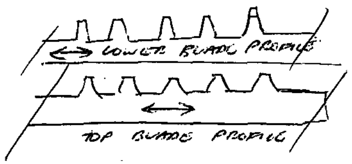


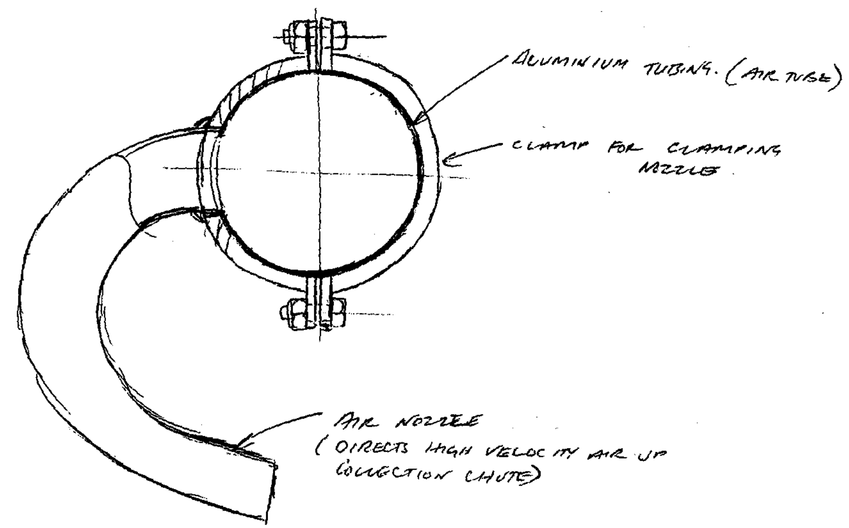
FIG. 17

TRUSS LAYOUT
MAIN CHASSIS FRAMES

CUTTER BAR MECHANISM.






ALUMINIUM TUBING. (AIR TUBE)
CLAMP FOR CLAMPING NOZZLE
AIR NOZZLE
(DIRECTS HIGH VELOCITY AIR UP COLLECTION CHUTE)

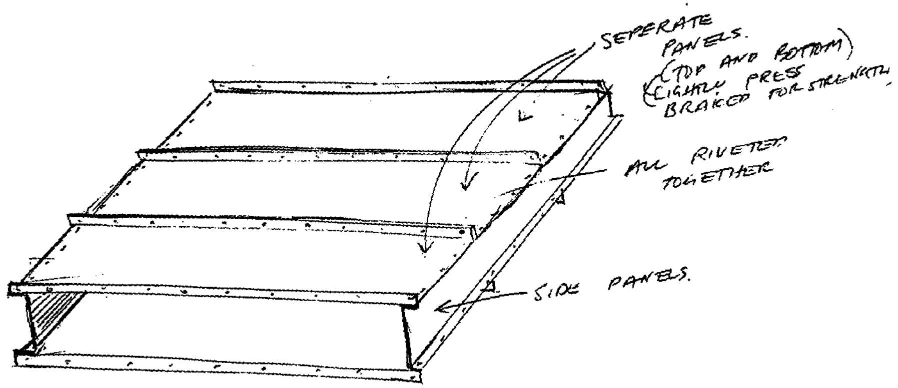
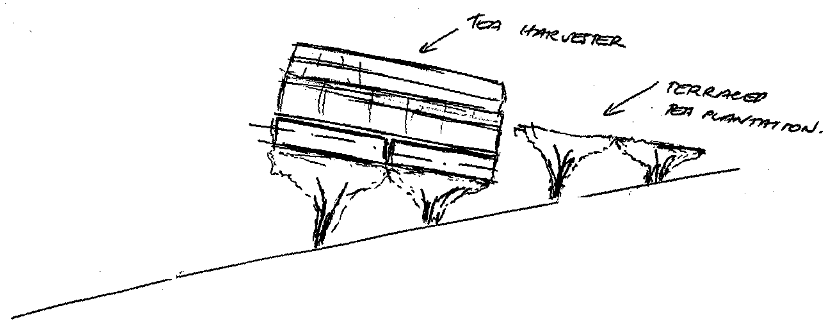


FIG 20

SECTION OF COLLECTION CHUTE.


TEA HARVESTER
TERRACED
TEA PLANTATION.