
The Inter-American Centre of Investigation and Documentation for Vocational Training (CINTERFOR) is a regional, specialist agency of the International Labour Organisation (ILO).

Established in 1964, CINTERFOR has as its objects the stimulation and co-ordination of the efforts of institutes, organisations and enterprises which are concerned with Vocational Training in Latin America.

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FOREWORD

1) The following sheets will serve as patterns for preparing masters or stencils to be used on office offset machines, mimeographs, or other types of duplicators.
   They should be handled carefully so as not to damage or soil the paper.

2) It is advisable to check the sheets before making the masters so that faint or broken lines can be retouched with an ordinary pencil or drawing ink, and spots and imperfections masked with gouache (white tempera).

3) Any addenda to the sheets, e.g. local codes, may be written on white paper and pasted into position. The same procedure can be used when correcting misprints or other errata.

INTRODUCTION

The Cinterfor Basic Collections for the rural sector are prepared under large headings *(Agriculture, Livestock, etc.)*. Each CBC for a particular group comprises a loose-leaf collection of operations and technological information, classified and arranged according to subject matter.

Therefore a complete CBC consists of a file of sheets containing all the necessary steps, techniques and know-how required for the development of courses dealing with the various agricultural crops grown in the different regions of America.

The preparation of this Collection will indeed take up a great deal of time, but the needs of teaching institutions require that reference material be available as soon as possible. A solution has been found in the use of loose-leaf fascicles each dealing with a crop or a particular technique, e.g. "Corn Crop" or "Agricultural Machinery Operator" These fascicles are not always comprehensive enough when used singly, so it will be necessary at times to refer to other pages in other fascicles.

This fascicle entitled *"Agricultural Machinery Operator"* is the first of the CBC series on *"Agriculture"*. Its applicability is limited to courses on mechanized farming as it deals only with operations involving machinery and equipment.
However, the technological information sheets have broad information and deal with general matters necessary for the basic training of a farmer.

NORMATIVE DOCUMENT

The pages of the CBC's are presented in a uniform manner, and they are prepared according to standards and procedures established by Vocational Training institutions in the region. The details of these procedures, constituting a *"Normative Document"*, ought to be prefixed to the first fascicle of each CBC.

In this case it has not been possible to include it as the norms have not been approved and laid down formally. For the time being, we abide by those standards currently used by the industrial sector.

CLASSIFICATION OF SUBJECTS

A complete CBC might easily comprise some 2,000 pages. To cope even adequately with so much material, in planning as well as in utilization, there must be a well-organized classification system that allows for the cataloguing and easy identification of each page.

Therefore each fascicle contains a *Classification of Subjects* adopted for the CBC on Agriculture.

On the left-hand margin of each page there are code-numbers corresponding to those in the classification, and by which each subject can be identified.

The other two parts of the code, "subject" and "plant", pertain to classifications which are still incomplete.

Classification of SUBJECTS in the family of Agricultural Occupations

GROUP I - EQUIPMENT, MATERIALS AND SUNDRY

1.1- DRAUGHT ANIMALS

1.1-1 Horses, mules, donkeys
- 1.1-11 Strength of animals. Ways of hitching
- 1.1-12 Implements
- 1.1-13 Care

1.1-2 Cattle
- 1.1-21 Strength of animals. Ways of hitching
- 1.1-22 Implements
- 1.1-23 Care

1.1-3 Other animals

1.2-

1.3- MANUAL EQUIPMENT AND TOOLS

1.2-1

1.2-2 Multi-purpose
- 1.2-11 Shovels
- 1.2-12 Pick-axes
- 1.2-13 Hoes

1.2-3 For infrastructural tasks

1.2-4 For soil preparation

1.2-5 For irrigation and water handling

1.2-6 For sowing and propagation

1.2-7
1.2-8 For cultivation

1.2-9 For harvesting

1.3-1 For transportation, loading, processing, packing, and marketing.

1.4- TRACTORS AND SELF-PROPELLED MACHINES

1.4-1 Rubber-wheeled tractor
 1.4-11 General aspects, types, models
 1.4-12 Components and their function
 1.4-13 Work conditions; limitations

1.4-14 Driving the vehicle
1.4-15 Hitches, couplings and connections
1.4-16 Preparation, regulation and adjustments
1.4-17 Parts and accessories
1.4-18 Maintenance and detection of faults
1.4-19 Minor repairs

1.4-2 Crawler Tractor

1.4-3 Walking garden tractor

1.4-4 Special-purpose tractors

1.4-5 Specialized machines
1.4-51 Self-propelled mowers
1.4-52 Wheat-threshers

1.4-6 Combines
1.4-61 Wheat-harvester-thresher-baler
1.4-62 Rice-harvester-thresher-baler

1.4-7 Stationary Equipment
1.4-71 Mills
1.4-72 Hulling equipment

1.5- TRAILED AND INTEGRAL-MOUNTED IMPLEMENTS AND EQUIPMENT

1.5-1 For infrastructural work
- 1.5-11 Subsoiler
- 1.5-12 Scraper
- 1.5-13 Ridger
- 1.5-14 Posthole digger
- 1.5-15 Trench digger
- 1.5-16 Excavator
- 1.5-17 Tree-cutting saws

1.5-2 For soil preparation
- 1.5-21 Trailed plough
- 1.5-22 Integral-mounted mouldboard plough
- 1.5-23 Integral-mounted disc plough
- 1.5-24 Reversible plough
- 1.5-25 Tine harrow
- 1.5-26 Disc harrow
- 1.5-27 Spring harrow
- 1.5-28 Rotovator
- 1.5-29 Furrower

1.5-3 For water handling and irrigation

1.5-4 For sowing and propagation
- 1.5-41 Row crop planter
- 1.5-42 Grain-fertilizer drill
- 1.5-43 Potato planter

1.5-5

1.5-6 For cultivating
- 1.5-51 Cultivator
- 1.5-52

1.5-53 Grain-fertilizer drill

1.5-54 Fertilizer distributor

1.5-55 Spinning disc fertilizer distributor

1.5-56 Manure spreader

1.5-57 Duster

1.5-58 Sprayer

1.5-7 For Harvesting

1.5-71 Rotovator

1.5-72 Reciprocating knife mower

1.5-73 Hay rake

1.5-74 Potato digger

1.5-75 Forage harvester

1.5-8 For Transportation, loading, processing, baling and industrialization

1.5-81 Loader

1.5-82 Trailer

1.5-83 Hay conditioner

1.5-84 Baler

1.6 Stationary equipment without engine

1.7 Fertilizers and Manures

1.7-1 For Soil amendment

1.7-11 Inorganic

1.7-111 With Potash

1.7-112 With Nitrogen

1.7-113 With Phosphates

1.7-12 Organic

1.7-121 Green plants

1.7-122 Dry plants

1.7-123 Manures

1.7-124 Compost

1.7-125 Trash

1.7-126 Alluvium

1.7-13 Composite types

1.7-2 For nurseries

1.7-3 For sowing

1.7-4 For soil nourishment

1.7-5 For covering (soil)

1.8- CHEMICAL PRODUCTS (NOT FERTILIZERS)

1.8-1 Insecticides

1.8-2 Fungicides

1.8-3 Pesticides (birds, rodents, etc.)

1.8-4 Herbicides

1.8-5 Medicines

1.8-6 Preservatives and inhibitors

1.8-7 Disinfectants and de-infestants

1.8-8 Other products (simple)

1.8-9 Other products (compound types)

1.9- MISCELLANEOUS MATERIALS

1.9-1 For nurseries

1.9-2 Training poles, trellis, etc.

1.9-3 For building shelters

1.9-4 For marking and fencing

1.9-5

1.9-6 For buildings

1.9-7 Fuels and lubricants

- 1.9-71 Fuel (general information)
- 1.9-72 Diesel oil
- 1.9-73 Other fuels
- 1.9-74 Lubricating oils
- 1.9-75 Lubricating greases

1.9-8 Pipe-lines, valves, taps, etc.

GROUP 2 - PLANTS AND THEIR REQUIREMENTS

2.1- PLANTS

2.1-1 Classification and description

- 2.1-11 Classification of plants
- 2.1-12 Description and types

2.1-2 Functions and organs

- 2.1-21 Plant life
- 2.1-22 Structure and organs
- 2.1-23 Nutritive functions
- 2.1-24 Reproductive functions
- 2.1-25 Other functions

2.1-3 Life cycle

- 2.1-31 General stages
- 2.1-32 Early stage (seed, cutting, etc.)
- 2.1-33 Intermediate stage (changes)
- 2.1-34 Adult stage
- 2.1-35 Vital calendar (with relation to zone and variety)

2.1-4 Varieties.

- 2.1-41 Sources and origin
- 2.1-42 Description
- 2.1-43 Developed characteristics
- 2.1-44 Applications
- 2.1-45 Yield

2.2- REPRODUCTION AND PROPAGATION

2.2-1 By seed

- 2.2-11 Types of seed
- 2.2-12 Selection and extraction
- 2.2-13 Sanitation

2.2-2

2.2-3 Other methods of propagation

2.2-21 Stolons

2.2-22 Cuttings or branches

2.2-23 Grafts

2.2-24 Rhizomes

2.2-25 Bulbs

2.2-26 Tubers

2.2-27 Transplanting

2.2-28 Plant selection and shoots (banana)

2.2-29 Other means

2.3- NUTRITIONAL AND GROWTH REQUIREMENTS

2.3-1 Soils

2.3-11 Definition, classification, composition and depth

2.3-12 Chemical and physico-chemical properties

2.3-121 Texture

2.3-122 Porosity

2.3-123 Colour

2.3-124 Temperature

2.3-125 Permeability

2.3-126 Structure

2.3-13 Ecology, bacterial activity and organic matter

2.3-14 Productivity, fertility, toxicity and previous use

2.3-15 Soil formation

2.3-16 Degeneration, recovery and crop rotation

2.3-2 Air

2.3-21 Chemical composition of air

2.3-22 Regeneration of oxygen by plants

2.3-3 Water

2.3-31 Surface movement (infiltration)

2.3-32 Underground movement (hygroscopic, capillary, gravitational)

2.3-33 Within the plant (absorption and circulation)
2.3-34 Relationship between water, earth and plant
2.3-35 Chemical content of water (salts, bases, etc.) and toxicity limits

2.4- ENVIRONMENTAL REQUIREMENTS

2.4-1 Topography

2.4-11 Conditions for working
2.4-12 Conditions for irrigating
2.4-13 Conditions for supporting plant life (protection)
2.4-14 Prevailing weather conditions (winds, frost, etc.)
2.4-15 Conditions for conservation

2.4-2 Microclimate

2.4-21 Effects of altitude
2.4-22 Nearness to the sea, lakes, rivers, etc.
2.4-23 Nearness to mountains
2.4-24 Nearness to woods and to other crops

2.4-3 Moisture

2.4-31 Rainfall
2.4-32 Soil moistrure
2.4-33 Water table
2.4-34 Relation to the microclimate

2.4-4 Sunshine

2.4-41 Light
2.4-42 Temperature

2.4-5 Other weather features

2.4-51 Winds

2.4-52 Dew

2.4-53 Frost

2.4-54 Hail

2.4-55 Snow

GROUP 3 - AGRICULTURAL TECHNIQUES

3.1- PLANNING OF CROPS

3.1-1 Size of land to be cultivated
- 3.1-11 Crop yield
- 3.1-12 Available work means
- 3.1-13 Time available
- 3.1-14 Surface determination

3.2-2 Time-tabling of work to be done
- 3.1-21 Preparing the land
- 3.1-22 Sowing (or planting)
- 3.1-23 Cultural practices
- 3.1-24 Treating crops
- 3.1-25 Harvesting
- 3.1-26 Processing, transporting

3.1-3 Estimating farm supplies
- 3.1-31 Estimating requirements for seed or other propagation means
- 3.1-32 Estimating sanitary products
- 3.1-33 Estimating machine-hours
- 3.1-34 Estimating work-force

3.2- SELECTING SUITABLE LANDS

3.2-1 Selection of soils
- 3.2-11 Collection of soil samples
- 3.2-12 Soil analysis
- 3.2-13 Determining physical characteristics
- 3.2-14 Earlier uses
- 3.2-15 Topographical features (slopes, drainage, position)

3.3- SOIL PREPARATION

3.3-1 Establishing boundaries
- 3.3-11 Marking limits
- 3.3-12 Measuring fields
- 3.3-13 Marking out work

3.3-2 Clearing the land
- 3.3-21 Removing stones, etc.
- 3.3-22 Levelling the surface

3.3-3 Preparing the land for water consumption and protective works
- 3.3-31 Levelling
- 3.3-32 Furrows, trenches and ditches
- 3.3-33 Drainage

3.3-4 Subsoiling
- 3.3-41 Why it should be done
- 3.3-42 Ideal conditions for subsoiling

3.3-5 Ploughing and harrowing
- 3.3-51 Ideal conditions

3.3-6 Amendment
- 3.3-61 Improving the physical properties of the soil
- 3.3-62 Sand addition
- 3.3-63 Clay addition
- 3.3-64 Polyelectrolyte addition
- 3.3-65 Green manure addition
- 3.3-66 Manuring

3.3-7 Corrective Measures
- 3.3-71 Improving the physical properties of the soil
- 3.3-72 Testing for pH
- 3.3-73 Scarifying

3.3-74 Washing

3.3-75 Crops that enrich the soil

3.3-8 Fertilizing

3.3-81 Loss of nutrients in the soil

3.3-82 Soil regeneration by fertilizing

3.3-9 Fallow periods

3.3-91 Usefulness of fallowing

3.3-92 Economic drawbacks of fallowing

3.3-93 Substitute practices for fallowing

3.4- SOWING, PLANTING AND PROPAGATION

3.4-1 Sowing permanent crops

3.4-11 General guidelines

3.4-12 Types of seeding

3.4-13 Sowing techniques

3.4-14 Times for sowing

3.4-15 Selecting seeds

3.4-16 Pre-germination and testing

3.4-17 Special precautions

3.4-18 Treating and sowing simultaneously

3.4-2 Planting tubers

3.4-21 General guidelines

3.4-22 Planting techniques

3.4-23 Suitable time for planting

3.4-24 Selecting and testing tubers for planting

3.4-25 Special precautions

3.4-26 Treating and planting simultaneously

3.4-3 Planting bulbs and rhizomes

3.4-31 General guidelines

3.4-32 Planting techniques

3.4-33 Suitable times for planting

3.4-34 Selecting propagation means and testing

3.4-35 Preparation and special care

3.4-36 Treating and planting simultaneously

3.4-4 Using cuttings for propagation

3.4-41 General guidelines

3.4-42 Propagating techniques

3.4-43 Suitable times for propagation

3.4-44 Selection of cuttings for propagation

3.4-45 Preparation and special care

3.4-46 Treating and planting simultaneously

3.4-5 Grafting

3.4-51 General guidelines

3.4-52 Grafting techniques

3.4-521 Insertion

3.4-522 Grafts

3.4-523 Buds

3.4-524 Herbaceous

3.4-53 Suitable times for grafting

3.4-54 Selecting the stalk and the graft

3.4-55 Preparation and special care

3.4-56 Care and treatment after grafting

3.5- CARE OF CROPS

3.4-1 Routine farming tasks

3.5.11 Weeding

3.5-12 Moulding

3.5-13 Second ploughing

3.5-14 Rolling

3.5-2 Fertilizing

- 3.5-21 Minimal use of fertilizers
- 3.5-22 Total fertilizing
- 3.5-23 Supplementary fertilizing

3.5-3 Pruning

- 3.5-31 The necessity of pruning
- 3.5-32 Recommended times for pruning
- 3.5-33 Pruning techniques
- 3.5-34 Removal of buds
- 3.5-35 Pruning of vines
- 3.5-36 Precautions during the pruning
- 3.5-37 Care and treatment after pruning

3.5-4 Safeguards

- 3.5-41 Protection from large animals
- 3.5-42 Protection from small pests
- 3.5-43 Protection from wind
- 3.5-44 Protection from cold
- 3.5-45 Protection from heat
- 3.5-46 Protection from other weather conditions

3.5-5 Irrigation and Drainage

- 3.5-51 Flood irrigation
- 3.5-52 Furrow irrigation
- 3.5-53 Irrigation by spraying
- 3.5-54 Irrigation by dripping
- 3.5-55 Selecting a method of irrigation
- 3.5-56 Deciding when to irrigate
- 3.5-57 Deciding how much irrigation to do
- 3.5-58 Drainage methods

3.5-6 Preventive measures

- 3.5-61 Pest and disease control
- 3.5-62 Weed control
- 3.5-63 Weather effects control

3.5-7 Special cultivating techniques
- 3.5-71 Dry farming
- 3.5-72 Using electricity
- 3.5-73 Hydroponics
- 3.5-74 Using radiations
- 3.5-75 In darkness
- 3.5-76 In greenhouses

3.6- NURSERIES

3.6-1 Positioning of nurseries
- 3.6-11 Environmental specifications for a nursery
- 3.6-12 Supplies for a nursery (e.g. water)

3.6-2 Lay-out and size requirements
- 3.6-21 Number of transplants required
- 3.6-22 Location of boxes and access-ways
- 3.6-23 Space requirements

3.6-3 Preparation of land
- 3.6-31 Choosing of land
- 3.6-32 Soil additives
- 3.6-33 Sifting and mixing of soil ingredients
- 3.6-34 Sanitation

3.6-4 Preparation of incubators

3.6-5 Fencing

3.6-51 Protection against large animals

3.6-52 Protection against small pests

3.6-53 Protection from sunshine and atmospheric conditions

3.6-6 Subsidiary installations

3.6-61 Water supply and storage

3.6-62 Deposits for soil, manure, etc.

3.6-7 Sowing in nurseries

3.6-71 Selection of seeds

3.6-72 Sowing techniques

3.6-73 Special precautions when sowing

3.6-8 Special care for nurseries

3.6-81 Weeding

3.6-82 Forking

3.6-83 Watering

3.6-84 Sanitation

3.6-9 Transplanting

3.6-91 Deciding when to transplant

3.6-92 How to uproot seedlings

3.6-93 How to replant seedlings

3.6-94 Temporary transplanting

3.7- PLANTING LONG-TERM OR PERMANENT CROPS

3.7-1 Planning

3.7-11 Number of plants and projected yield

3.7-12 Planning in stages, for future expansion

3.7-2 Space Requirements

3.7-21 How to position plants in special formation

3.7-22 Pathways and access-ways

3.7-23 Safeguards, fire-extinguishers, etc.

3.7-24 Tracing the shape and calculating the area of the plantation

3.7-3 Choosing a suitable site

3.7-31 Type of soil required

3.7-32 Sunshine required

3.7-33 Moisture required

3.7-34 Weather protection

3.7-35 Security factors, transportation, etc.

GROUP 4 - HEALTH OF PLANTS

4.1- NOXIOUS PESTS AND BLIGHTS

4.1-1 Pathogens

4.1-11 Mosses and fungi

4.1-111

4.1-12 Bacteria and micro-organisms

4.1-121

4.1-13 Viral infections

4.1-131

4.1-2 Nematodes, mites, molluscs

4.1-3 Insects

4.1-4 Birds

4.1-5 Rodents

4.1-6 Large predators

4.1-7 Plant parasites (lower forms)

4.1-8 Competitive plants (higher forms)

4.1-81 Weeds

4.2- DEFICIENCIES

4.2-1

4.2-2 Mineral deficiencies

4.2-11 Nitrogen

4.2-12 Phosphorus

4.2-13 Potassium

4.2-14 Calcium

4.2-15 Magnesium

4.2-16 Sulphur

4.2-21 Iron

4.2-22 Manganese

4.2-23 Boron

4.2-24 Molybdenum

4.2-25 Copper

4.2-26 Zinc

4.2-27 Chlorine

4.2-3 Salt deficiencies

4.3- EXCESSES

4.3-1 Mineral excesses

4.3-2

4.3-3 Excess salts

4.3-31 Chlorides

4.4- DAMAGE BY CUTS

4.4-1 By pruning

4.4-11 Techniques for reducing damage

4.4-2 By natural agents

4.4-21 Types of damage: tearing, leaning (of cereals), leaf-shedding

4.5- CURING DAMAGE WITH CHEMICALS

4.5-1 General guidelines

4.5-11 Precautions

4.5-2 Spraying

4.5-21 Aerial spraying

4.5-22 Mechanical spraying

4.5-23 Manual spraying

4.5-3 Dusting

4.5-31 Aerial dusting

4.5-32 Mechanical dusting

4.5-33 Manual dusting

4.5-4 Use of chemicals when sowing

4.5-41 Treating seeds

4.5-42 Treating the soil during sowing

4.5-5 Treating the soil with chemicals

4.5-51 As a preventive measure

4.5-52 When preparing the soil prior to sowing

4.5-53 In the irrigation system

4.6- CURATIVE TECHNIQUES USING BIOLOGICAL WEAPONS

4.7- CURATIVE TECHNIQUES USING MECHANICAL AIDS

4.8- PROTECTION AGAINST LARGE PESTS

GUIDE 5 - HARVESTING

5.1- MATURITY

5.1-1 When to harvest

- 5.1-11 Physiological and technical maturity
- 5.1-12 Products of varying ripeness
- 5.1-13 Selective harvesting according to maturity

5.2- TREATMENTS PRIOR TO REAPING

5.2-1 Heat treatment

5.2-2 Chemical treatments

5.2-3 Manual tending

5.3- HARVESTING CONDITIONS

5.3-1 Relevant to the plant (ripeness excepted)

5.3-11 Humidity

5.3-12 Plant height

5.3-2 Relevant to the land

5.3-3 Climatic conditions

5.3-4 Other conditions

5.4- STEPS IN MECHANICAL HARVESTING

5.4-1 Reaping and cutting techniques

5.4-11 Simple reaping

5.4-12 Reaping combined with other simple operations

5.4-13 Other types of harvesting

5.4-14 Cane-cutting

5.4-15 Cutting other crops

5.4-2 Techniques of swathing and collecting

5.4-21 Making swaths

5.4-22 Collecting swaths

5.4-23 Collecting forage
5.4-24 Collecting mixed forage
5.4-25 Collecting hay
5.4-26 Collecting and loading hay

5.4-3 Threshing techniques
5.4-31 Threshing grain cereals

5.4-4 Techniques of harvesting tubers and root crops
5.4-41 Potatoes
5.4-42 Beets
5.4-43 Peanuts

5.4-5 Special combine-harvesting
5.4-51 Harvesting cotton
5.4-52 Harvesting corn

5.5- STEPS FOR MANUAL REAPING

5.6- ACTIVITIES CONNECTED WITH HARVESTING

GROUP 6 - TREATMENT OF CROPS AFTER REAPING

6.1- PROCESSING

6.1-1

6.1-2 Techniques of processing

- 6.1-11 Selecting and grading
- 6.1-12 Cleaning
- 6.1-13 Drying
- 6.1-14 Baling and packing
- 6.1-15 Bagging
- 6.1-16 Milling
- 6.1-17 Hay making
- 6.1-18 Winnowing
- 6.1-19 Sweeping
- 6.1-21 Sifting
- 6.1-22 Hulling
- 6.1-23 Ensilage

6.1-3 Processing installations

- 6.1-31 Types of installations
- 6.1-32 Requirements
- 6.1-33 Settings

6.2- STORAGE

6.2-1 Storage conditions

- 6.2-11 Humidity
- 6.2-12 Ventilation
- 6.2-13 Temperature

6.2-2 Forms and conditions of storage

6.2-21 In granaries

6.2-22 In silos

6.2-221 Filling

6.2-222 Closing

6.2-223 Periodic checks

6.2-224 Emptying

6.2-225 Use of produce

6.2-23 In stacks

6.2-3 Location of stores

6.2-31 Granaries

6.2-32 Silos

6.2-4 Methods of preservation, prevention and sanitation

6.2-5 Safety measures

6.2-51 Spontaneous combustion

6.3- TRANSPORTATION

6.3-1 Loose produce

6.3-11 Grain

6.3-12 Forage

6.3-13 Straw

6.3-14 Cane

6.3-15 Leaves

6.3-2 Packed produce

6.3-21 Bundles

6.3-22 Bags

6.3-23 Bales

6.4- INDUSTRIALIZATION

GROUP 7 - INFRASTRUCTURAL WORKS

7.1- IMPROVING THE SOIL

7.1-1 Deforestation
- 7.1-11 Felling trees
- 7.1-12 Burning or stubbing

7.1-2 Clearing
- 7.1-21 Removal of trunks and stumps
- 7.1-22 Dynamiting and clearing rocks

7.1-3 Earth movement
- 7.1-31 Bulldozing
- 7.1-32 Embanking
- 7.1-33 Levelling

7.1-4

7.1-5 Terracing, erosion control, binding of soil and sand
- 7.1-41 Terraces
- 7.1-42 Mounds
- 7.1-43 Ridges
- 7.1-44 Contour lines
- 7.1-45 Plants with binding roots
- 7.1-46 Palisades
- 7.1-47 Filling
- 7.1-48 Channels

7.1-6 Draining and drying

7.2- WATER HANDLING

7.2-1 Obtaining water

7.2-11 Underground sources

7.2-12 Digging wells

7.2-13 Harnessing river water

7.2-14 Collecting rain water

7.2-2 Water analysis

7.2-3 Water flow

7.2-31 By gravity

7.2-32 Water wheels

7.2-33 Pumps

7.2-34 Rams

7.2-4 Channelling water

7.2-41 Canals

7.2-42 Pipes

7.2-5 Water deposits

7.2-51 Storage tanks

7.2-52 Rain water tanks

7.2-53 Dams

7.2-6 Utilizing hydraulic energy

7.2-61 Wheels

7.2-62 Turbines

7.2-7 Protection against harmful effects of water
7.2-71 Dikes
7.2-72 Detouring canals
7.2-73 Channels

7.3- ROADS AND BOUNDARIES

7.3-1 Roads

7.3-2 Aqueducts
7.3-21 Culverts
7.3-22 Gullies

7.3-3 Boundaries
7.3-31 Wire fencing
7.3-32 Gates
7.3-33 Fences and railing
7.3-34 Hedges

7.4- PROTECTIONS AND SAFEGUARDS

7.4-1 Retaining devices made of branches

7.4-2 Protective ranges

7.4-3 Greenhouses

7.4-4 Shade trees

7.4-5 Dry embankments

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II - *Operations* ordered by *reference* number

III - *Operations* in *alphabetical* order

IV - *Operations* classified according to the *plants* to which they apply

Technological Information sheets

VI - *Technology* classified according to *subject* matter

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*P = Plant

I - OPERATIONS classified by SUBJECTS for "AGRICULTURE" from OS.001 to OS.049 (including reference, plant code and level of sheet). (contd.)

SUBJECT	Operation Title	Ref.	*P	L
1.5-14	Operating the post hole digger	048	-	2
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1.5-23	Adjusting the integral-mounted disc plough	024	-	2
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1.5-25	Operating the tine harrow	022	-	2
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1.5-28	Operating the rotary cultivator	029	-	2
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1.5-54	Operating the fertilizer and manure spreader	020	-	2
1.5-55	Operating the spinning disc distributor	034	-	2
1.5-57	Operating the duster	040	-	2
1.5-58	Operating the spraying machine	039	-	2
1.5-71	Operating the rotary mower	017	-	2
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*P = Plant

I - OPERATIONS, classified by SUBJECTS for "AGRICULTURE" from OS.001 to OS.049 (including reference, plant code and level of sheet).

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1.5-81	Operating the loader	018	-	2
1.5-82	Operating the trailer	019	-	2
1.5-83	Operating the hay conditioner	045	( )	2
1.5-84	Adjusting the baler	046	-	2
1.5-84	Operating the baler	047	-	2

*P = Plant

VII - AGRICULTURAL TECHNOLOGY, arranged by REFERENCE number. (Including: subject code, plant code and level of sheet). (cont.)

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001	Plant production	2.1-2	-	2
002	Soils (Definition. Formation)	2.3-11 2.3-15	-	2
003	Soils (Physical structure and Chemical composition)	2.3-12	-	2
004	Soil texture	2.3-12	-	2
005	Porosity, colour, temperature and permeability of soils	2.3-12	-	2
006	Soil structure	2.3-12 2.3-16	-	2
007	Profile of soils	2.3-11	-	2
008	Organic matter contained in soils	2.3-13	-	2
009	Nutrients, fertility and productivity of soils	2.3-14 4.2-1	-	2
010	Nutrients, production and their relationship	2.3-14 3.3-6/8 4.2- 4.3-	-	2
011	Nutrients, pH and their relationship	2.3-14 4.2-1	-	2
012	Nutrients (General Information)	2.3-14 4.2- 4.3-	-	2
013	Fertilizers (General Information)	1.7- 2.3-14 3.5-2	-	2
014	Cultivation of soils (General Information)	3.3-51	-	2
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016	Plants (Definition and structure)	2.1-12	G	2
017	Vegetative organs of plants	2.1-22	G	2
018	Reproductive organs of plants	2.1-24	G	2
019	Plant nutrition	2.1-23	G	2
020	Plant reproduction	2.1-24	G	2
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*P = Plant

VII - AGRICULTURAL TECHNOLOGY, arranged by REFERENCE number. (Including: subject code, plant code, and level of sheet). (cont.)

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023	Pest control (General Information)	4.1- 4.5-1	-	2
024	Pesticides (General Information)	4.5-11	-	2
025	Weeds	1.8-4 3.5-1 3.5-62 4.1-81	( )	2
026	Plants (Classifications)	2.1-1	G	2
027	Tractor (General Information)	1.4-11	-	2
028	Tractor (Types)	1.4-11	-	2
029	Fuel (storage and supply)	1.9.71	-	2
030	Control panel of the tractor	1.4-12	-	2
031	Track width of the tractor	1.4-16	-	2
032	Tyres	1.4-19	-	2
033	Ballasting of the tractor	1.4-16	-	2
034	Tractor drawbar	1.4-15	-	2
035	Hydraulic system (General aspects)	1.4-12	-	2
036	Three-point linkage (Description)	1.4-15	-	2
037	Three-point linkage (Operation)	1.4-15	-	2
038	Pulley (types and calculations)	1.4-15 8.1-11	-	2
039	Power take-off (Description)	1.4-15	-	2
040	Power take-off (Use and maintenance)	1.4-15 1.4-18	-	2
041	Record keeping	8.3/5-	-	2
042	A.S.A.E. Standards	1.4-15	-	2
043	Rotary mowing machine	1.5-71	-	2

CBC: Agriculture
Fasc.: Agricultural Machinery Operator-72

*P = Plant

REF	Title of Technological Subject	Subject	*P	L
044	Loader	15-81	-	2
045	Trailers	1.5-82	-	2
046	Fertilizer distributors	1.5-54	-	2
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049	Tine harrows	1.5-25	-	2
050	The spring tine harrow	1.5-27	-	2
051	Disc harrows (General Information, Types, Description)	1.5-26	-	2
052	Disc harrows (Use and maintenance)	1.5-26	-	2
053	Harrows (Applications and use)	1.5-25/7	-	2
054	Ploughs	1.5-21/4	-	2
055	Maouldboard ploughs	1.5-21/2	-	2
056	The ploughshare (Adjustment)	1.5-22	-	2
057	The disc ploughs	1.5-23	-	2
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059	The subsoiler	1.5-11	-	2
060	The post hole digger	1.5-14	-	2
061	Graders	1.5-12	-	2
062	Rotovator	1.5-28	-	2
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064	The ridger	1.5-13	-	2
065	Spinning disc fertilizer distributor	1.5-55	-	2
066	The grain-fertilizer drill	1.5-53	( )	2

VII - AGRICULTURAL TECHNOLOGY, arranged by REFERENCE number. (Including: subject code, plant code, and level of sheet).

REF	Title of Technological Subject	Subject	*P	L
067	Markers (Adjustment)	1.5-41 1.5-53	( )	2
068	Row crop planters	1.5-41	( )	2
069	Potato planters	1.5-43	( )	2
070	Cultivators	1.5- 51/2	( )	2
071	Spraying machines (structure and types)	1.5-58	-	2
072	Crop dusters	1.5-57	-	2
073	Potato digger	1.5-74	( )	2
074	Reciprocating knife mowers	1.5-72	-	2
075	Forage harvester	1.5-75	( )	2
076	Hay rakes	1.5-73	-	2
077	Hay conditioners	1.5-83	( )	2
078	The baler	1.5-84	-	2
079	Sprayers (Adjustment, use, maintenance)	1.5-58	-	2

*P = Plant

OPERATION SHEETS

This operation consists of carrying out the daily preventive maintenance on a tractor before beginning the daily work. This brings about greater efficiency and longer working life.

PROCEDURE

OBSERVATION
Carry out the following steps with the engine switched off.

1st Step - *Check the level of the coolant in the radiator*, thus:

a) Remove the radiator cap.

b) Check the level of the coolant.

c) Top up if necessary (Fig. 1).

d) Replace the cap.

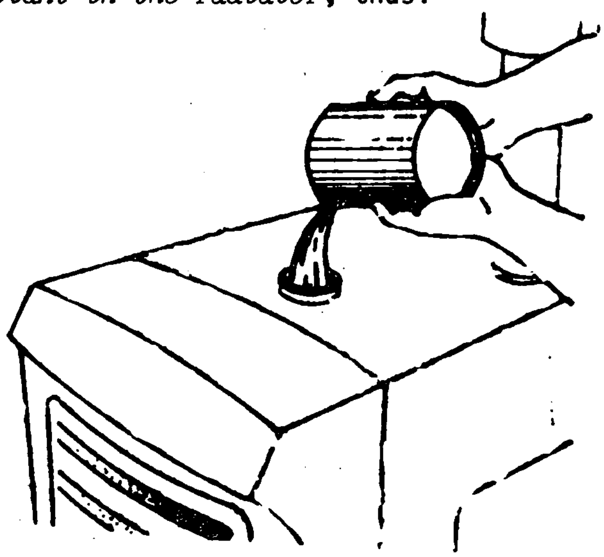


Fig. 1

2nd Step - *Check the level of the engine*, thus:

a) Clean around the dip-stick.
b) Remove the dip-stick and wipe it.
c) Replace the dip-stick in its normal position.
d) Remove the dip-stick and hold it in a horizontal position (Fig. 2).
e) Check if the oil level is between the MIN. and MAX. marks.
f) If necessary, top up to the MAX mark.

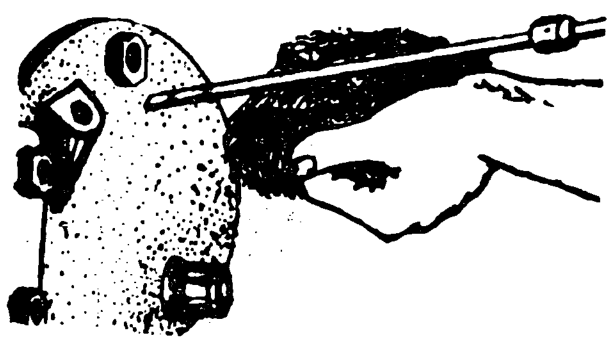


Fig. 2

OBSERVATION
For this check, the tractor should be parked on level ground.

3rd Step - *Tighten the fan belt* thus:-

a) Loosen the generator bolts.

b) Tighten the belt by pushing the generator outwards until the required tension is achieved.

c) Tighten the bolts.

d) Check the tension of the fan belt. Test if its deflection between the pulleys is correct (Fig. 3).

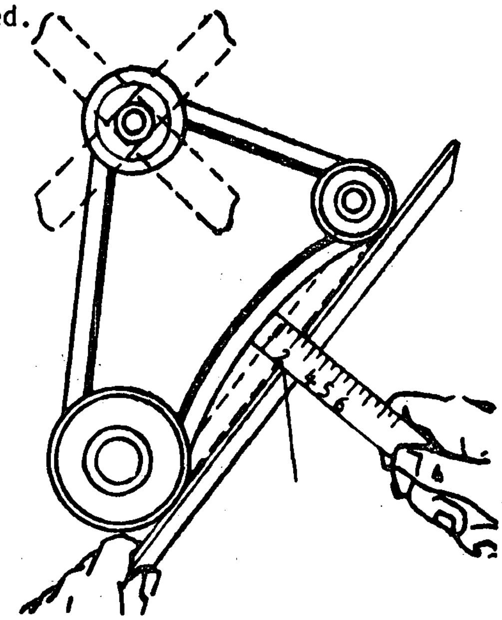


Fig. 3

OBSERVATIONS

1) Check the fan belt tension daily and adjust it when necessary.

2) If the fan belt is defective, change it.

4th Step - *Check the air cleaner* thus:-

CASE I - OIL BATH AIR CLEANER

a) Remove the oil bowl. (Figs. 4, 5, and 6).

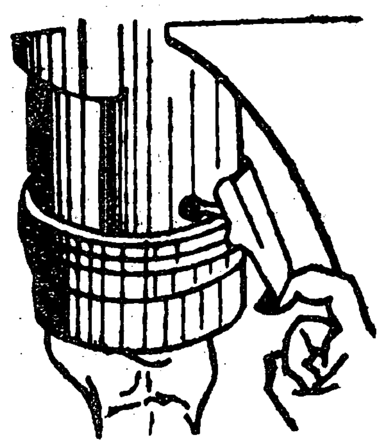


Fig. 4

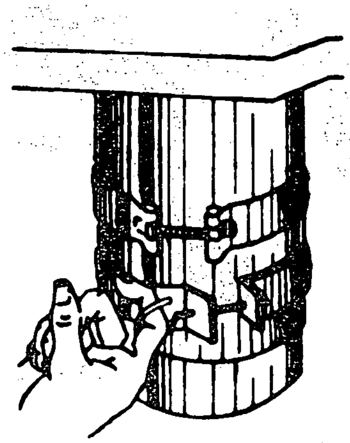


Fig. 5

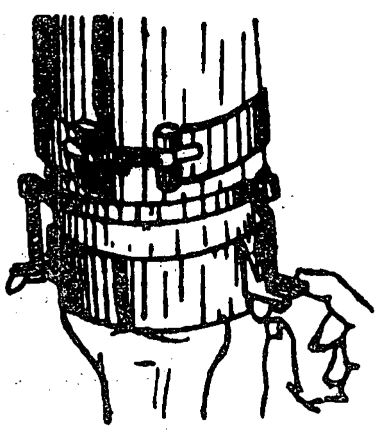


Fig. 6

b) Drain away the oil if it is dirty.
c) Clean the bowl.
d) Refill with oil to the indicated level (Fig. 7).
e) Replace the bowl.

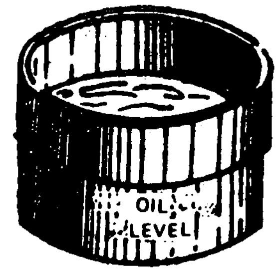


Fig. 7

CASE II - DRY ELEMENT AIR CLEANER

a) Remove the securing bolt and take off the cover of the element.
b) Clean the element (Fig. 8) or change it if necessary. Follow the operator's manual.

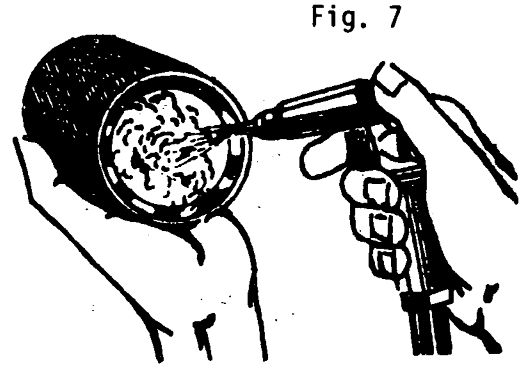


Fig. 8

c) Replace element, cover and bolt.

OBSERVATION
When working under dusty conditions, check air cleaner oil or element more often.

5th Step - *Clean the bowl of the fuel filter* thus:-

a) Close the fuel inlet tap.

b) Remove the filter bowl (Fig. 9).

c) Clean and replace the bowl.

d) Open the fuel inlet tap.

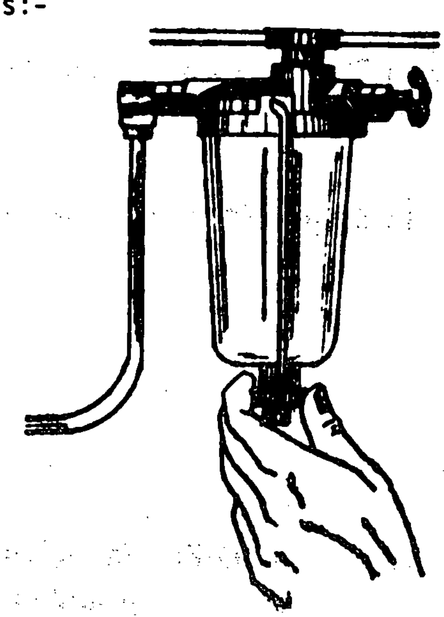


Fig. 9

6th Step - *Check and clean*, if necessary, *the protective screen of the radiator.*

7th Step - *Grease* thus:-

a) Clean the grease nipples.

b) Grease (Fig. 10)

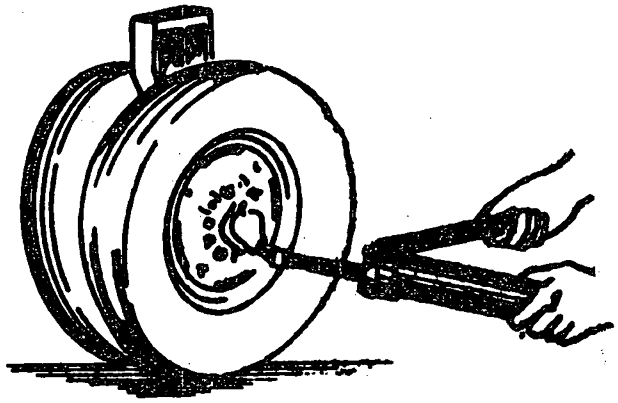


Fig. 10

OBSERVATION

Consult the operator's manual to determine which points require daily greasing.

c) Remove the excess grease.

8th Step - *Enter the reading of the proof meter* in the daily register.

OBSERVATION

Carry out the following steps with the engine running.

9th Step - *Check the correct functioning of the gauges and controls on the instrument panel.*

10th Step - *Check the functioning of the lighting circuit.*

11th Step - *Check the functioning of the hydraulic system.*

NOTE: The *operator's manual* is the literature supplied by the manufacturer of a machine or implement. This manual contains all the specifications and instructions required.

CBC

OPERATION:
DRIVING THE TRACTOR

This operation consists of using controls correctly to get the best output from tractor and implements, such as ploughs, harrows or planters needed in agricultural work.

PROCEDURE

1st Step - *Inspect the tractor.*

2nd Step - *Turn on the engine,* thus:

a) Sit in the driver's seat.
b) Press the clutch pedal and put the gearshift in the neutral position (Figs. 1 and 2).
c) Release the clutch pedal (Fig. 3).
d) Open the fuel tap.
e) Place the throttle at the centre of its total possible travel (Fig. 4).

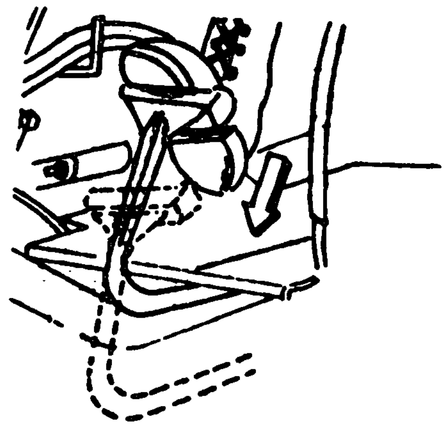


Fig. 1

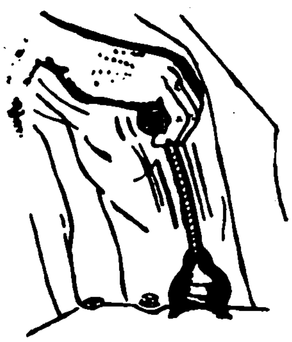


Fig. 2

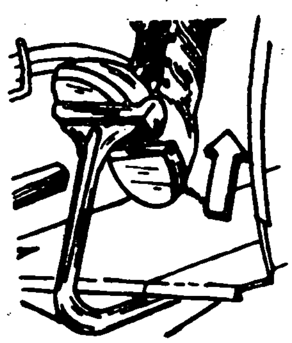


Fig. 3

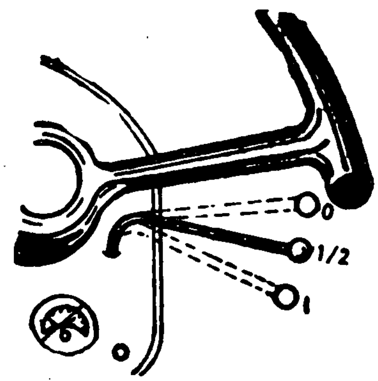


Fig. 4

f) Insert the key and start the engine (Fig. 5)

OBSERVATION
Release the key as soon as the engine starts.

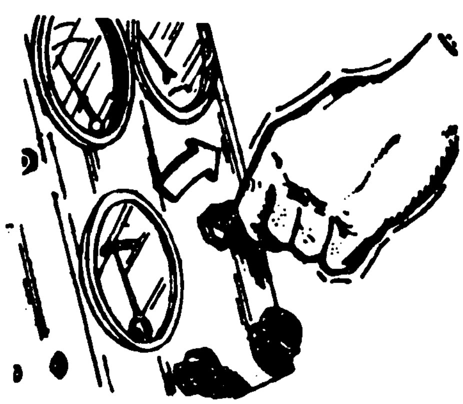


Fig. 5

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 1.4-14

SAFETY MEASURE

NEVER RUN THE ENGINE IN A CLOSED AREA. THE EXHAUST FUMES ARE HIGHLY TOXIC.

3rd Step - *Drive thetractor* thus:

a) Hold the steering wheel with your left hand (Fig. 6).
b) Press the clutch pedal.
c) Select first gear.

Fig. 6

d) Release the hand brake (Fig. 7).
e) Slowly release the clutch pedal and accelerate simultaneously.

Fig. 7

OBSERVATIONS

1) Engage slowly and progressively.
2) Keep your feet on the floor of the tractor, never on the brake or clutch pedal.

4th Step - *Stop the tractor* thus:

a) Decelerate.
b) Press the clutch pedal.
c) Apply the brakes until the tractor is stopped (Fig. 8).
d) Put the gearshift in the neutral position.

Fig. 8

5th Step - *Change gears* thus:

a) Place the gearshift in another gear.
b) Release the brakes.

c) Engage the clutch and accelerate simultaneously.

6th Step -

a) Stop the tractor.
b) Close the fuel tap.
c) Shift to first gear.
d) Engage the clutch.
e) Apply the hand brake (Fig. 9).
f) Remove the key.

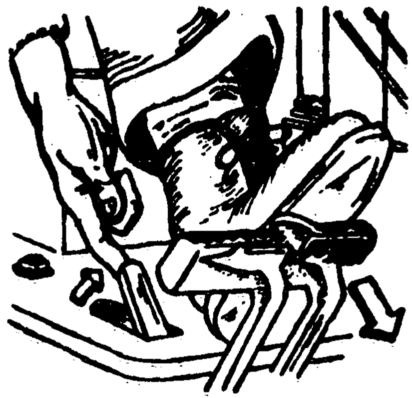


Fig. 9

CBC

OPERATION:
DAILY MAINTENANCE OF THE TRACTOR
(after daily work)

REF. OS.003 | 1/1

Caribbean

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 1.4-18

It is carried out after the daily work is complete. The aim is to check for failures or damages which occur during work.

PROCEDURE

1st Step - *Drive the tractor* to the maintenance area.

2nd Step - *Check the functioning* of gauges and controls on the instrument panel (Fig. 1).

3rd Step - *Check for* water, fuel or oil leaks. Pinpoint loose parts.

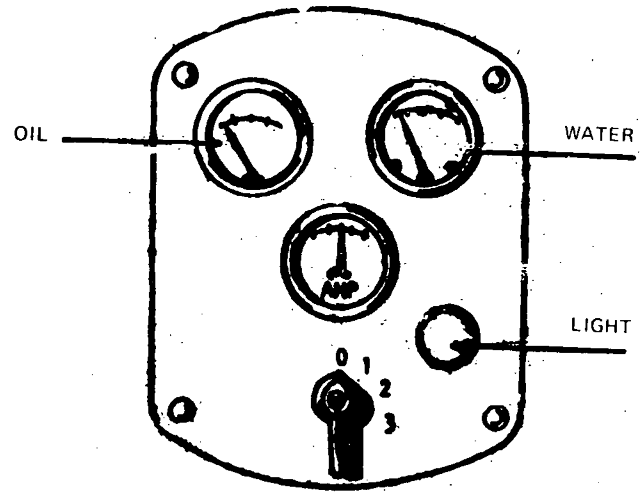


Fig. 1

4th Step - *Stop the engine.*

5th Step - *Tighten* all loose nuts and bolts.

6th Step - *Fill the fuel* tank.

7th Step - *Enter in the daily register* the reading on the proof meter.

8th Step - *Enter in the daily register* the amount of fuel used.

9th Step - *Drive the tractor* to the parking area.

OBSERVATION
If the exhaust pipe has no flap valve, use a protective cover when the tractor is parked outdoors.

TECHNICAL VOCABULARY

Daily Register - Log-book

This operation consists of changing the fluids and greasing the tractor after a given number of working hours as indicated in the operator's manual. These changes keep the machine in good working condition.

PROCEDURE

CHANGE THE WATER IN THE COOLING SYSTEM

1st Step - *Drain the water from the system* thus:

a) Remove the radiator cap.
b) Open the taps on the radiator and engine.
c) Close the taps when all the water is drained.

2nd Step - *Fill the radiator with clean water and replace the cap.*

OBSERVATION
Consult the operator's manual to determine when to change the water and when to use antirust or antifreeze.

CHANGE THE OIL

1st Step - *Take the tractor to a level area. Stop the engine* when it has reached its normal working temperature.

2nd Step - *Empty the sump* thus:

a) Remove the filling cap.
b) Loosen the drain plug.
c) Place a container below the drain plug to collect the oil.
d) Remove the drain plug.

OBSERVATIONS

1) The transmissions and hydraulic system drain plugs are magnetic; remove the metal particles; if these are excessive, consult the mechanic.

2) Clean the crankcase breather pipe.

3) Replace and tighten the plug when all the oil is drained.

3rd Step - *Fill the sump* with the recommended oil to the level indicated in the operator's manual (see Fig. 1). Replace the filler cap.

OBSERVATIONS

1) Check the operator's manual to determine the periods of change for each lubricant.

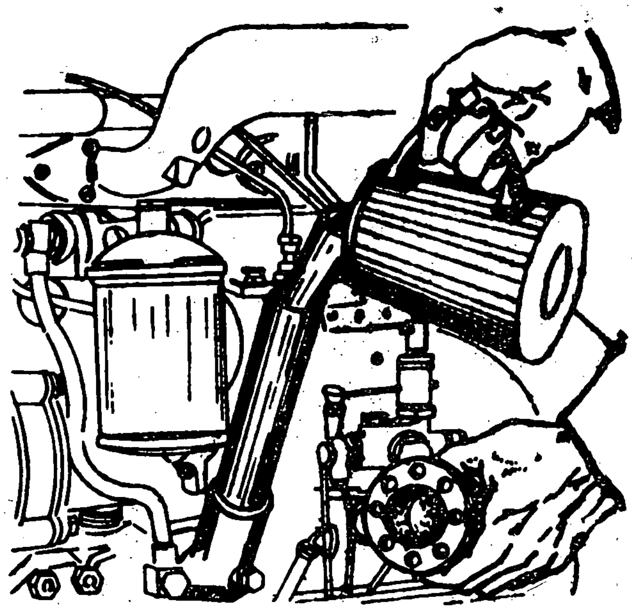


Fig. 1

2) The oil change should be done when the engine is hot, preferably after the daily work is done.

4th Step - *Change the element of the oil filter* following the instructions of the operator's manual.

GREASING

1st Step - *Wash the tractor* thus:-

a) Drive the tractor to the maintenance area.
b) Remove the grease using detergents.
c) Wash the tractor with pressurized water.

OBSERVATION

Avoid directing the pressurized water at the core of the radiator honeycomb and exposed parts of the electrical system.

2nd Step - *Grease.*

a) Clean the grease nipples.
b) Grease.
c) Clean off the excess grease.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 1.4-18

This operation consists of replacing the filter elements of the fuel system of the tractor, following specifications in the operator's manual, and bleeding the air which enters the system.

PROCEDURE

1st Step - *Drive the tractor to the maintenance area.*

2nd Step - *Switch off the engine.*

3rd Step - *Change the fuel filter element,* thus: (Fig. 1).

a) Close the fuel tap.
b) Clean the outside of the filter.

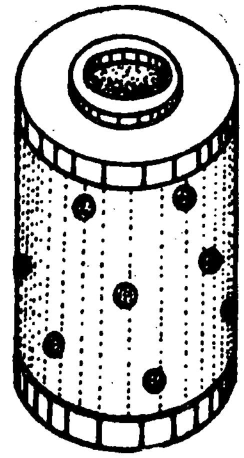


Fig. 1

c) Loosen the securing bolt and remove the filter body (Fig. 2).
d) Remove the filter element, wash the body and dry it.
e) Install the new filter element and the sealing ring.
f) Mount the filter body and tighten the securing bolt.

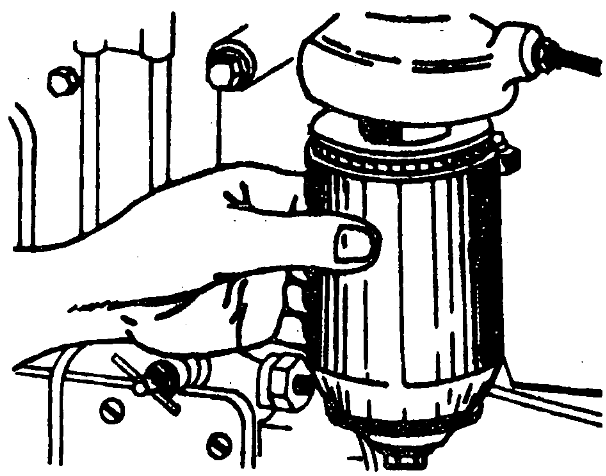


Fig. 2

4th Step - *Bleed the fuel system,* thus:

a) Clean the glass bowl. Check all the connections of the system for leaks.
b) Open the fuel line tap.
c) Loosen the bleed screw of the first filter.

d) Actuate the lever of the fuel lift pump (Fig. 3).

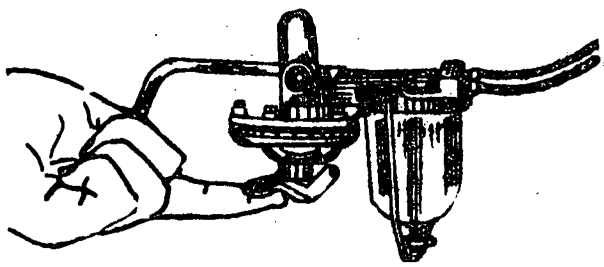


Fig. 3

e) Tighten the bleed screw.

OBSERVATIONS

1) To clean the other filters, repeat substeps c, d, and e.

2) The lever of the fuel lift pump must be actuated until the fuel flows without air bubbles.

3) Consult the operator's manual to locate the bleed screws.

f) Loosen the bleed screws of the injection pump and actuate the lever of the lift pump.

g) Loosen the fittings between the high pressure tubes and the injectors.

h) Position the throttle to the maximum travel and turn on the starter motor until fuel flows from the fittings free of air bubbles. Tighten the fittings.

i) Start the engine. Allow it to run for a few minutes. Check for fuel leaks.

TECHNICAL VOCABULARY

First filter = Primary filter

This is to make the mechanical adjustments on the clutch, brake and differential lock pedals. The purpose is to get the indicated travel to avoid accidents, damage or excessive wear.

PROCEDURE

CLUTCH PEDAL

1st Step - *Loosen the lock-nut* of the rod (Fig. 1).

2nd Step - *Remove the clevis pin.*

3rd Step - *Adjust the travel* by screwing or unscrewing clevis.

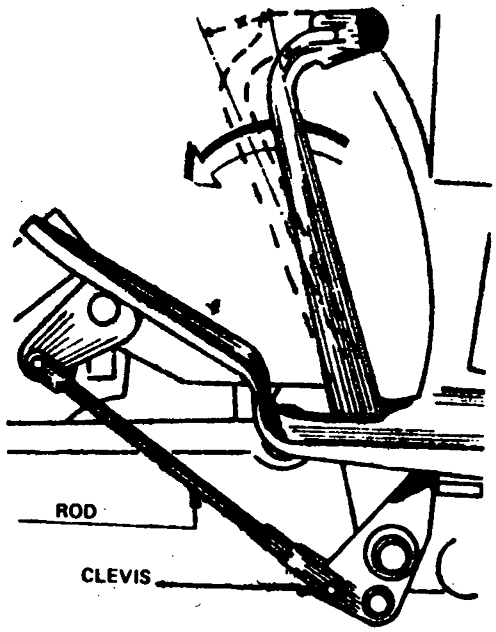


Fig. 1

OBSERVATION
To carry out the previous step, consult the operator's manual.

4th Step - *Tighten the lock-nut and replace pin.*

BRAKE PEDALS

CASE I - DISC BRAKES

1st Step - *Lift the rear wheels.*

2nd Step - *Adjust the travel,* thus:
a) Disconnect the return springs.
b) Adjust by turning the nuts to increase or decrease the travel (Fig. 2).
c) Check the travel by pressing the pedal with your hand until a greater resistance is felt.
d) Replace the return spring.

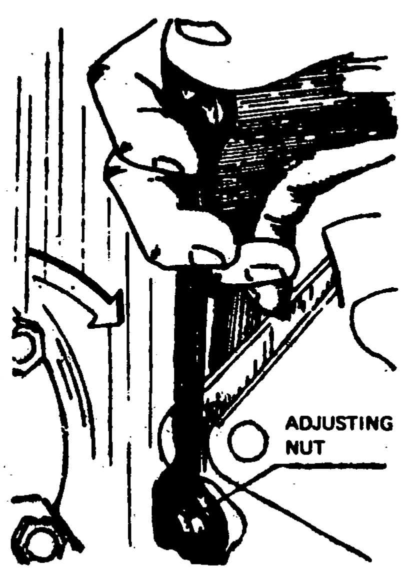


Fig. 2

OBSERVATION

Turn the wheels by hand to check if they are free.

e) Lower the wheels.

CASE II - SHOE BRAKE

1st Step - *Lift the rear wheels.*

2nd Step - *Adjust the travel,* thus: (Fig. 3).

a) Disconnect the return springs.
b) Loosen the lock-nuts of the adjusting rod and remove the clevis pin.
c) Adjust by turning the rod until the desired travel is obtained.
d) Replace the pin and tighten the lock-nut.
e) Replace the return springs.
f) Lower the wheels.

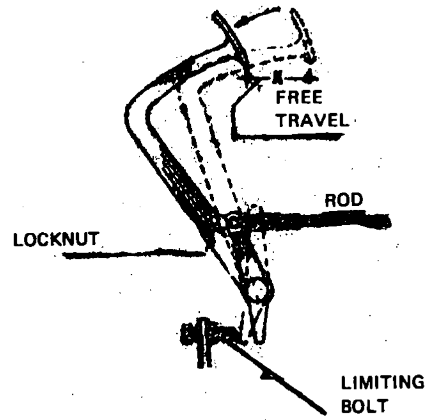


Fig. 3

OBSERVATION

Consult the operator's manual to carry out substep b, of CASE I and substep c, of CASE II.

DIFFERENTIAL LOCK PEDAL

1st Step - *Lift the wheel* on the side where the pedal is located.

2nd Step - *Adjust the travel,* thus:-

a) Loosen the clamp nut which holds the pedal to its shaft.
b) Turn the shaft in a clockwise direction with the spanner. Also, rotate the wheel to completely couple the locking device.
c) Keep the shaft in that position. Lower the pedal leaving between it and the floor the free travel recommended in the operator's manual.
d) Tighten the clamp nut and release the pedal.
e) Lower the wheel.

This operation consists of removing damaged electrical accessories from the tractor and after repair or change, to mount them ensuring their proper functioning.

PROCEDURE

REMOVING AND MOUNTING BATTERIES

1st Step - *Remove the battery,* thus:

a) Prepare a solution of one part of bicarbonate of soda and 10 parts of water.
b) Wash the outside of the battery with this solution, then wash off the solution with plenty of water.
c) Loosen nuts and bolts which hold the terminals (Fig. 1).
d) Remove the terminals.
e) Remove nuts and bolts from the upper frame of the battery tray (Fig. 2).
f) Remove the battery (Fig. 3).

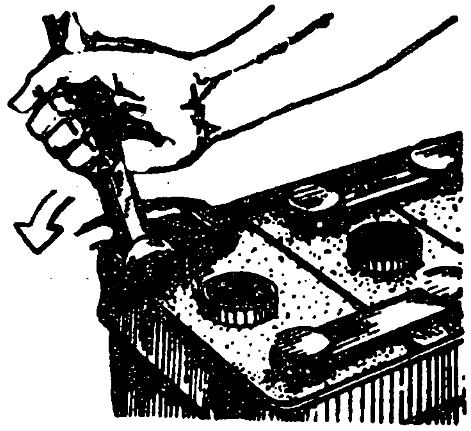


Fig. 1

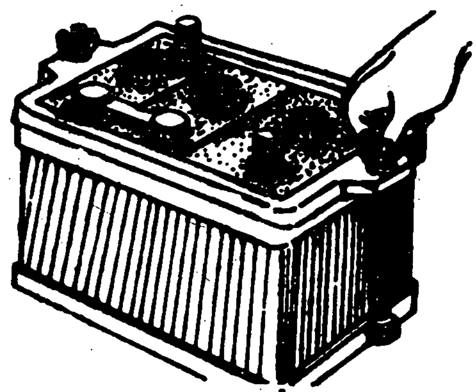


Fig. 2

CAUTION

YOUR CLOTHES SHOULD NOT COME INTO CONTACT WITH THE BATTERY. IT WILL DAMAGE THEM AND CAUSE SKIN BURNS.

OBSERVATION

Avoid metal contacts between the posts of the battery.

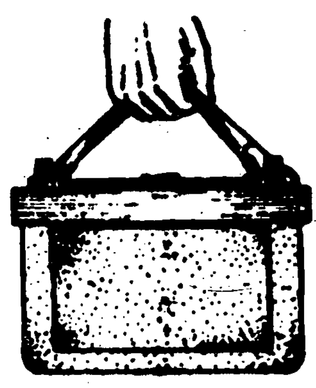


Fig. 3

2nd Step - *Mount the battery,* thus:

a) Put the battery in its tray.
b) Mount the upper frame of the battery.

c) Connect terminals to corresponding posts. Tighten terminals.

d) Cover posts and terminals with grease, vaseline or paint.

REMOVING AND REPLACING GENERATORS

OBSERVATION

To remove and replace any electrical part first disconnect terminals from battery posts.

1st Step - *Remove the generator,* thus:-

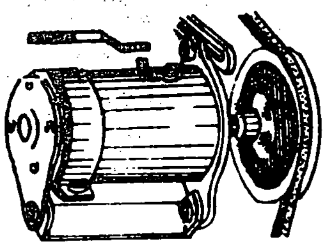


Fig. 4

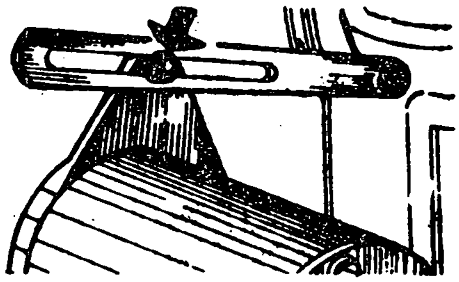


Fig. 5

a) Disconnect the leads and mark their position (Fig. 4).

b) Loosen the bolt which holds the generator to the bracket (Fig. 5).

c) Loosen the securing bolts of the generator and release tension from the belt (Fig. 6).

d) Remove belt.

e) Remove generator.

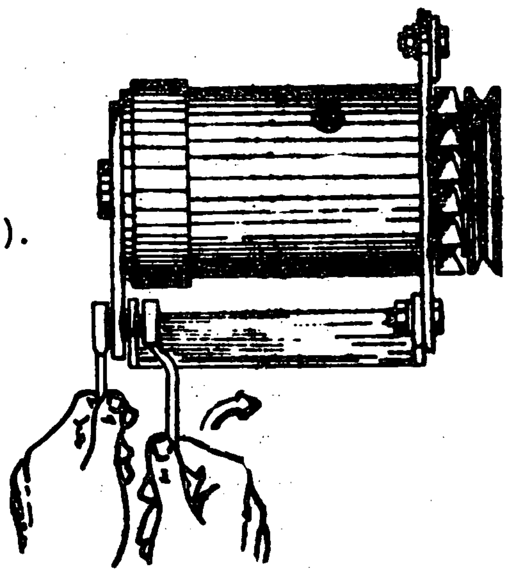


Fig. 6

2nd Step - *Mount the generator.*

a) Place the generator on its mount securing it with the bolts. Do not tighten the bolts.

b) Mount the belt.

c) Adjust the belt and tighten the securing bolts.

d) Connect the terminals, according to their marks.

OBSERVATION

Consult the operator's manual to determine the deflection of the belt.

REMOVING AND MOUNTING STARTER MOTORS

1st Step - *Remove the starter motor,* thus:

a) Disconnect the terminals and mark their position.

b) Remove the connecting link from the shift lever (Fig. 7).

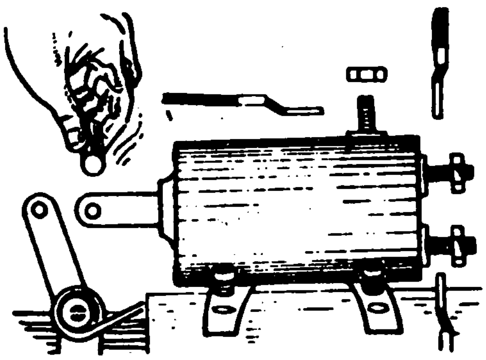


Fig. 7

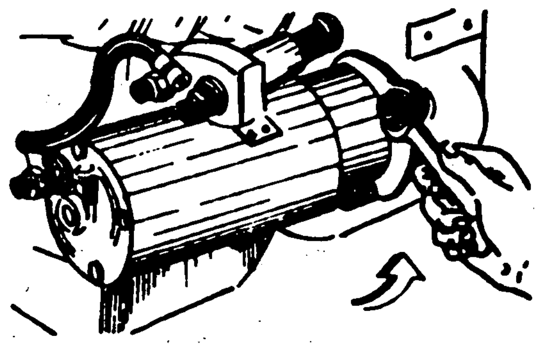


Fig. 8

c) Remove the fastening bolts of the starter motor (Fig. 8).

d) Remove the starter motor.

2nd Step - *Mount the starter motor.*

a) Position the starter motor on its mount.

b) Insert and tighten bolts and nuts.

c) Connect the terminals according to their marks.

d) Replace the connecting link of the shift lever.

REMOVING AND MOUNTING LAMPS

1st Step - *Remove the lamps,* thus:

a) Disconnect the terminals and mark their position.

b) Loosen the securing screws and nuts.

c) Remove the lamps.

d) Disassemble the lamps and remove the bulbs.

OBSERVATIONS

1) If the unit is of the sealed type, change it. It cannot be disassembled.

2) Avoid putting your fingers in the lower part of the reflector.

2nd Step - *Mount the lamps,* thus:-

a) Reassemble the lamp.
b) Put the lamp in its socket.
c) Place and tighten the securing screws. Connect the terminals. according to their marks.

OBSERVATION

If improper functioning of the regulator is suspected, have it checked by the electrician.

REMOVING AND MOUNTING SWITCHES

1st Step - *Remove the switch,* thus:-

a) Disconnect the terminals and mark their position.
b) Loosen the screws and securing nuts.
c) Remove the switch.

2nd Step - *Mount the switch.*

a) Place the switch in its position.
b) Place and tighten the securing screws.
c) Connect the terminals.
d) Check its functioning.

OBSERVATION

Some switches must be connected before securing them. Check the operator's manual.

The preventive maintenance of electrical accessories ensures correct functioning. It also prevents wear and failures during work.

PROCEDURE

1st Step - *Carry out maintenance of battery,* thus:

a) Remove it from the tractor.

b) Clean the battery, tray and clamp. (Fig. 1).

c) Check the charge (Figs. 2 and 3).

d) Add distilled water if necessary.

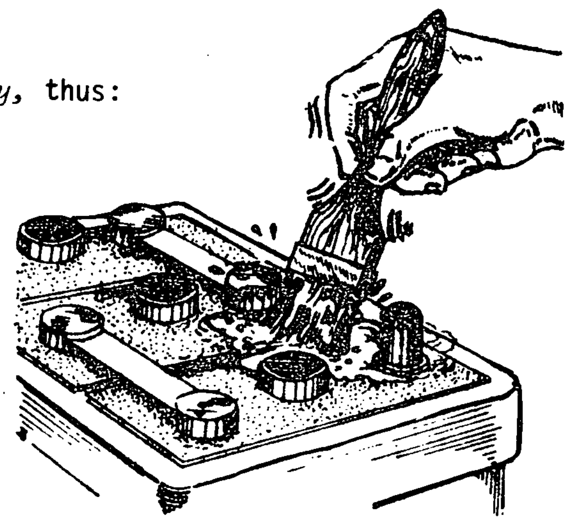


Fig. 1

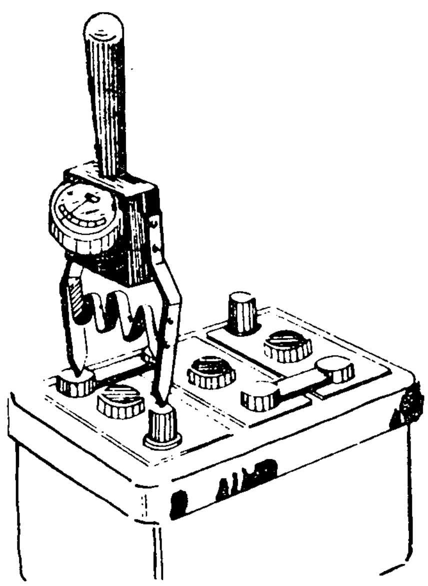


Fig. 2

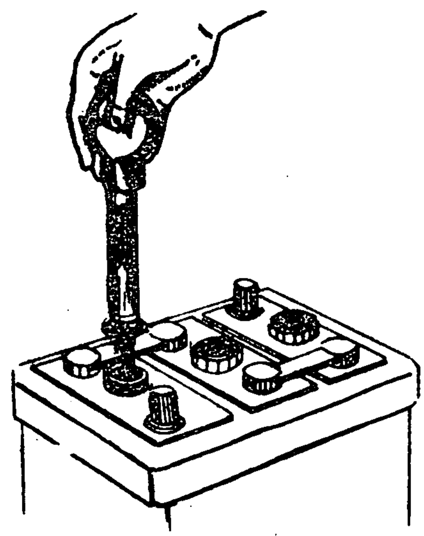


Fig. 3

e) Clean the breather hole on the cap of each cell.

OBSERVATIONS

1) The electrolyte must slightly cover the plates of each cell.

2) Add only distilled water to the electrolyte.

2nd Step - *Carry out maintenance of generator and starter motor*, thus (Fig. 4).

a) Disconnect the terminals and mark their positions.

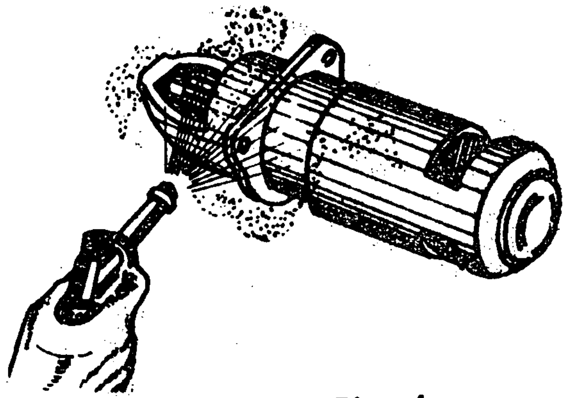
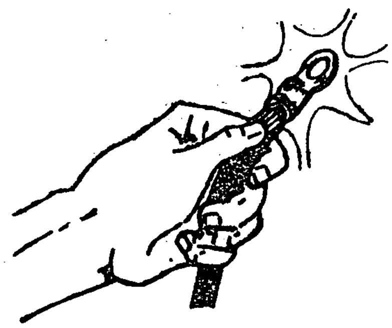


Fig. 4

b) Clean the terminals (Fig. 5).



c) Lubricate.

Fig. 5

OBSERVATION
To lubricate these accessories, oil the places indicated in the operator's manual.

d) Connect the terminals.

3rd Step - *Carry out maintenance of lighting circuit*, thus:-

a) Repair broken and burnt wires.
b) Be sure the focus of the head lamps is correct.

OBSERVATION
Replace the bulbs, the sealed beams and the fuses, if necessary

4th Step - *Carry out maintenance of the switches*, thus:-

a) Clean them with a dry brush or clean rag.
b) Check if the terminals are broken or loose, or if the insulators are cracked.

This is to modify the separation between wheels to fit the work to be done (ploughing, sowing, cultivating and others) (Fig. 1).

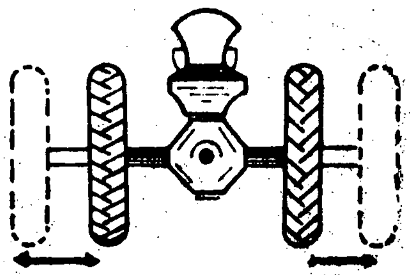


Fig. 1

PROCEDURE

FRONT TRACK WIDTH

1st Step - *Lift the wheels,* thus:-

a) Put the tractor in gear.
b) Chock the wheels.
c) Place a jack under the front of the frame and lift the wheels.

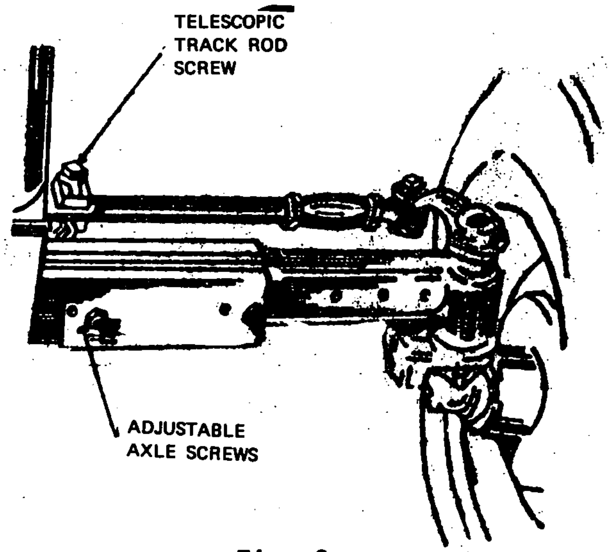


Fig. 2

2nd Step - *Loosen and remove the bolts of the adjustable* axle and telescopic track rod (Fig. 2).

3rd Step - *Adjust the width,* thus:-

a) Regulate the adjustable axle to the required measurement.
b) Adjust the telescopic track rod.
c) Place and tighten bolts.
d) Lower the wheels.

OBSERVATION

Tighten the bolts of the adjustable axle to avoid play.

4th Step - *Check alignment of wheels.*

OBSERVATION
Consult the operator's manual.

REAR TRACK WIDTH

CASE I - MECHANICAL ADJUSTMENT

1st Step - *Loosen the bolts* which hold the wheel to the disc.

2nd Step - *Remove the stop from the adjusting guides. Place* it at the point where the necessary width is obtained (Fig. 3).

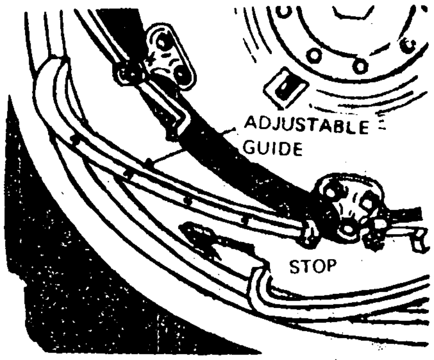


Fig. 3

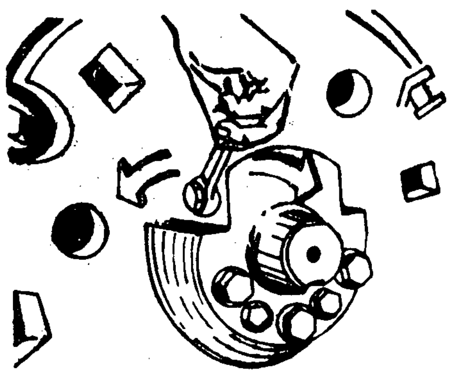
3rd Step - *Adjust the width,* thus:-
a) Move the tractor until the wheel reaches the stop.
b) Check the adjustment.
c) Tighten the bolts.

CASE II - ADJUSTMENT ON REAR AXLES

1st Step - *Loosen the bolts* which hold the wheel to the axle.

2nd Step - *Position the jack and lift the wheel.*

3rd Step - *Slide the wheel along the axle-shaft,* until the necessary measurement is obtained. (Fig. 4).



4th Step - *Tighten bolts and lower the wheel.*

Fig. 4

5th Step - *Complete the tightening of the bolts* which hold the wheel.

CASE III - ADJUSTING BY CHANGING THE POSITION OF DISCS

1st Step - *Loosen the bolts which hold* the wheels.

2nd Step - *Chock and lift the tractor.*

3rd Step - *Remove the wheels.*

4th Step - *Adjust the track width* according to the operator's manual.

5th Step - *Mount the wheels.*

6th Step - *Tighten the bolts.*

7th Step - *Lower the tractor.*

8th Step - *Complete the tightening of the wheel bolts.*

This is to add or remove weight from the tractor using water in the tyres and weights on the wheels or at the front of the frame. This is done to reduce skidding and wheel-spin for certain types of work or to stabilize the machine.

PROCEDURE

CASE I - PUTTING WATER IN THE TYRES

1st Step - *Connect the hose to the water tap.*

2nd Step - *Bring the tractor* close to where the hose was installed and near to the compressed air outlet.

3rd Step - *Lift the wheel which* is to be ballasted and turn it until the valve is at the top.

4th Step - *Put water in the tyre*, thus:

a) Remove the air valve core.

b) Connect the hose to the water adapter. Connect the water adapter to the valve stem.

c) Open the water tap (Fig. 1).

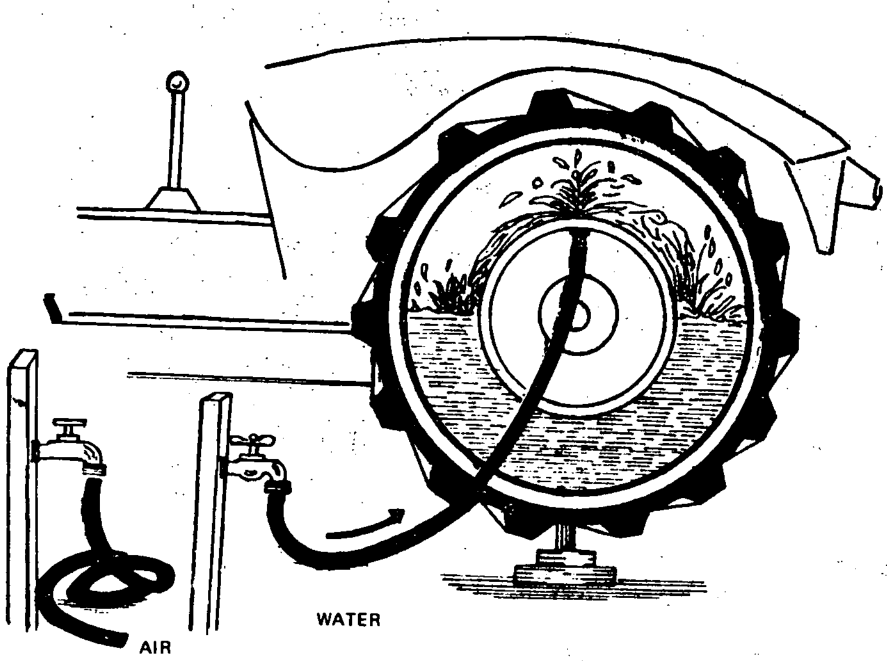


Fig. 1

d) Stop the flow of water, when water flows from the air breather on the adapter.

5th Step - *Check the air pressure,* thus:

a) Remove the adapter.
b) Install the air valve.
c) Add air to the tyre and check if pressure is as recommended.
d) Replace the dust cap.

6th Step - *Lower the wheel.*

CASE II - REMOVING WATER FROM THE TYRES

1st Step - *Drive the tractor* close to the compressed air outlet.

2nd Step - *Lift the wheel and turn* it until the valve is at its lower position.

3rd Step - *Remove the air valve* and allow the water to run out. (Fig. 2).

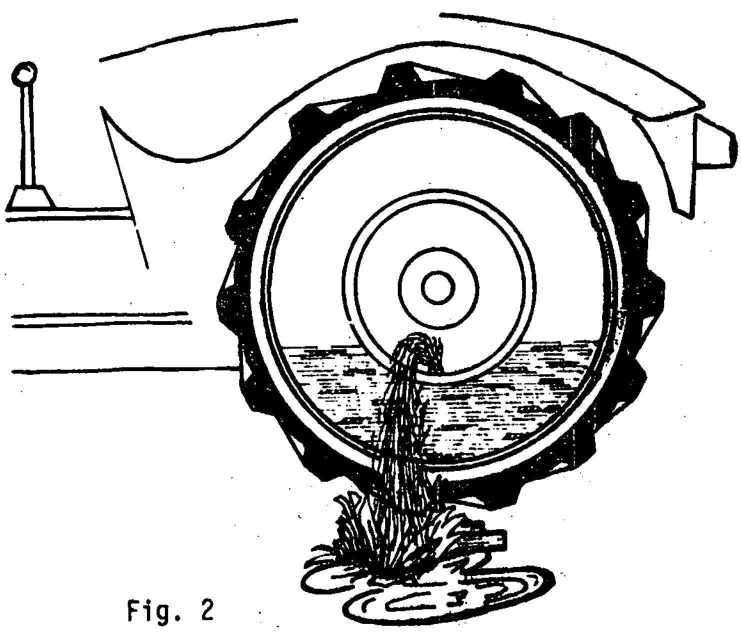


Fig. 2

4th Step - *Change the air pressure.*

5th Step - *Lower the wheel.*

CASE III - ADDING WEIGHTS

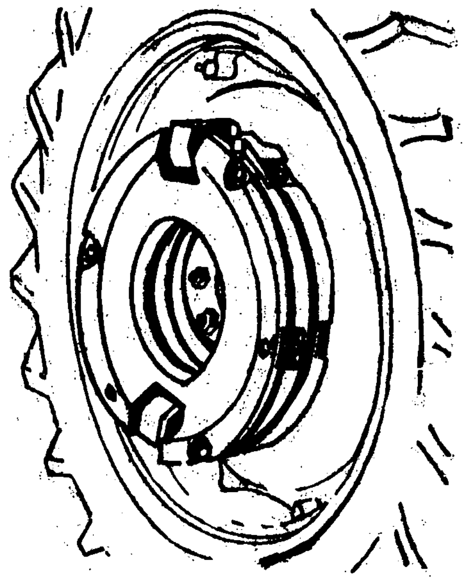
1st Step - *Place the weight* in its position.

2nd Step - *Secure it* with nuts and bolts.

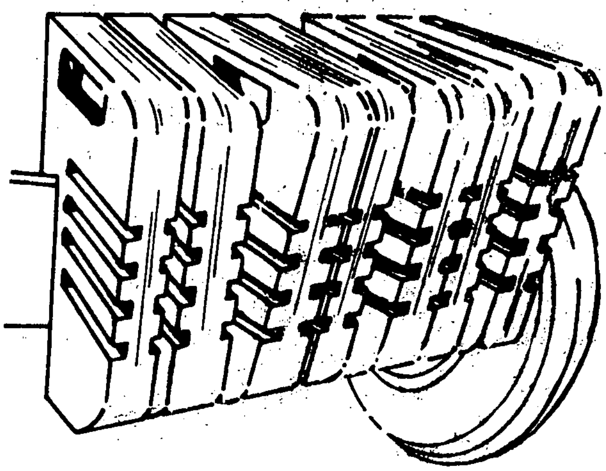
CASE IV - REMOVING WEIGHTS

1st Step - *Loosen nuts and bolts.*

4th Step - *Remove the weight.*



Rear wheel ballast



Front of frame ballast

CAUTION

SEEK HELP TO MOUNT AND REMOVE WEIGHTS.

TECHNICAL VOCABULARY

Air Valve Core = Insert.

This operation consists of removing the tyre from the rim to repair the inner tube or change the tyre when necessary.

PROCEDURE

1st Step - *Remove the wheel of the tractor,* thus:

a) Place the tractor on level ground.
b) Chock the front wheels.
c) Apply the hand brake.
d) Shift to a low gear.
e) Loosen the nuts which hold the wheel.

f) Place a jack under the rear axle and lift the wheel (Fig. 1).

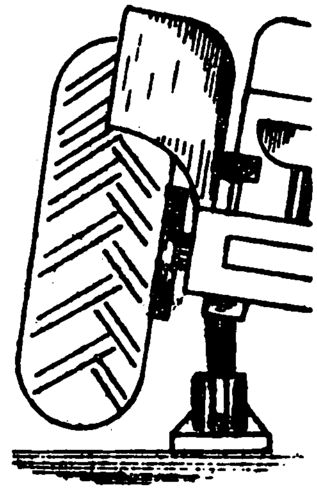


Fig. 1

CAUTION
MAKE SURE THE JACK IS FIRMLY SEATED AND WILL NOT SLIP.

g) Remove the nuts from the wheel.
h) Remove the wheel from the tractor.

2nd Step - *Dismount one side of the tyre from the rim,* thus:-

a) Lubricate the bead of the tyre with soap water.
b) Remove the air valve core and let out the air.
c) Remove the nut from the valve stem.

d) Press the bead downward (Fig. 2).

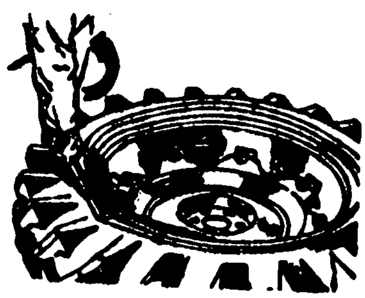


Fig. 2

OBSERVATION

Use a tyre lever to press the bead downwards. Work on short sections around the tyre until the bead leaves the flange. Do this on both sides.

e) Place a tyre lever between the bead and the flange of the rim (Fig. 3).

Fig. 3

OBSERVATION

Make sure that the point of the lever does not pinch the inner tube.

f) Lift the bead of the tyre with the lever.

g) Place another lever beside the first one and work it until the bead is lifted over the flange of the rim (Fig. 4).

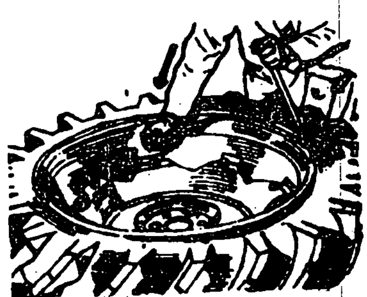


Fig. 4

OBSERVATION

With the first lever keep the portion of bead above the rim.

h) Remove the second lever and push it in further around.

i) Keep lifting the bead from the rim with the second lever.

OBSERVATION

Carry out this sub-step over short sections until the entire bead is removed from the rim.

3rd Step - *Remove the inner tube* thus:-

a) Push the valve stem through the hole in the rim.

b) Place two wooden blocks to hold the bead away from the rim (Fig. 5).

c) Remove the blocks and the inner tube at the same time.

Fig. 5

4th Step - *Remove the rim from the other side of the tyre,* thus:-

a) Place the wheel in a vertical position.

b) Place a tyre lever between the bead and the flange of the rim (Fig. 6).

c) Work the lever until the rim is removed.

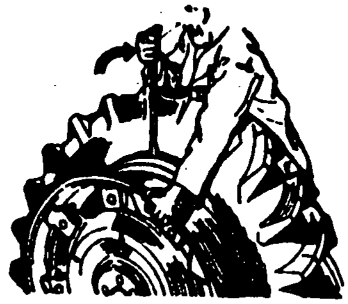


Fig. 6

MOUNTING TYRES

1st Step - *Mount one side of the tyre on the rim,* thus:-

a) Place the rim on the ground horizontally with the valve hole upwards.

b) Lay the tyre on the rim and press until part of the bead is under the flange.

c) Place a lever as near as possible to the place where the bead is below the flange.

d) Work the lever until the bead is completely under the flange.

2nd Step - *Place the inner tube in the tyre,* thus:-

a) Place the valve stem in the hole of the rim and secure it with the nut.

b) Place the inner tube in the tyre and rim.

OBSERVATION

Partially inflate the inner tube to set it in place and avoid pinching it when mounting the tyre. Afterwards, let out all the air.

3rd Step - *Mount the other side of the tyre on the rim,* thus:-

a) Carry out sub-steps b and c of the first step.

b) Work the levers until the bead is entirely under the flange (Fig. 7).

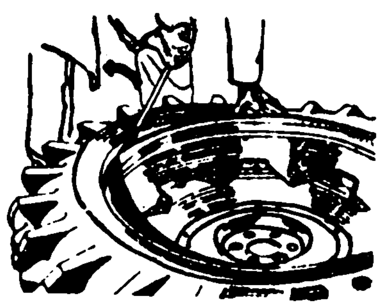


Fig. 7

c) Inflate the inner tube to the recommended pressure.

4th Step - *Mount the wheel on the tractor,* thus:-

a) Place the wheel in front of the hub.
b) Center the holes of the rim with the lugs on the hub.
c) Place the wheel on the hub.
d) Place and tighten the nuts.
e) Lower the jack until the wheel slightly touches the ground.
f) Finish tightening the nuts in an alternate manner (Fig. 8).

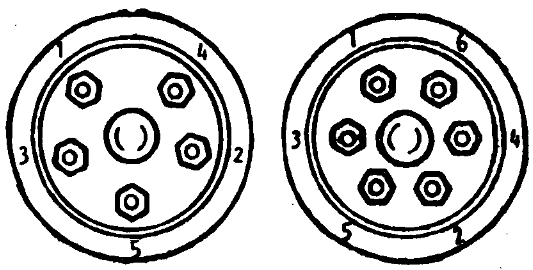


Fig. 8

g) Remove the jack.

This is to remove the inner tube from the wheel, locate the damage and repair it. This care extends tyre life and enables the tractor, machine or implement to continue working.

PROCEDURE

1st Step - *Remove the inner tube.*

2nd Step - *Locate the damage,* thus:

a) Inflate the inner tube.

b) Hold the tube under water to locate the damage. Turn the tube until you see bubbles. These will indicate the leaks (Fig. 1).

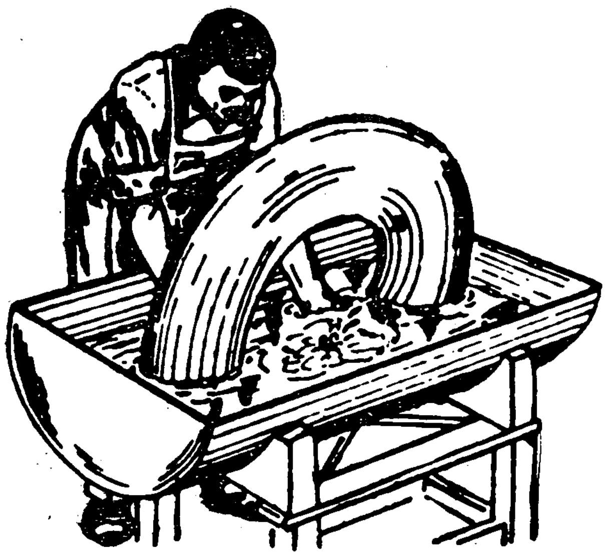


Fig. 1

c) Mark the puncture.

d) Let the air out.

3rd Step - *Repair the tube,* thus:

a) Clean around the puncture with gasoline to remove grease.

b) Scrape the punctured area with a file or sandpaper.

c) Remove the protecting cover from the patch. Then, place the patch over the puncture.

d) Put the tube with the patch in a press.

e) Light the fuel in the metal box (Fig. 2).

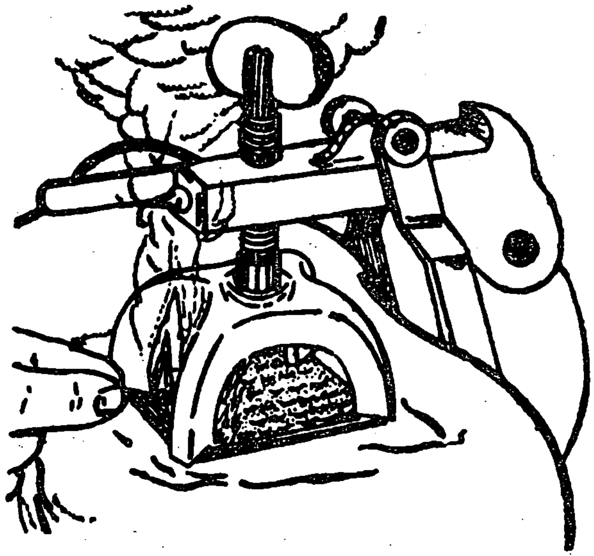


Fig. 2

f) Remove the tube from the press after 5 minutes.
g) Inflate the tube and hold it under water to check the repair.
h) Let the air out.

OBSERVATION
If the damage is large, take the tube to a vulcanizing plant.

4th Step - *Put the tube* in the wheel.

OBSERVATION
Make sure that the tyre is free from any objects which might puncture the tube again.

5th Step - *Inflate the inner tube* to the recommended pressure.

OBSERVATION
Ballast the wheel with water if necessary.

CINTERFOR
1st. Edition

RURAL SECTOR
Agricultural

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 1.4-15

This is to hitch the draw-bar of an implement to the draw-bar of the tractor in order to use the implement and unhitch it after the work is completed (Fig. 1).

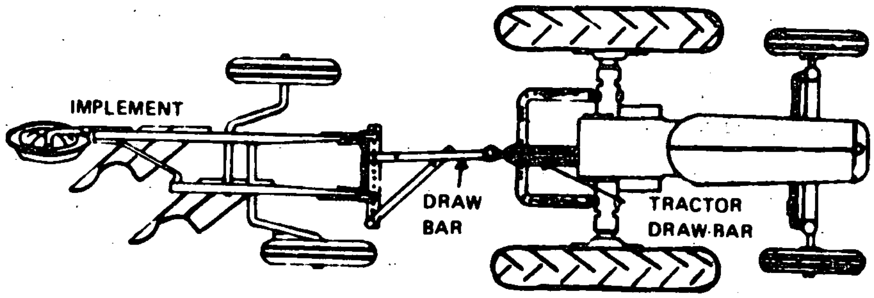


Fig. 1

PROCEDURE

1st Step - *Hitch the implement,* thus:

a) Reverse the tractor slowly. Line up the holes on the draw-bar (Fig. 2).

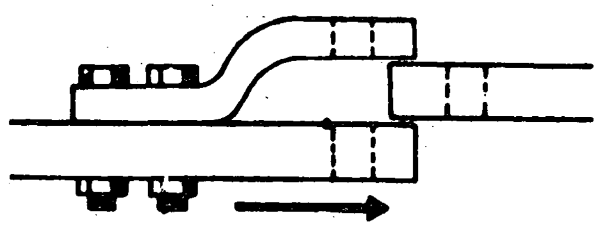


Fig. 2

b) Insert the pin (Fig. 3).

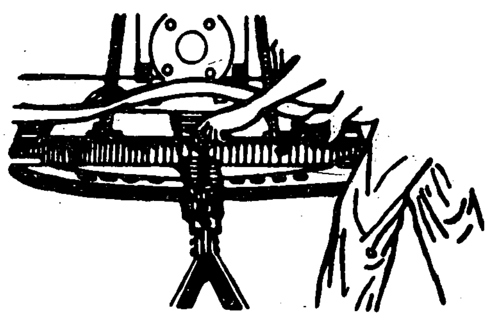


Fig. 3

SAFETY MEASURE

BEFORE GETTING OFF THE TRACTOR TO INSERT THE PIN, ENGAGE THE HAND BRAKE.

2nd Step - *Unhitch the implement,* thus:-

a) Take the implement to the chosen place.
b) Place a support to lift the implement's drawbar.
c) Remove the pin (Fig. 4).
d) Move the tractor.

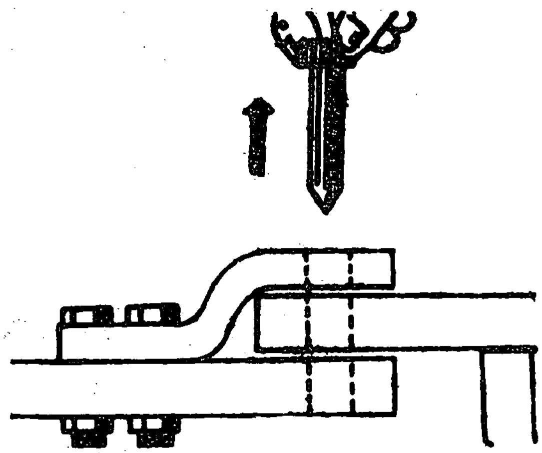


Fig. 4

This is to couple the drive shaft of a stationary machine or implement to the power take-off shaft of the tractor. The coupling will transmit the rotary movement needed. The operation is completed by uncoupling the implement after work.

PROCEDURE

1st Step - *Couple to the power take-off shaft,* thus:

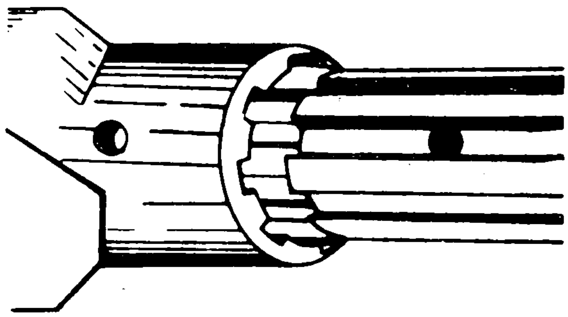


Fig. 1

a) Remove the cover from the power take-off shaft.
b) Couple the drive shaft to the power take-off shaft making sure that the holes coincide (Fig. 1).
c) Insert the pin.
d) Check the drive shaft's safety guards.

2nd Step - *Uncouple the power take-off shaft,* thus:

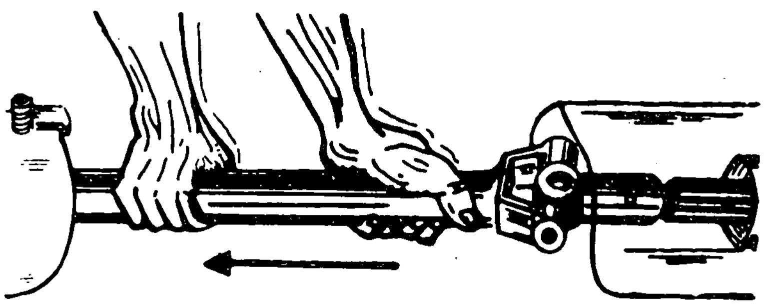


Fig. 2

a) Remove the pin.
b) Uncouple the drive shaft (Fig. 2).
c) Replace the cover over the power take-off shaft.

SAFETY MEASURE

WHEN CARRYING OUT THIS OPERATION, THE ENGINE MUST BE SWITCHED OFF.

CBC

OPERATION:

HITCHING, ADJUSTING AND UNHITCHING INTEGRAL MOUNTED IMPLEMENTS

REF. OS.014 1/2

Caribbean

This is to hitch and unhitch an implement to the three-point linkage of the tractor and to align crosswise and lengthwise with relation to the ground.

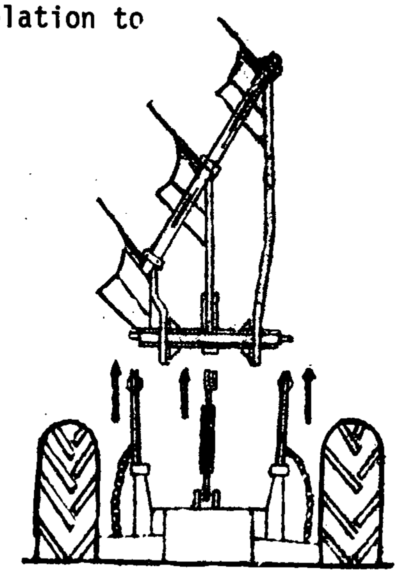


Fig. 1

PROCEDURE

1st Step - *Hitch the implement,* thus:-

a) Slowly reverse the tractor and get the hydraulic lift arms near the hitch points of the implement (Fig. 1).
b) Stop the tractor.
c) Actuate the hydraulic controls so that the hitch points coincide.
d) Hitch the lower left arm and insert the pin (Fig. 2).
e) Adjust the lower right arm to the necessary height by cranking the levelling box (Fig. 3).
f) Hitch the lower right arm and insert the pin (Fig. 4).
g) Adjust the top link until it coincides with the upper hitch point of the implement (Fig. 5).
h) Hitch the top arm and insert the pin.

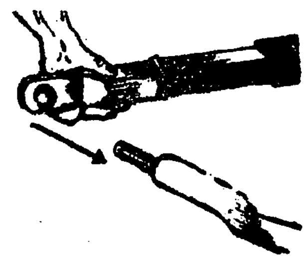


Fig. 2

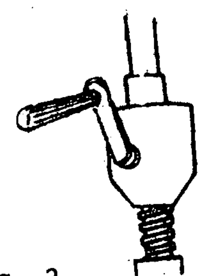


Fig. 3

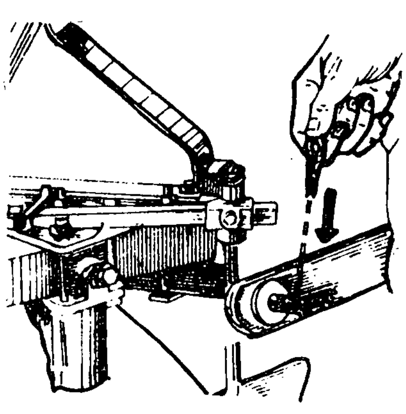


Fig. 4

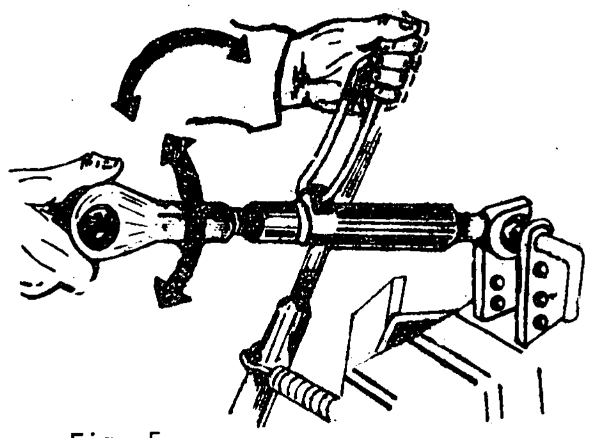


Fig. 5

2nd Step - *Adjust crosswise and lengthwise,* thus:-

a) Take the implement to level ground.

b) Lower the implement.

c) Adjust crosswise by cranking the levelling box until the frame of the implement is parallel to the ground (Fig. 6).

d) Adjust lengthwise by extending or shortening the top link until the frame of the implement is parallel to the ground (Fig. 7).

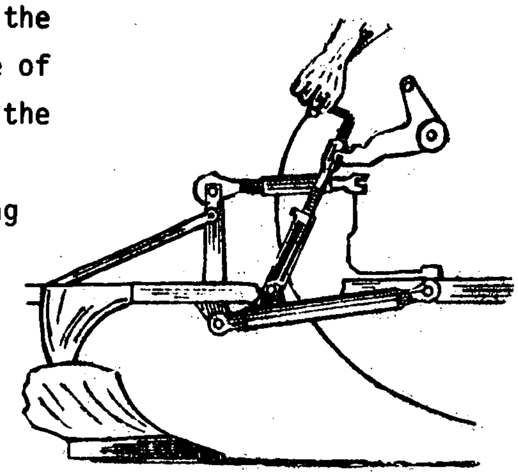


Fig. 6

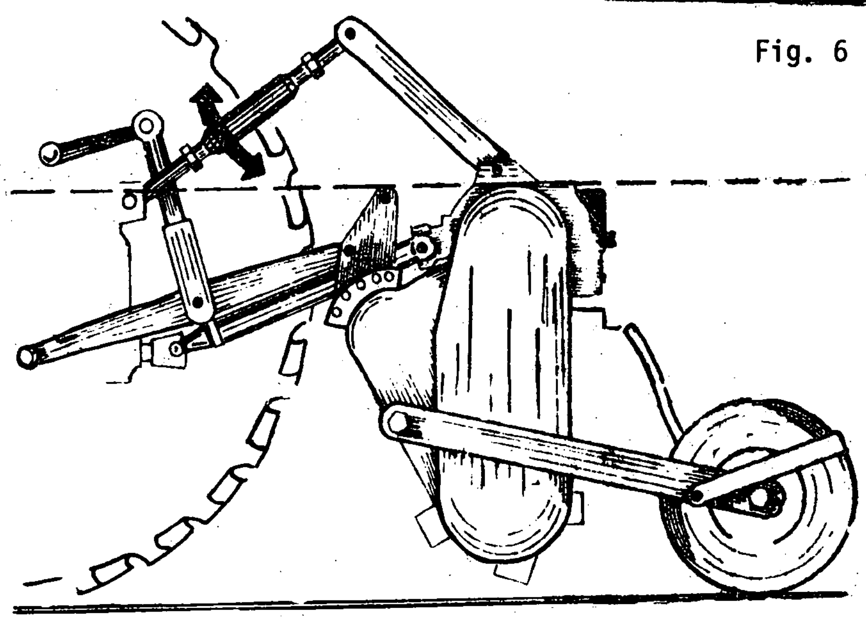


Fig. 7

3rd Step - *Unhitch the implement,* thus:-

a) Take the implement to the chosen spot.

b) Support the implement.

c) Lower the implement.

d) Unhitch the top link.

e) Unhitch the lower left link.

f) Unhitch the lower right link.

g) Move the tractor.

This is to connect and disconnect hoses to the hydraulic systems of implement and tractor. These hoses carry oil to the hydraulic system of the implement. When they are connected; the implement can be controlled from the tractor. The hoses are disconnected after the work is completed.

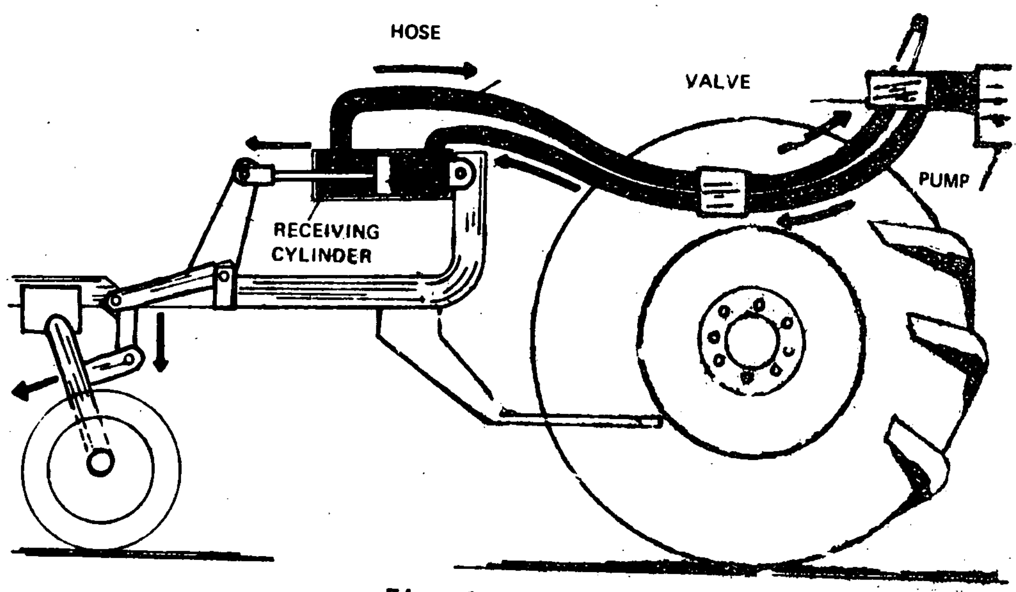


Fig. 1

METHOD OF EXECUTION

CONNECTING REMOTE CONTROL

CASE I - FAST CONNECTION

1st Step - *Prepare the tractor and the implement,* thus:

a) Clean the fittings of the hose.
b) Cut off the pressure from the hydraulic system.
c) Remove the dust covers.

2nd Step - *Connect the remote control,* thus:

a) Connect the end of the hose to the oil outlet fitting (Fig. 2).
b) Check the connection.

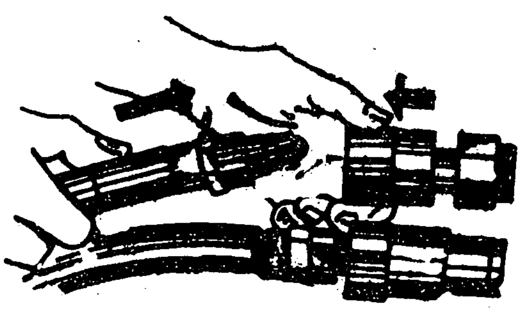


Fig. 2

CASE II - SCREW-ON CONNECTION

Prepare the tractor and implement, thus:

a) Clean the plugs and nozzles.
b) Cut off the oil pressure.
c) Remove the plug.

2nd Step - *Connect the remote control,* thus:-
a) Screw the swivel of the hose to the fitting of the oil outlet (Fig. 3).
b) Check the connection.

OBSERVATION
To check the functioning of the remote control, use the control or levers only according to the instructions in the operator's manual.

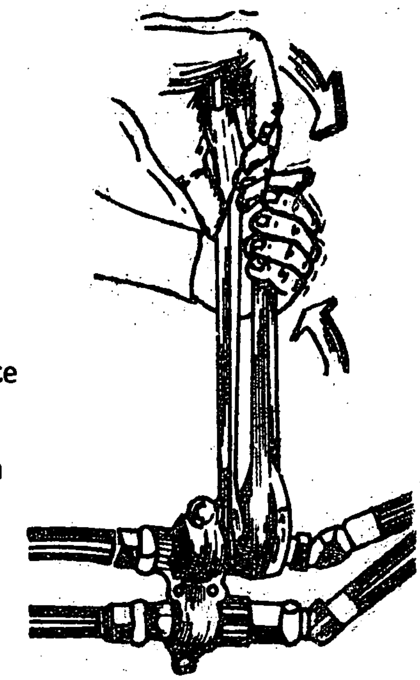


Fig. 3

DISCONNECTING THE REMOTE CONTROL

CASE I - FAST DISCONNECTION

1st Step - *Cut off the oil pressure.*

2nd Step - *Slide the fitting backwards and remove the hose.*

3rd Step - *Replace the dust covers.*

CASE II - DISCONNECTING SCREW-ON CONNECTION

1st Step - *Cut off the oil pressure.*

2nd Step - *Screw off the swivel.*

3rd Step - *Replace the plugs.*

OBSERVATION
Check the oil level of the hydraulic system when using the remote control. Consult the operator's manual.

This operation is to prepare and operate the mower to cut the grass or stubble from the harvest, to mow fields and prepare them for raking, ploughing or weed control.

PROCEDURE

1st Step - *Hitch the machine.*

2nd Step - *Adjust the machine.*

CASE I - INTEGRAL MOUNTED MOWER

a) Adjust crosswise.
b) Adjust lengthwise.
c) Adjust the cutting height by actuating the hydraulic system and the rear wheel of the machine (Fig. 1).
d) Place the stop.

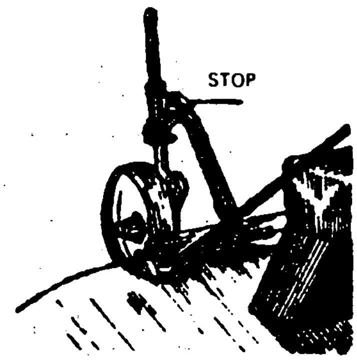


Fig. 1

CASE II - TRAILED MOWER

a) Adjust the cutting height by actuating the control mechanism (Fig. 2).
b) Adjust lengthwise by varying the position of one or both drawbars (machine and tractor).

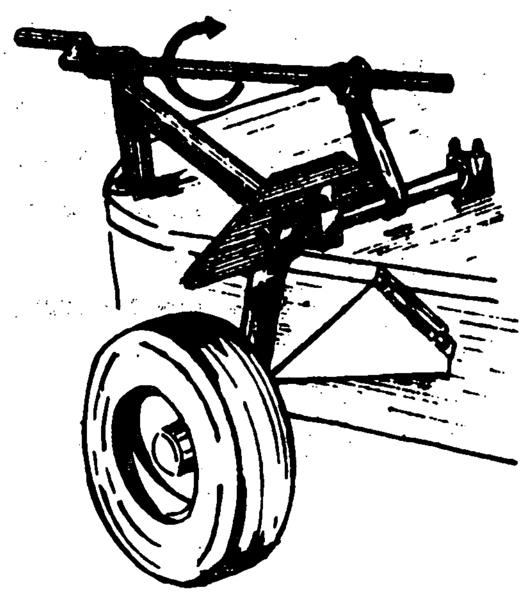


Fig. 2

OBSERVATION

Consult the operator's manual in order to make the adjustments.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 1.5-71

3rd Step - *Take the machine to the field.*

4th Step - *Mow the field,* thus:-

a) Inspect the field.
b) Mark out the obstacles.
c) Lower the machine to its working position.
d) Engage the power take-off shaft.
e) Begin the working operation.

OBSERVATION
Do not make sharp turns. These will break the universal joints.

f) Check for the correct adjustments.

SAFETY MEASURE

IF ANY FURTHER ADJUSTMENT IS NECESSARY, SWITCH OFF THE TRACTOR'S ENGINE.

g) Complete the operation.

5th Step - *Park the machine,* thus:

a) Take it to the maintenance area.
b) Carry out the maintenance.
c) Take it to the parking area.
d) Unhitch.
e) Move the tractor.

This operation consists of lifting different materials from the ground and unloading them at another place on a vehicle using a loader mounted on the tractor (Fig. 1).

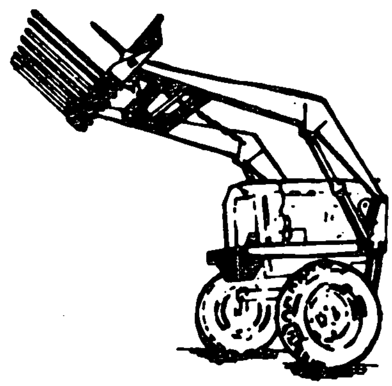


Fig. 1

PROCEDURE

1st Step - *Hitch the loader,* thus:-

CASE I - FRONT MOUNTED LOADER

a) Raise the supports of the loader until the hitch points coincide.

b) Place and tighten the bolts and nuts.

c) Couple the shovel to the arms of the loader.

d) Connect the hydraulic rams.

e) Connect the mechanical unloading system of the shovel.

f) Connect the remote control.

CASE II - REAR MOUNTED LOADER

a) Hitch the loader to the three point linkage.

b) Adjust crosswise.

OBSERVATIONS

1) Adjust the track width of the tractor to the maximum when working with any loader.

2) Place weights opposing the position of the loader in order to balance the equipment.

2nd Step - *Transport the implement to the working site.*

OBSERVATION

Transport the loader keeping it as near as possible to the ground.

3rd Step - *Operate the loader,* thus:-

a) Take the shovel near to the load, driving the tractor at the appropriate speed.
b) Push the shovel into the load and at the same time lift it to the necessary height.
c) Transport the load to the indicated area keeping the shovel as low as possible.
d) Lift the load and empty the shovel.

OBSERVATIONS

1) Manoeuver the loader carefully; jerky movements may cause damage.

2) Actuate the loading and lifting controls gently.

CAUTION

ALWAYS WORK ON FLAT GROUND

4th Step - *Park the implement.*

a) Take it to the maintenance area.
b) Carry out maintenance.
c) Take it to the parking area.
d) Unhitch the implement.
e) Move the tractor.

Using the trailer or train of trailers hitched to a tractor to transport products within and out of a cattle and crop farm (Fig. 1).

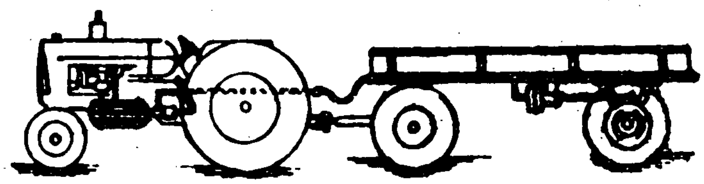


Fig. 1

PROCEDURE

TRAILER

1st Step - *Hitch the trailer.*

2nd Step - *Operate the trailer* thus:-

a) Install the brake locking pin.
b) Transport the trailer to the loading area.

OBSERVATION
The trailer has a fixed load capacity. Any overloading may cause damage or accidents.

3rd Step - *Transport the trailer* to the unloading area.

TRAILER TRAIN

1st Step - *Form the trailer train* thus:-

a) Hitch the first trailer to the tractor with a chain or hitch the draw-bars and insert the pin.
b) Move the tractor slowly until the chain is taut.
c) Take the trailer to the place selected for forming the train.
d) Unhitch the trailer.

e) Hitch the second trailer with the chain. Slowly tow it towards the first one until the two coupling holes are in line, and insert the pin (Fig. 2).

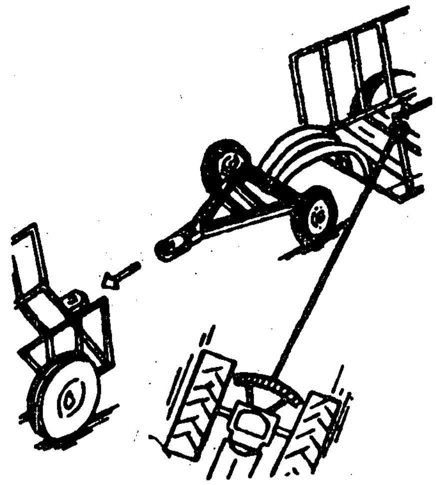


Fig. 2

f) Repeat the above sub-step to hitch the other trailers.

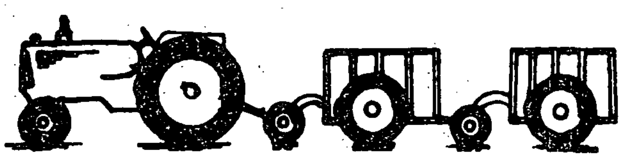


Fig. 3

g) Hitch the train to the tractor and take it to the work area.

OBSERVATIONS

1) Make sure that the trailers roll freely.

2) Make sure that the brakes are connected and work properly.

3) Bends must be taken wide and at low speed to prevent the trailers from leaving the road.

4) Observe the traffic laws.

5) An assistant is needed when forming the train.

This operation consists of spreading in the field the chemical or organic fertilizers required to balance the nutrients of the soil so that the crops may develop properly.

PROCEDURE

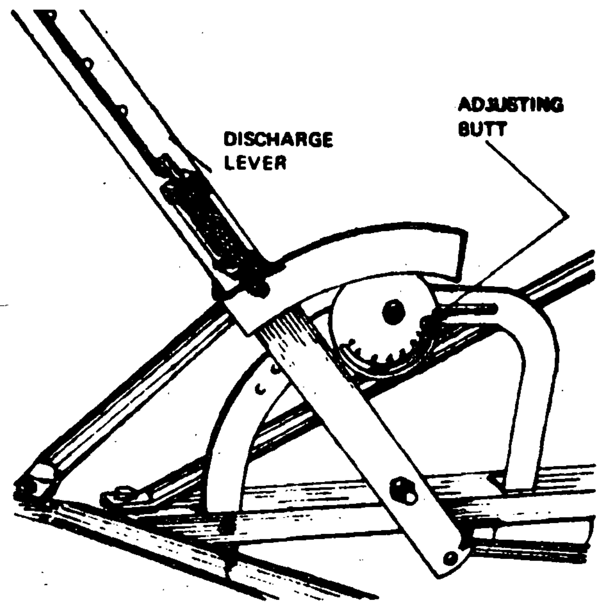
FERTILIZER

1st Step - *Hitch the machine.*
2nd Step - *Take the machine* to the field.
3rd Step - *Load it with fertilizer.*
4th Step - *Adjust the flow of fertilizer* thus:-

a) Loosen the adjusting butt.

b) Move the lever for adjusting the size of the outlets (Fig. 1).

c) Tighten the adjusting butt.



OBSERVATION
Consult the operator's manual for this step.

Fig. 1

4th Step - *Fertilize* thus:-
a) Place the tractor at the spot where fertilizing will begin.
b) Operate the fertilizer outlet lever and begin spreading.
c) Operate the lever to cut off the flow of fertilizer at the end of the run.
d) Continue making parallel runs until spreading is completed.

MANURE SPREADER

1st Step - *Hitch the spreader and load it with manure.*

2nd Step - *Take the spreader* to the field.

3rd Step - *Adjust:*

a) The tension of the conveyor.

b) The lever of the feeding arm (Fig. 2).

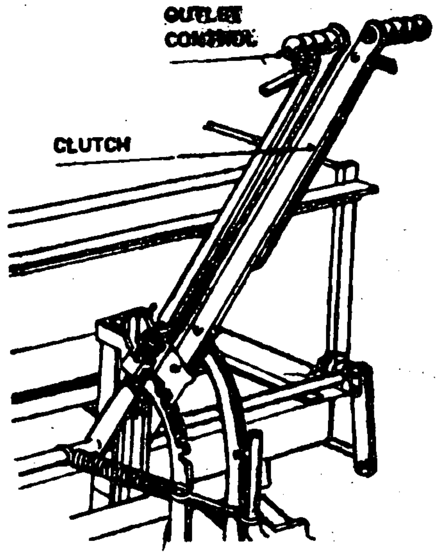


Fig. 2

OBSERVATION
Consult the operator's manual for this step.

4th Step - *Spread the manure* thus:-
a) Place the loader spreader at the spot where application will begin.
b) Begin the spreading by engaging power take-off (if this system is used) or engaging the clutch coupling by means of the corresponding lever.
c) Continue spreading in parallel runs, disengaging the clutch or power drive at each turn.

5th Step - *Park the spreader* thus:-
a) Take it to the maintenance area.
b) Carry out maintenance.
c) Take it to the parking area.
d) Unhitch the spreader.
e) Move the tractor.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 1.5-26

Adjusting and operating the harrow to break up clods, bury plant residues and level the land to make planting easy.

PROCEDURE

1st Step - *Hitch the implement.*

2nd Step - *Adjust the mud scrapers* thus:-

a) Loosen the securing nuts and bolts.
b) Adjust for the correct distance between the scraper and the disc.

3rd Step - *Take it to the field (Fig. 1).*

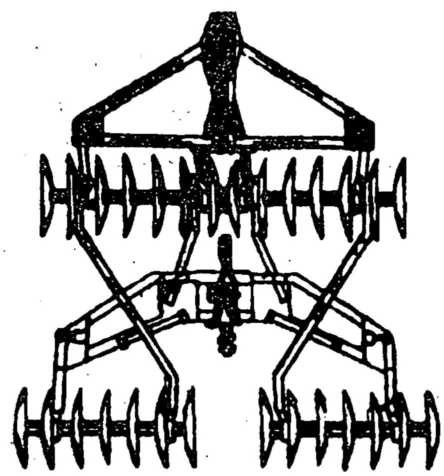


Fig. 1

4th Step - *Adjust* thus:-

CASE I - INTEGRAL MOUNTED HARROW

a) Adjust crosswise by means of the lower lift arm.
b) Level the implement lengthwise by adjusting the third point of the tractor.
c) Set the gangs at the angle desired, and adjust depth with the hydraulic lift control system.

CASE II - TRAILING HARROW

a) Adjust lengthwise by varying the height of the hitch of the implement.
b) Set the cutting angle of the gangs of the harrow.

5th Step - *Harrow* thus:

a) Place the harrow at one side of the field.
b) Place it in working position (Fig. 2).

c) Begin harrowing: in rows, contouring or in circles.
d) Check the adjustments.

OBSERVATIONS

1) If the implement is integral mounted, always lift it when turning.

2) If the implement is of the offset type, always turn towards the left.

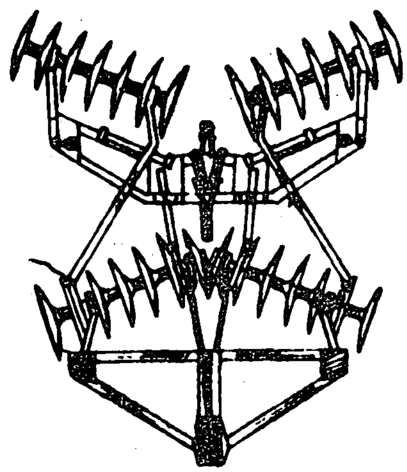


Fig. 2

e) Harrow until the field is completed.

6th Step - *Park the harrow* thus:-

a) Take it to maintenance area.
b) Carry out maintenance.
c) Take it to parking area.
d) Unhitch.
e) Move the tractor.

This is to operate the tine harrow mainly to break up the crust of the soil, to remove harvest residues or weeds, and to prepare the soil for planting.

PROCEDURE

1st Step - *Hitch the tine harrow.*

2nd Step - *Adjust it.*

CASE I - INTEGRAL MOUNTED HARROW (Fig. 1)

a) Adjust it crosswise using the lower lift arms.
b) Use the third point to adjust it lengthwise.
c) Adjust the depth by operating the lever of the hydraulic system.

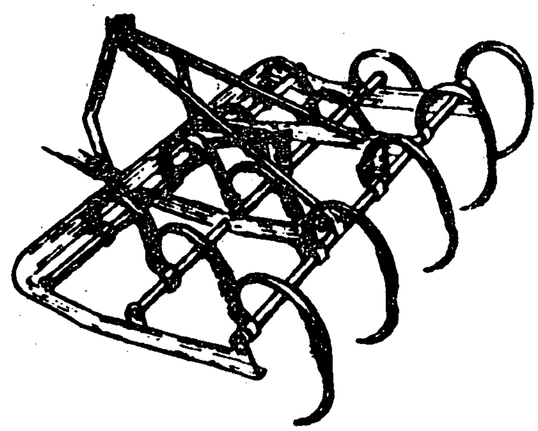


Fig. 1

CASE II - TRAILING HARROW

a) Adjust it lengthwise. Both drawbars of tractor and implement should be parallel to the ground.
b) Adjust the depth by working the lever which lifts all the tines or by sliding them vertically one by one, (Figs. 2 and 3).

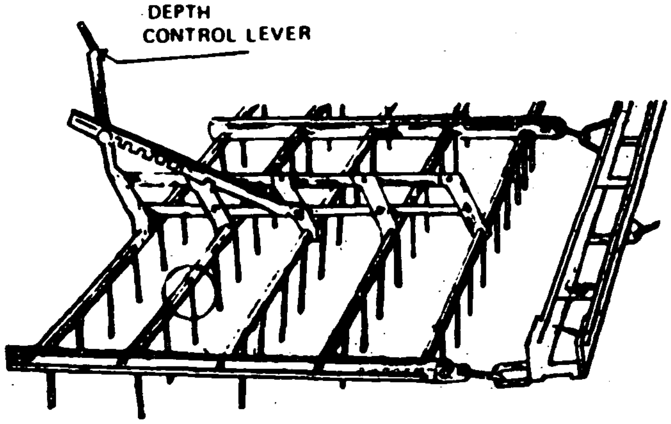


Fig. 2

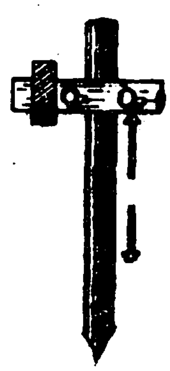


Fig. 3

3rd Step - *Take the implement to the field.*

4th Step - *Harrow* thus:-

a) Place the implement at the boundary of the field.
b) Place it in working position.
c) Begin harrowing.
d) Check adjustments.
e) Harrow until the task is completed.

5th Step - *Park the implement* thus:-

a) Take it to the maintenance area.
b) Carry out maintenance.
c) Take it to the parking area.
d) Unhitch the implement.
e) Move the tractor.

This operation is to break the impermeable layers of the soil where the ordinary plough does not reach. By breaking the stiff clay subsoils, water circulates freely and the root system of the plant develops better (Fig. 1).

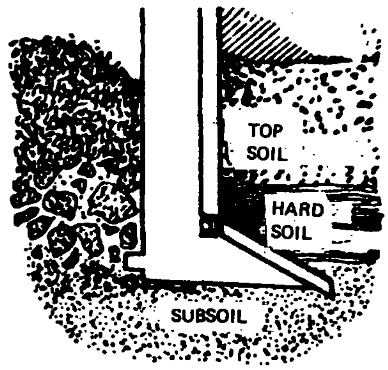


Fig. 1

PROCEDURE

1st Step - *Hitch the implement.*

2nd Step - *Take the sub-soiler to the field.*

3rd Step - *Adjust the sub-soiler,* thus:

a) Crosswise, by means of the lower lift arm.
b) Lengthwise, by adjusting the top link.
c) Working depth, with the hydraulic system of the tractor, or with depth wheels or skids.

OBSERVATIONS

1) With the integral-mounted sub-soiler the depth is controlled with the hydraulic system lever.

2) Consult the operator's manual when adjusting the depth of the trailed sub-soiler.

4th Step - *Carry out sub-soiling,* thus:

a) Position the tractor to begin the work.
b) Lower the implement.
c) Work at the recommended depth.
d) Lift the subsoiler at the end of the field
e) Continue subsoiling in consecutive parallel lines until the task is completed.

5th Step - *Park the implement.*

a) Take it to the maintenance area.
b) Carry out maintenance.
c) Take it to the parking area.
d) Unhitch the implement.
e) Move the tractor.

This is to break and turn over the top-soil using the plough. The purpose of this operation is to loosen, aerate and incorporate organic matter in the soil.

PROCEDURE

1st Step - *Take the plough* to the field.

2nd Step - *Make the headland mark* with the last outer disc thus:

a) Extend the top link sufficiently to allow the last disc to plough (Fig. 1).

b) Drive the tractor around the field lifting the plough at the corners.

c) Control the depth of the furrow with the lever of the hydraulic system making it shallower than the final depth.

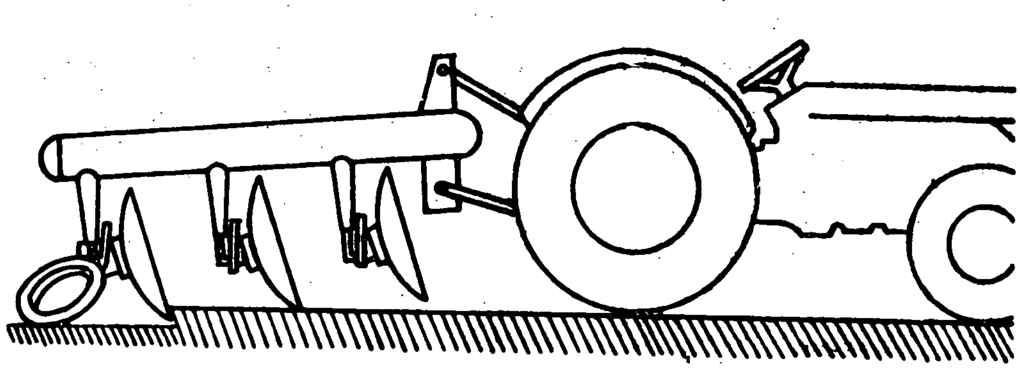


Fig. 1

3rd Step - *Check the adjustment* of the scrapers.

4th Step - *Begin the first ridge* ploughing from the centre outwards thus:-

a) Place the tractor where the centre line of the ridge begins and lower the plough.

b) Adjust crosswise and lengthwise.

c) Plough in a straight line to the end of the ridge (Fig. 2).

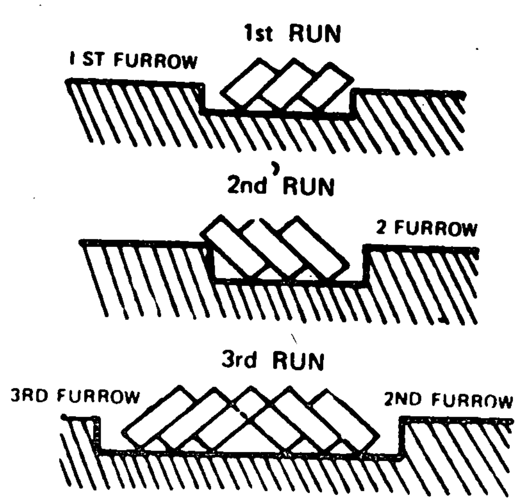


Fig. 2

d) Control the ploughing depth with the lever of the hydraulic system making it shallower than the final depth.

e) Make the second and third runs increasing the depth. Drive the tractor making the front wheels run inside the furrow made by the outer disc during the first run.

5th Step - Make the necessary adjustment *to the plough* to continue ploughing thus:-

a) Place the tractor with the right wheels in the furrow to begin the fourth run.

b) Adjust the plough crosswise keeping it parallel to the ground (Fig. 3).

c) Check the lengthwise adjustment while ploughing and adjust if necessary so that the discs turn over the same amount of earth.

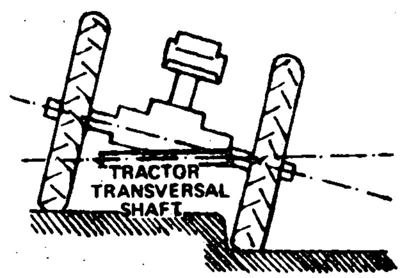


Fig. 3

d) Adjust the ploughing depth following the operator's manual.

e) Set the position of the lever of the hydraulic system to obtain the required depth.

f) Place a stop in order to mark how far the lever should go while ploughing.

g) Finish the ridge.

6th Step - *Plough the odd-numbered ridges* in the same manner as the first one.

7th Step - *Plough the even-numbered ridges* inwards.

OBSERVATIONS

1) When ploughing an even-numbered ridge, those on both sides should already have been ploughed.

2) **When the ploughing of the even-numbered ridge is complete, reduce the ploughing depth in the last two runs to leave a shallow furrow (Fig. 4).**

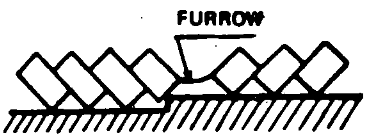


Fig. 4

8th Step - *Plough the headlands* by circling the field and turning the earth to the inside of the ploughed field.

9th Step - *Park the plough* thus:-

a) Take it to the maintenance area.
b) Carry out maintenance.
c) Take it to the parking area.
d) Unhitch the plough.
e) Move the tractor.

This operation involves turning over the topsoil using the plough. The purpose of this operation is to loosen, aerate and incorporate organic matter in the soil.

PROCEDURE

1st Step - *Hitch the implement.*

2nd Step - *Adjust crosswise by extending or shortening the lower lift link of the tractor.*

3rd Step - *Adjust lengthwise* thus:-

a) Take the plough to level ground.

b) Lengthen or shorten the top link until all the bodies rest uniformly on the ground.

4th Step - *Adjust the cutting width* of the first share of the plough.

OBSERVATIONS

1) Consult the operator's manual for this step.

2) Check the track width of the tractor.

5th Step - *Adjust the cutting depth.*

OBSERVATIONS

1) This adjustment is obtained through the hydraulic system of the tractor or the depth wheel of the plough according to the make or type.

2) If the plough has a furrow wheel, adjust it so that it is at one half to one centimetre below the heel of the plough. This wheel balances the force produced by the lateral suction of the plough-share.

3) If the plough has a skid in place of the furrow wheel, it does not need adjusting.

6th Step - *Adjust the disc coulter,* thus:

a) Loosen the bolts.

b) Adjust the vertical and lateral position in accordance with the operator's manual (Figs. 1 and 2).

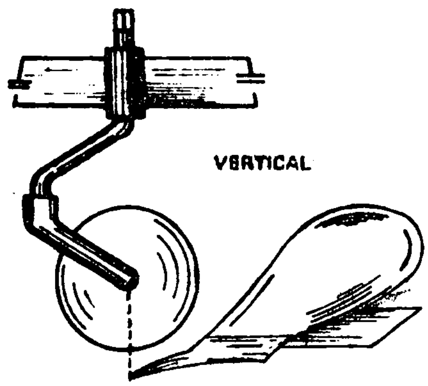


Fig. 1

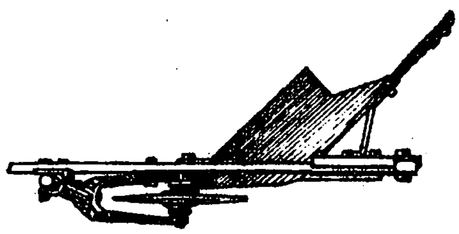


Fig. 2

c) Tighten the bolts.

7th Step - *Take the plough* to the field.

8th Step - *Plough.*

OBSERVATION
The operation of this implement is carried out in the same manner described for the operation of the integral mounted disc plough. The only difference is that the marking of the headland should be made by superficially ploughing with all the ploughshares.

9th Step - *Park* thus:-

a) Take the tractor to the maintenance area.
b) Carry out maintenance.
c) Take it to the parking area.
d) Unhitch the implement.
e) Move the tractor.

This is to break and turn over the surface layer of the soil in order to loosen and aerate it and to incorporate organic matter using the reversible plough. This type of plough turns over the earth to the right or left making it possible to plough on the same furrow in both directions. This characteristic makes round-and-round ploughing easy (Fig. 1). Dead furrows and ridges are thus eliminated, and the ploughing is said to be level.

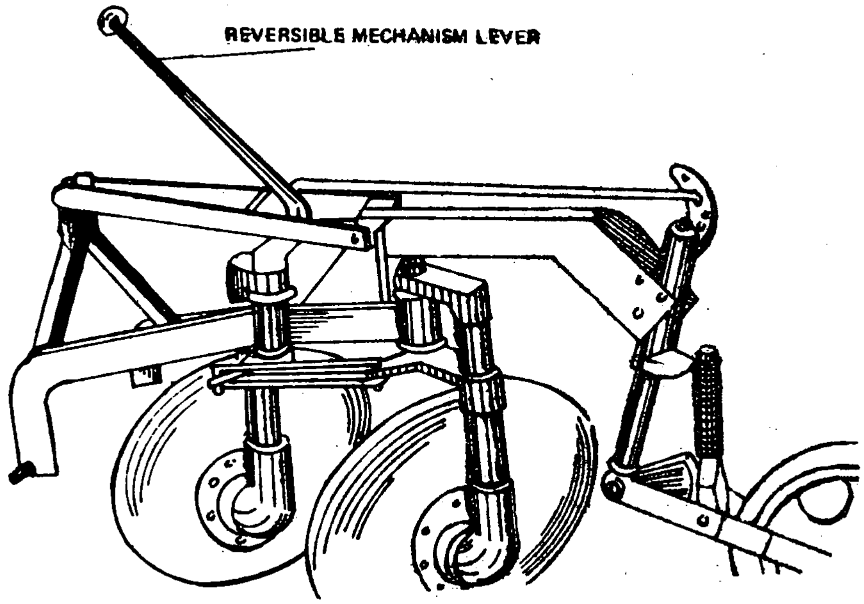


Fig. 1

PROCEDURE

1st Step - *Hitch the plough.*

2nd Step - *Take the plough to the field.*

3rd Step - *Adjust the plough.*

OBSERVATION
The integral mounted reversible plough is adjusted in the same way as the regular integral mounted plough, but in both working positions, right and left.

4th Step - *Plough round and round,* thus:

a) Place the tractor at the highest point in order to make the first run.
b) Lower the plough and plough using all the discs following the shallow furrow mark and turning over the soil upwards in the direction of the slope.

c) Lift the plough when the first run is completed. Turn the tractor and place the furrow wheel inside the furrow to make the second run.

d) Change the cutting direction of the shares or disc by actuating the lever of the reversible mechanism.

e) Lower the plough and make the second run.

f) Continue ploughing in this way until the work is completed.

OBSERVATION

During the operation make sure that the plough works evenly in all directions. Check and make adjustments if necessary.

5th Step - *Park the implement* thus:-

a) Take it to the maintenance area.

b) Carry out maintenance.

c) Take it to the parking area.

d) Unhitch the plough.

e) Move the tractor.

This operation is to break and turn over the surface layer of the soil using the plough. The purpose of this operation is to loosen, aerate and incorporate organic material in the soil.

PROCEDURE

1st Step - *Hitch the implement.*

2nd Step - *Adjust the angle of the discs.*

3rd Step - *Adjust the depth* thus:-

OBSERVATION
This step also takes care of the crosswise and lengthwise adjustments.

a) Drive the tractor to level ground.
b) Mount the land wheel on a block of the same height as the ploughing depth (Fig. 1).
c) Pull the trip cord to get the plough in working position.

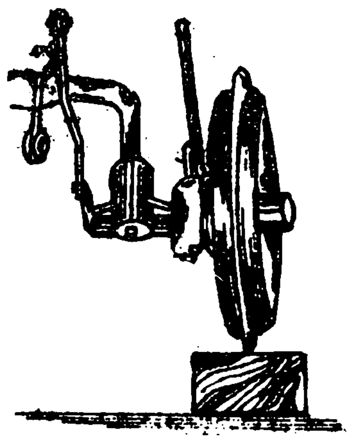


Fig. 1

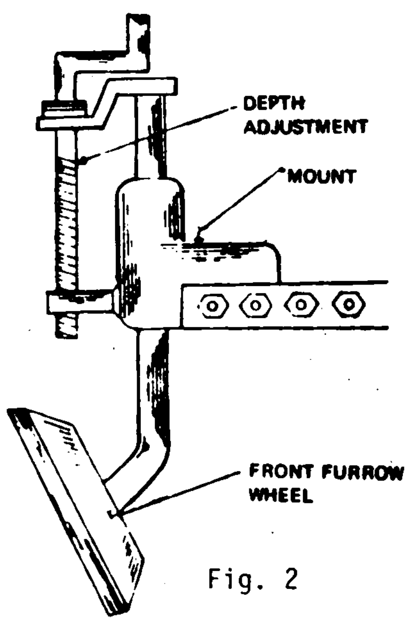


Fig. 2

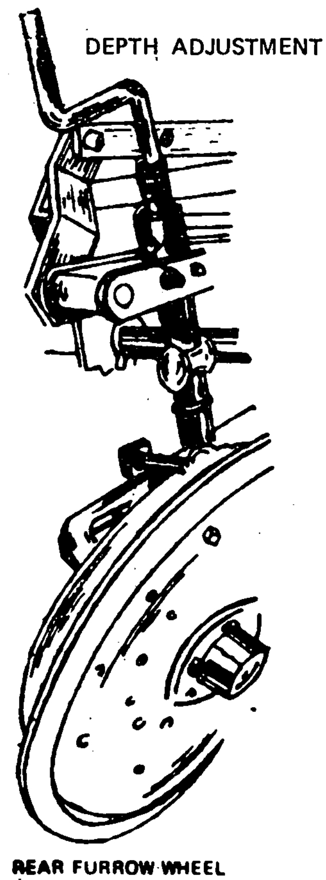


Fig. 3

d) Actuate the depth adjustment cranks until the discs just touch the ground (Figs. 2 and 3).

4th Step - *Adjust the cutting width.*

CASE I - REMOVING OR ADDING A DISC

a) Remove or add the disc unit.
b) Shift the furrow width adjustment on the beam.

OBSERVATIONS
1) Consult the operator's manual to determine the position of the furrow-width adjustment.
2) To reduce the cutting width remove the unit. To increase it, add it.

CASE II - VARYING THE ANGLE FORMED BY THE BEAM AND THE FURROW WIDTH ADJUSTMENT

a) Loosen the nuts and bolts which hold the clamp on the beam and the furrow-width adjustment.
b) Adjust the bolt which is located on the furrow-width adjustment.

Fig. 4

OBSERVATION
Check and adjust the track width of the tractor following recommendations of the manufacturer of the plough.

5th Step - *Adjust the draw-bar,* thus: (Fig. 5).

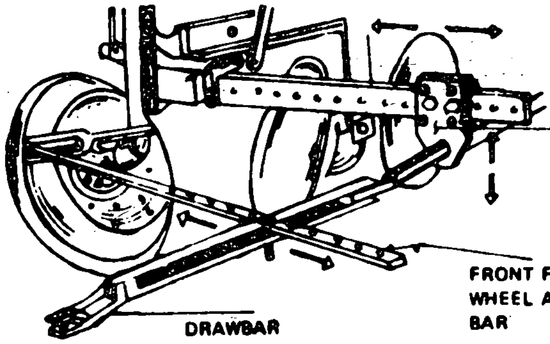


Fig. 5

a) Crosswise by shifting the adjustable plate of the link on the adjustable draw-bar.
b) Vertically by raising and lowering the adjusting plate of the link on the adjusting bar.
c) Shift the draw-bar on the adjustable steering bar of the front furrow-wheel.

6th Step - *Adjust the plough wheel in* accordance with the manufacturer's manual

7th Step - *Adjust the scrapers.*

8th Step - *Take the plough to the field.*

9th Step - *Plough* thus:-

a) Place the tractor at the working site.
b) Place the plough in a working position.
c) Begin ploughing.
d) Check the adjustments.

OBSERVATION

If the ploughing is done by ridging, lift the plough when turning.

10th Step - *Park the implement* thus:-

a) Take it to the maintenance area.
b) Carry out maintenance.
c) Take it to the parking area.
d) Unhitch the implement.
e) Move the tractor.

This is to break up the top layer of the soil in order to destroy and control weeds and to add organic matter to the soil (Fig. 1).

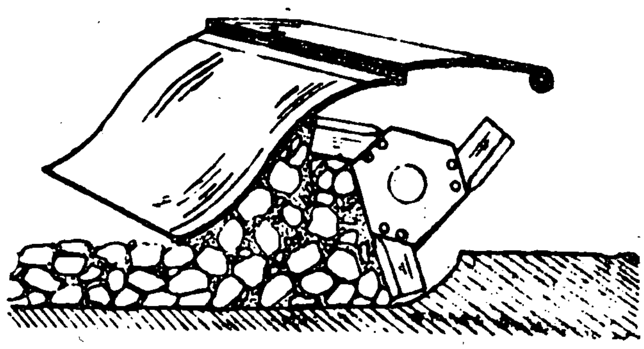


Fig. 1

PROCEDURE

1st Step - *Hitch the machine and install the stabilizers.*

OBSERVATION
If the machine is of the integral-mounted type, check for the correct hitch positions of the machine in the operator's manual.

2nd Step - *Adjust:*

a) Crosswise and lengthwise (Fig. 2).

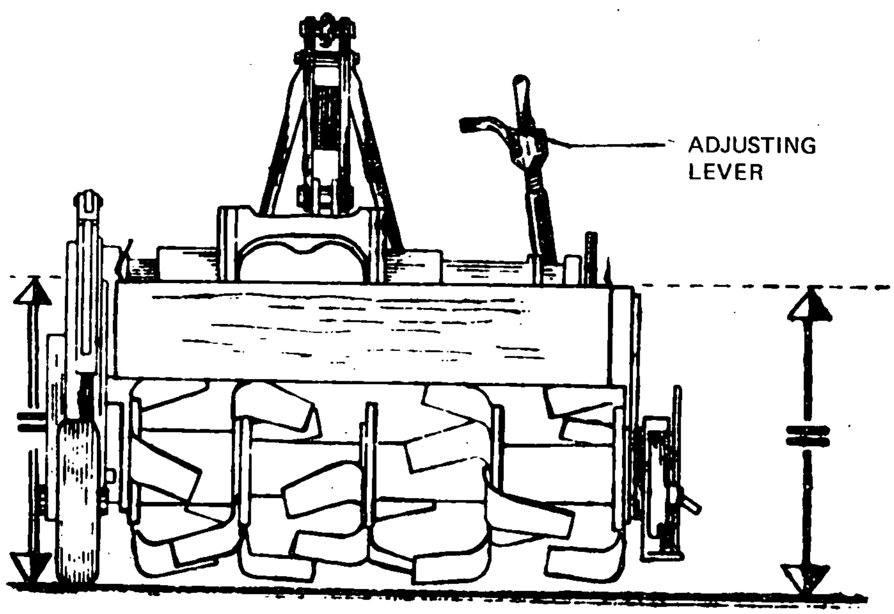


Fig. 2

b) Cutting depth, by actuating the lifting mechanism if it is a trailed machine. On an integral-mounted machine actuate the rear wheel and set the skids correctly.

c) Working speed, by interchanging the position of the drive and driven gears (Fig. 3).

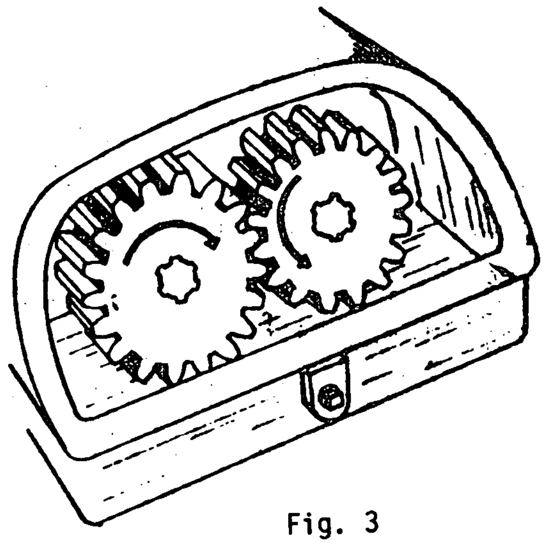


Fig. 3

OBSERVATION
There are several ways of placing the gears. Consult the operator's manual.

d) Check the safety clutch (Fig. 4).

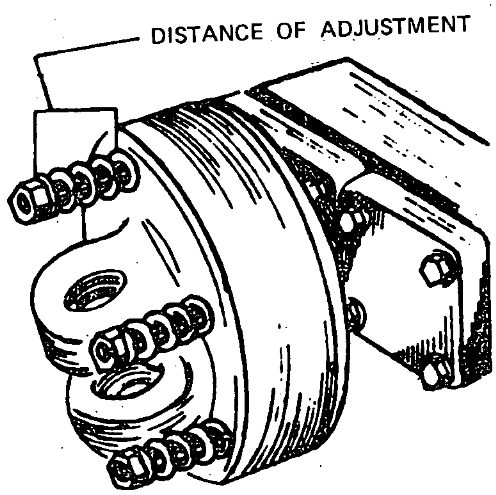


Fig. 4

3rd Step - *Take the machine to the work site.*

4th Step - *Begin cultivating* thus:-

SAFETY MEASURE
ALWAYS OPERATE THE MACHINE WITH ALL THE SAFETY GUARDS IN PLACE.

a) Inspect the field.
b) Mark out the obstacles.
c) Lower the machine.
d) Engage the power take-off shaft.
e) Begin the operation.
f) Check the adjustments.

SAFETY MEASURE

IF IT IS NECESSARY TO MAKE AN ADJUSTMENT, THIS SHOULD BE DONE WITH THE ENGINE SWITCHED OFF.

5th Step - *Park the machine* thus:-

a) Take it to the maintenance area.
b) Carry out maintenance.
c) Take it to the parking area.
d) Unhitch the machine.
e) Move the tractor.

This operation consists of levelling a field in order to obtain a uniform surface (Fig. 1).

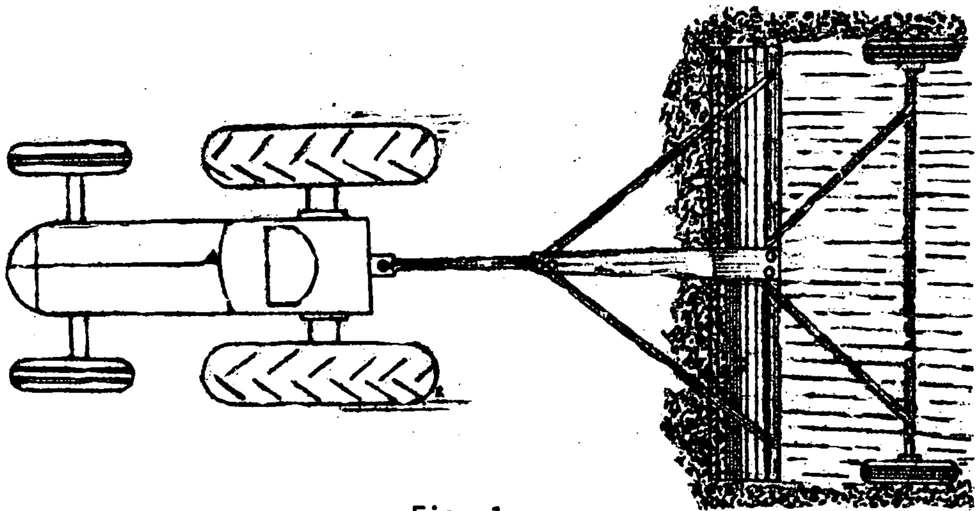


Fig. 1

<u>PROCEDURE</u>

1st Step - *Hitch the implement.*

2nd Step - *Take the implement* to the working site.

3rd Step - *Adjust.*

CASE I - TRAILED SCRAPER

a) Adjust the cutting depth.

b) Adjust the vertical and horizontal angle of the blade.

CASE II - INTEGRAL-MOUNTED SCRAPER

a) Adjust crosswise (angle of blade).

b) Adjust lengthwise.

c) Adjust the cutting depth with the lever of the hydraulic system of the tractor and the rear wheel of the implement (Fig. 2).

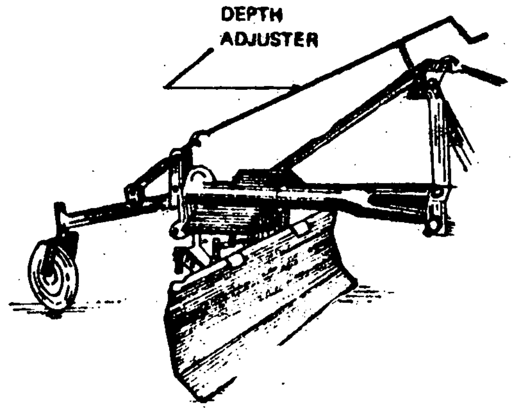


Fig. 2

4th Step - *Level* thus:-

a) Place the implement at the spot where the work is to begin.

b) Begin the work by operating the scraper at ground level.

OBSERVATION

While levelling, make adjustments to suit the type of irregularities.

5th Step - *Park the implement* thus:-

a) Take it to the maintenance area.

b) Carry out maintenance.

c) Take it to the parking area.

d) Unhitch the implement.

e) Move the tractor.

CBC

OPERATION:

OPERATING THE TRENCHER

This is to adjust the implement and use it to dig canals or ditches for irrigation or drainage of a field (Fig. 1).

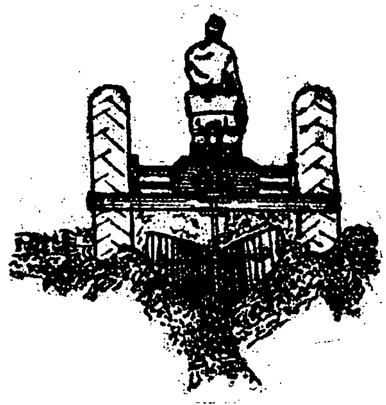


Fig. 1

PROCEDURE

1st Step - *Hitch the implement.*

2nd Step - *Make adjustments* thus:-

CASE I - TRAILED TRENCHER

a) Adjust the draft angle with the adjustable plate.

b) Adjust the trenching depth by moving the blade vertically.

OBSERVATION

Consult the operator's manual to carry out this tep.

CASE II - INTEGRAL-MOUNTED TRENCHER

a) Adjust crosswise.

b) Adjust lengthwise.

c) Adjust the cutting depth with the hydraulic system control.

OBSERVATION

A few types of trenchers have an adjustable plate between the mouldboards. The plate allows for widening or narrowing the width of the trench (Fig. 2).

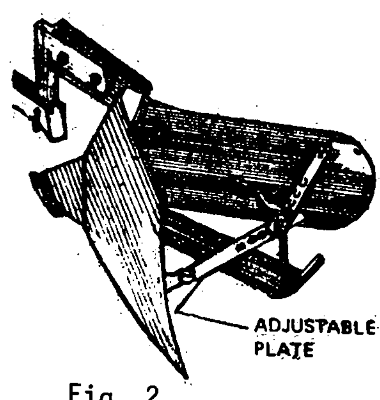


Fig. 2

3rd Step - *Take the implement to the field.*

4th Step - *Start trenching* thus:-

a) Place the implement on the spot where the work is to begin.
b) Begin trenching.
c) Check adjustments.
d) Continue trenching until the work is completed.

OBSERVATION
Follow the stakes which outline the trenches to be dug.

5th Step - *Park the implement* thus:-
a) Take it to the maintenance area.
b) Carry out maintenance.
c) Take it to the parking area.
d) Unhitch the implement.
e) Move the tractor.

TECHNICAL VOCABULARY

Trencher = Ditch Digger

This is to form ridges for retaining the water used in crops which require furrow irrigation (Fig. 1).

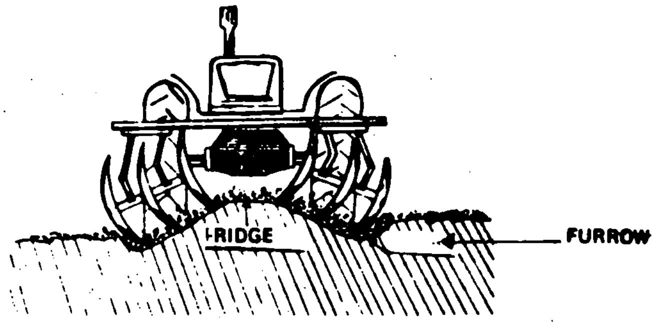


Fig. 1

PROCEDURE

1st Step - *Hitch the implement.*

2nd Step - *Adjust crosswise.*

3rd Step - *Adjust lengthwise.*

4th Step - *Adjust the angle of the discs* thus:-

a) Release the bolt which holds the standards.
b) Adjust the angle regulating plate.
c) Fix the lateral support of the discs.
d) Tighten the bolts.

5th Step - *Take the implement* to the working site.

6th Step - *Start ridging* thus:-

a) Place the tractor in a working position facing the stakes and mark the position where the ridge is to be made.
b) Lower the implement.
c) Carry out the first run with the implement adjusted to the minimum depth.

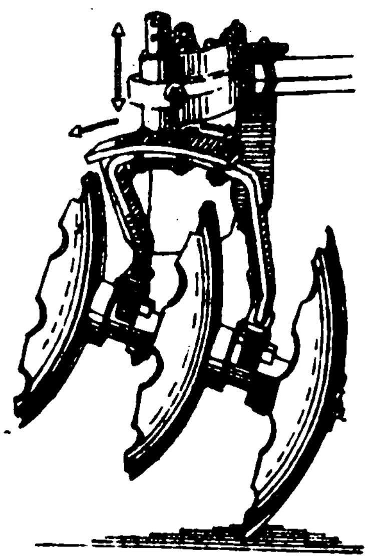


Fig. 2

OBSERVATION
Lift the implement when turning.

d) Adjust the implement for greater depth.
e) Continue with the second run.

OBSERVATION
Make the necessary runs until the required height for the ridge is obtained.

7th Step - *Park the implement* thus:-

a) Take the implement to the maintenance area.
b) Carry out maintenance.
c) Take it to the parking area.
d) Unhitch the implement.
e) Move the tractor.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 1.5-29

This is to dig furrows of a given depth and width for planting crops.

PROCEDURE

1st Step - *Hitch the implement.*

2nd Step - *Adjust crosswise and lengthwise.*

3rd Step - *Adjust distance between listers* thus:-

a) Loosen the bolts which hold the lister to the tool bar (Fig. 1).
b) Lift the implement.
c) Shift the listers on the tool bar until the recommended distance is obtained.
d) Tighten the bolts.
e) Lower the implement.

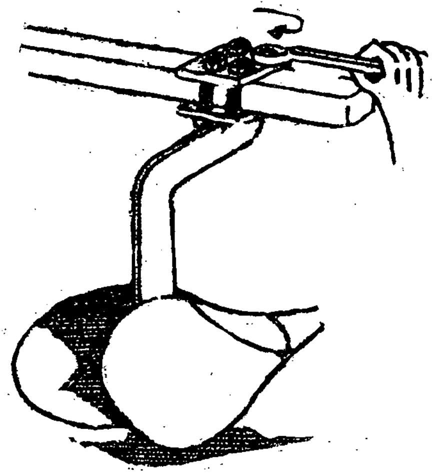


Fig. 1

OBSERVATIONS

1) Check or adjust the track width of the tractor, if necessary, to keep any lister from digging on trodden soil.

2) The listers should be at an equal distance from the centre of the tool bar.

4th Step - *Take the implement* to the field.

5th Step - *Start digging furrows* thus:-

a) Place the tractor on the spot where the work is to begin and lower the implement.

b) Adjust the depth with the hydraulic system lever, or with the side wheels, while digging along the first few yards, (Fig. 2).

c) Cut the furrows in the field following the stakes which outline the rows during the first run. The next runs should be parallel to the first.

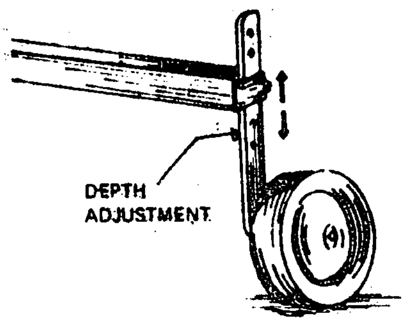


Fig. 2

6th Step - *Park the implement* thus:-

a) Take it to the maintenance area.
b) Carry out maintenance.
c) Take it to the parking area.
d) Unhitch the implement.
e) Move the tractor.

This is to spread seeds or chemical fertilizers by using the action of the centrifugal force of the distributor. A good spreading is obtained once the necessary adjustments have been made to the machine (Fig. 1).

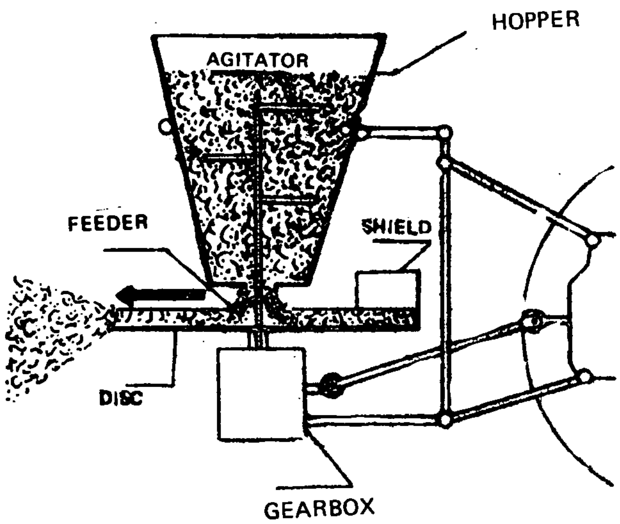


Fig. 1

PROCEDURE

1st Step - *Hitch the distributor and connect the stabilizers to the arms of the hydraulic system.*

2nd Step - *Adjust crosswise and lengthwise.*

3rd Step - *Take the machine* to the field.

4th Step - *Adjust the metering device* (Fig 2) thus:

a) Loosen the wing nut which holds the lever.

b) Shift the adjusting lever to the point indicated on the distributor's table or according to the operator's manual.

c) Tighten the wing nut.

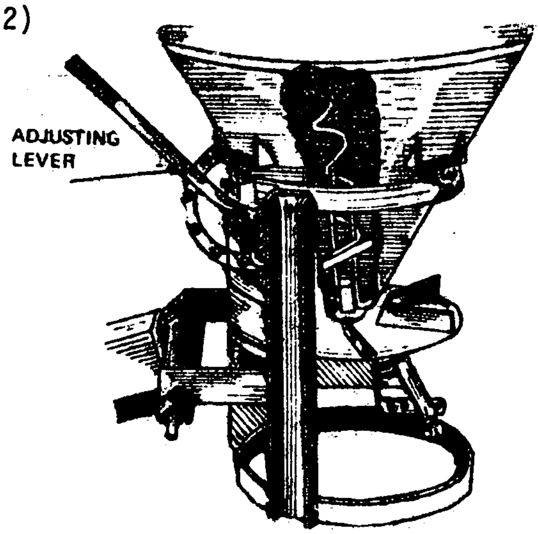


Fig. 2

5th Step - *Adjust the direction of the flow* thus:

a) Loosen the nuts on the lever of the adjustable plate.

b) Adjust the plate to the desired direction.

c) Tighten the nuts.

OBSERVATION

Consult the operator's manual for this step.

6th Step - *Fill the hopper* with the product to be spread.

7th Step - *Start spreading* thus:

a) Place the machine on the spot where the work is to begin.

b) Lower the machine to the necessary height.

c) Engage the power take-off shaft and drive the tractor.

SAFETY MEASURE

TO CHECK ADJUSTMENTS, DISENGAGE THE POWER TAKE-OFF SHAFT.

OBSERVATION

Reduce speed when turning to ensure that seeds or fertilizer are evenly spread out at the headlands.

d) Continue spreading in consecutive parallel lines.

8th Step - *Park the machine* thus:-

a) Take it to the maintenance area.

b) Carry out maintenance.

c) Take it to the parking area.

d) Unhitch the machine.

e) Move the tractor.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: ( )
Level: 2
Subject: 1.5-41

This is to drive the row crop planter on an adequately prepared field. The machine deposits the correct amount of seeds at the recommended depth. These conditions and the distance between rows are obtained by previously adjusting the machine.

PROCEDURE

1st Step - *Hitch the planter, mount the stabilizers and take it to level ground.*

2nd Step - *Adjust crosswise and lengthwise* (Fig. 1).

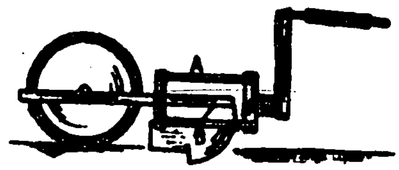


Fig. 1

3rd Step - *Adjust the distance* between rows, thus:

a) Lift the planter.
b) Allow the sowing units to remain lifted by placing blocks under both ends of the frame.
c) Loosen the bolts which join the sowing units to the frame.
d) Separate the units from the centre so that they are at an equal distance from the middle of the frame leaving between them the distance recommended for sowing.

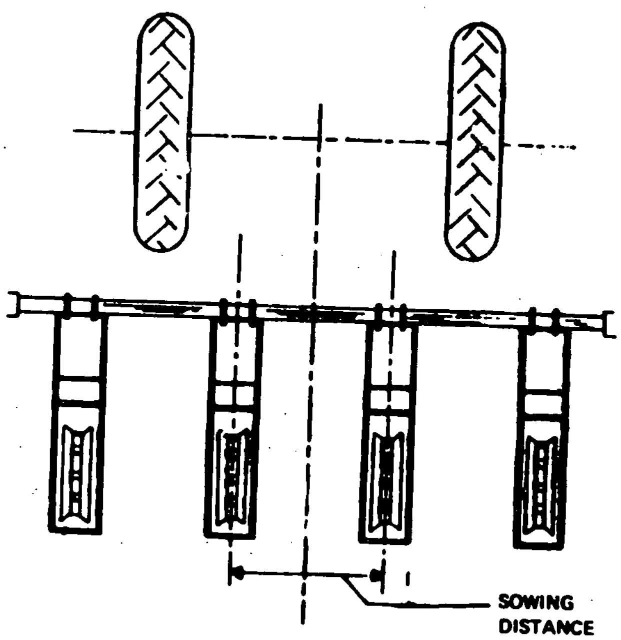


Fig. 2

e) Separate the other units leaving between them the recommended sowing distance.

f) Tighten the bolts.

OBSERVATION

If necessary, check and adjust the track width of the tractor to keep any unit from sowing on trodden soil.

4th Step - *Adjust the markers.*

5th Step - *Meter the seeds* thus:

a) Install the seed plate.

b) Engage the bevel gear.

OBSERVATION

Consult the operator's manual for this step.

6th Step - *Adjust the sowing dpeth* thus:

a) Lift the drive wheels of the planters and place them on blocks of a height equal to the sowing depth.

b) Lower the planter until the hoes touch the ground.

c) Mark the position of the hydraulic control by using stops provided on the quadrant.

7th Step - *Adjust the scrapers.*

8th Step - *Take the planter to the field and fill the hoppers.*

9th Step - *Start sowing* thus:

a) Place the planter on the spot where sowing will begin.

b) Lower the planter and place the marker in working position.

c) Start sowing by driving the tractor along the marking stakes.

d) Lift the planter at the end of the field.

e) Continue sowing along the marks.

10th Step - *Park the machine* thus:-

a) Take planter to the maintenance area.
b) Carry out maintenance.
c) Take it to the parking area.
d) Unhitch the planter.
e) Move the tractor.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: ( )
Level: 2
Subject: 1.5-42 1.5-53

This is to deposit a given amount of seed and fertilizer in equally spaced furrows at a set depth and distance so the plants will germinate and grow uniformly. For these results adjust the machine beforehand (Fig. 1).

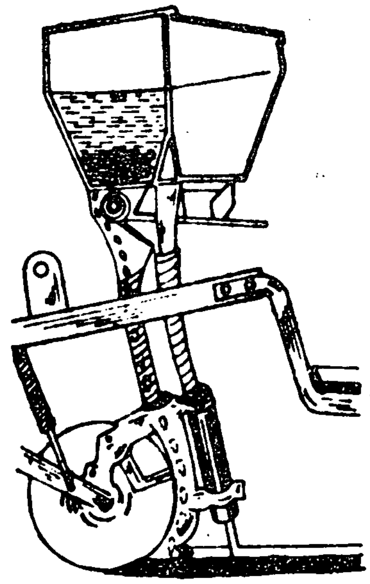


Fig. 1

PROCEDURE

1st Step - *Hitch the machine.*

2nd Step - *Adjust lengthwise.*

3rd Step - *Adjust sowing rate,* thus:

a) Actuate the seed feed lever (Fig. 2).

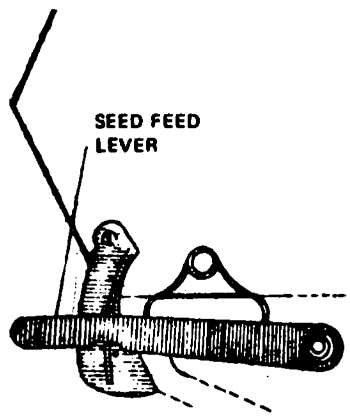


Fig. 2

b) Adjust the outlets (Fig. 3).

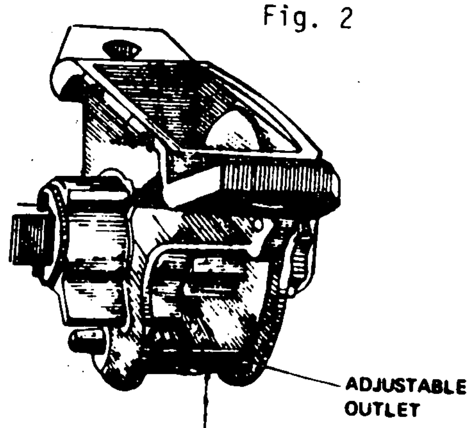


Fig. 3

c) Engage the drive which moves the feed shaft to obtain the desired speed.

OBSERVATION

Consult the tables furnished by the manufacturer.

4th Step - *Adjust sowing depth* thus: (Fig. 4).

a) Remove the pin which holds the spring of the discs.

b) Choose the appropriate notch and insert the pin.

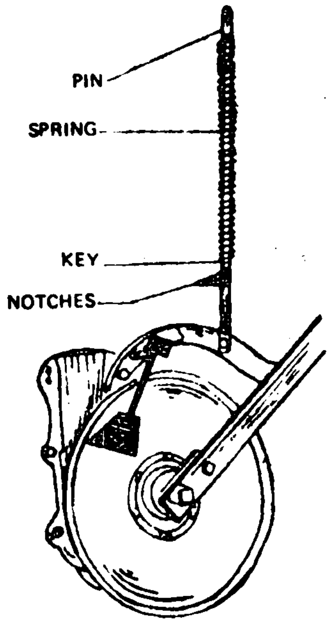


Fig. 4

OBSERVATIONS

1) The pins of the springs should all be in the same position to obtain equal pressure on each coulter.

2) The pressure on all the springs of the coulter is controlled by the lift arm designed for this purpose.

5th Step - *Adjust the distance* between furrows, thus:

a) Stop the flow of seed using the covering plate.
b) Remove the coulter from this outlet.

OBSERVATION
Consult the operator's manual.

6th Step - *Meter the amount of fertilizer* thus:-

a) Loosen the wing nut.
b) Adjust the outlet.
c) Tighten the wing nut.

OBSERVATION
Consult the tables supplied by the manufacturer.

7th Step - *Take the machine* to the field.

8th Step - *Adjust the markers* (Fig. 5).

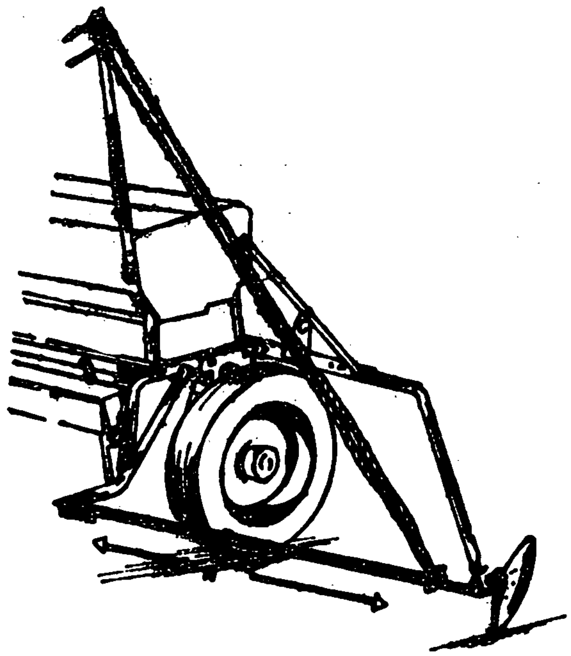


Fig. 5

9th Step - *Start sowing and fertilizing* thus:

a) Fill the hoppers with seed and fertilizer.

b) Place a point of reference facing the tractor on the opposite end of the field.

c) Lower the marker on the side of the field.

d) Actuate the mechanism which lowers the coulters.

e) Start sowing in parallel lines until the field is completed.

OBSERVATIONS

1) Sow the headlands last.

2) Make sure, periodically, that seed and fertilizer are coming from all tubes.

3) Lift the entire sowing mechanism at the end of the field when turning.

10th Step - *Park the machine* thus:

a) Take it to the maintenance area.

b) Carry out maintenance.

c) Take it to the parking area.

d) Unhitch the machine.

e) Move the tractor.

This is to operate the potato planter adjusted in such a manner that the tubers fall at the same distance and depth in the furrows (Fig. 1).

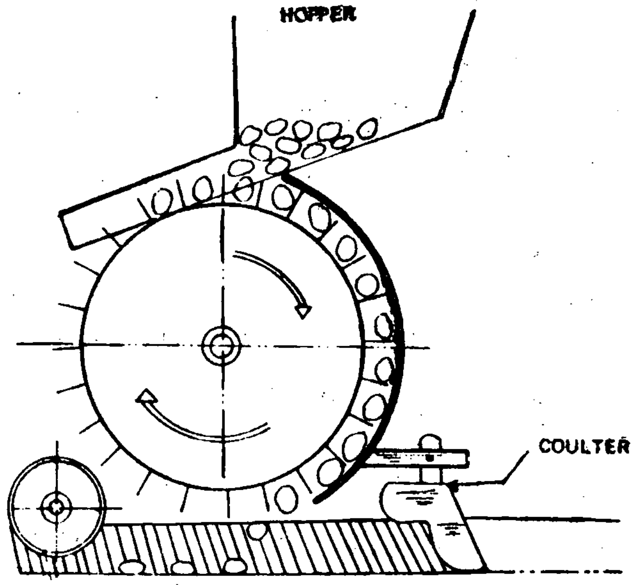


Fig. 1

PROCEDURE

1st Step - *Hitch the planter.*

2nd Step - *Adjust the planter* thus:

OBSERVATION
Consult the operator's manual.

a) Adjust crosswise.
b) Adjust lengthwise.
c) Adjust distance between furrows.

d) Adjust depth of planting (Fig. 2).

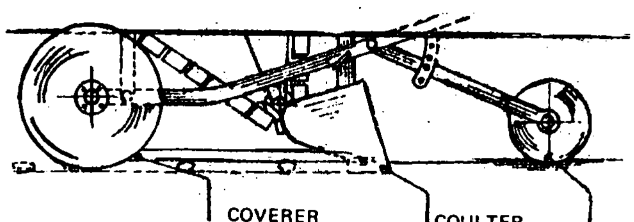


Fig. 2

e) Adjust the metering mechanism (Fig. 2).
f) Adjust position of press wheels.
g) Adjust markers to the exact distance.

3rd Step - *Take the planter* to the field.

4th Step - *Start planting* thus:

a) Place the equipped tractor in working position.

b) Lower the coulters.

OBSERVATION

If the planter is semi-automatic, get an assistant.

c) Start planting and check adjustments.

OBSERVATION

Lift the coulters on completion of the row and before turning.

d) Continue planting until the task is completed.

5th Step - *Park the planter* thus:

a) Take it to the maintenance area.

b) Carry out maintenance.

c) Take it to the parking area.

d) Unhitch the planter.

e) Move the tractor.

This is to adjust the cultivator and use if for harrowing, moling or weeding crops.

PROCEDURE

1st Step - *Hitch the cultivator and mount the stabilizers.*

2nd Step - *Adjust the cultivator.*

a) Crosswise.

b) Lengthwise.

3rd Step - *Adjust distance and working pitch of the hoes* thus:

a) Release bolts.

b) Adjust working pitch (Fig. 1).

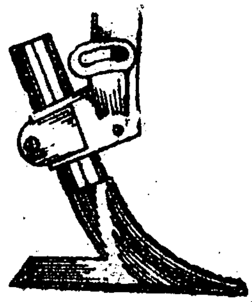


Fig. 1

OBSERVATION
Consult operator's manual.

c) Adjust the distance between the hoes (Fig. 2).

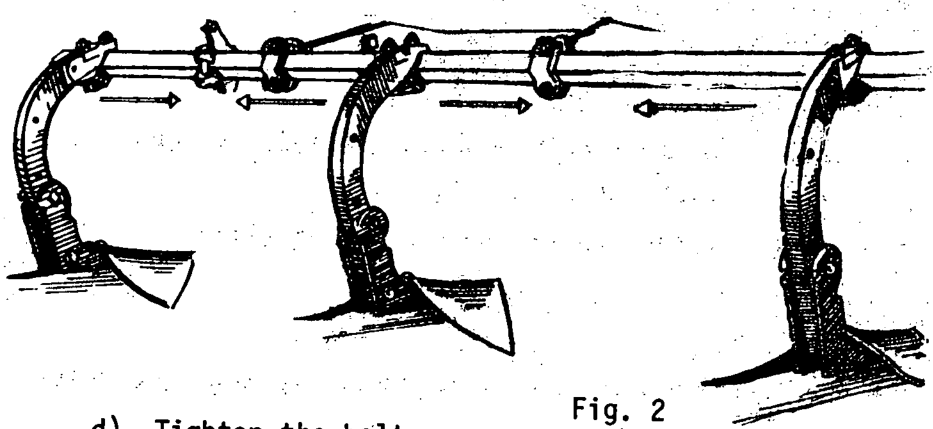


Fig. 2

d) Tighten the bolts.

4th Step - *Adjust depth* thus:

a) Loosen the bolts of the clamp on the tool bar.

b) Adjust the height of the hoes (Fig. 3).

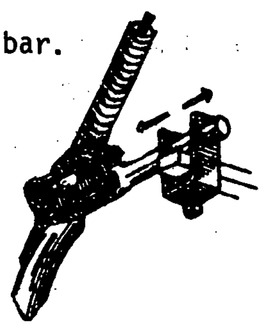


Fig. 3

c) Adjust the depth wheels of the implement.

d) Tighten the bolts.

OBSERVATION

If the hoe has a safety mechanism, adjust its tension. Consult the operator's manual.

e) Adjust the hydraulic system lever.

OBSERVATION

Check the track width of the tractor and, if necessary, adjust it (Fig. 4).

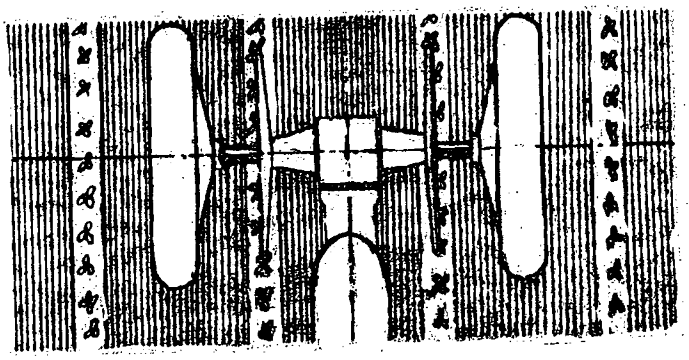


Fig. 4

5th Step - *Take the implement* to the field.

6th Step - *Start cultivating* thus:

a) Place the tractor in working position so that the wheels fall between the rows (Fig. 4).

b) Lower the implement and start cultivating.

OBSERVATIONS

1) Check if the hoes are damaging the plants; correct the adjustment if necessary.

2) Lift the implement when turning at the end of the row.

7th Step - *Park the implement* thus:

a) Take it to the maintenance area.

b) Carry out maintenance.

c) Take it to the parking area.

d) Unhitch the implement.

e) Move the tractor.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 1.5-58

This is to apply chemical products dissolved in water over a given crop or over the soil using the spraying machine. The purpose is to control diseases or weeds or to defoliate plants. The spraying machine should be properly adjusted and calibrated for the recommended application (Fig. 1).

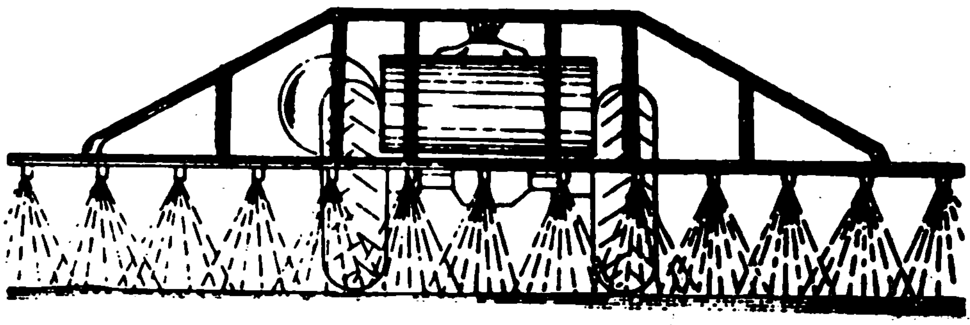


Fig. 1

PROCEDURE

1st Step - *Hitch the machine and place the stabilizers.*

2nd Step - *Adjust the machine,* thus:

a) Adjust crosswise.
b) Adjust lengthwise.
c) Adjust the boom height.

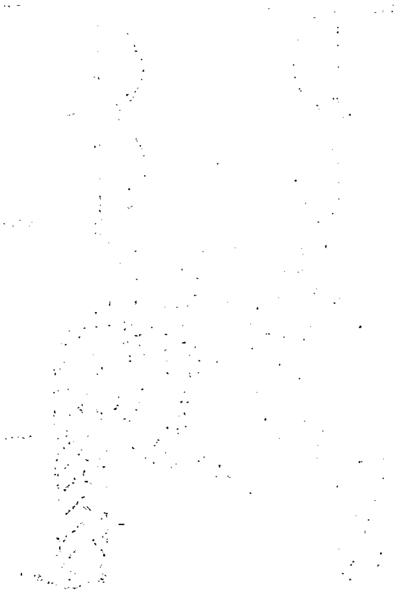
d) Adjust the direction of the spray (Fig. 2).

Fig. 2

e) Adjust the distribution rate by means of the speed of the tractor, the pressure and type of nozzle.

OBSERVATION
To adjust the spray and the amount of liquid, fill the tank with water.

[illegible]



[illegible] ... height.

[illegible]

d) [illegible] pressure on the pressure gauge [illegible]

[illegible] runs.

[illegible] in successive parallel runs until [illegible]

OBSERVATION

At the end of each run close the control valve.

SAFETY MEASURES

1) SPRAY WHEN THERE IS LITTLE WIND AND IN THE OPPOSITE [illegible] TO IT SO AS NOT TO POISON YOURSELF OR DAMAGE OTHER [illegible] PLANTS AND ANIMALS.

2) USE A SAFETY MASK AND RUBBER GLOVES WHEN HANDLING [illegible] LIQUID.

5th Step - Park the machine thus:

a) Take it to the maintenance area.

b) Carry out maintenance.

c) Take it to the parking area.

d) Unhitch the machine.

e) [illegible] the tractor.

SAFETY MEASURE

WASH HANDS THOROUGHLY WITH SOAP AND WATER [illegible] COMPLETED.

This is to apply powdered chemical products uniformly to combat pests or diseases in crops. The machine should be properly adjusted to perform well.

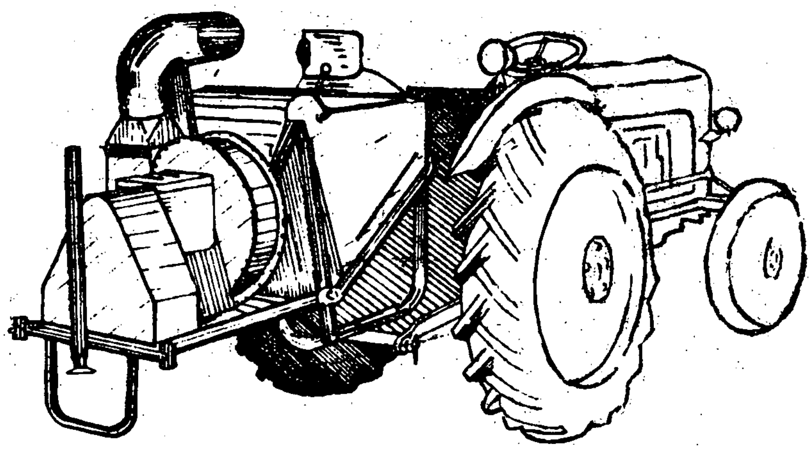


Fig. 1

PROCEDURE

1st Step - *Hitch the machine and place the stabilizers* (Fig. 1).

2nd Step - *Adjust the machine* thus:

a) Adjust crosswise.
b) Adjust lengthwise.

c) Adjust the direction of dusting (Fig. 2).

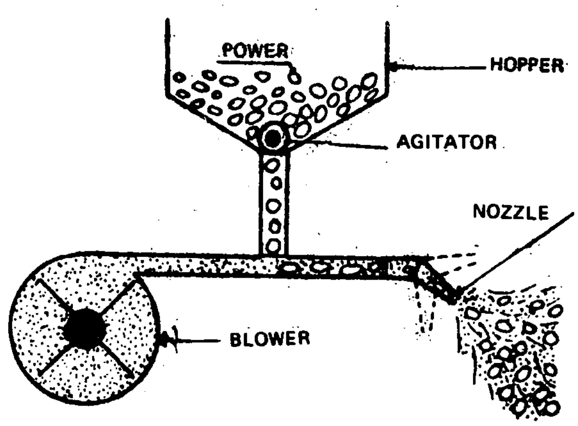


Fig. 2

d) Adjust opening of the dust nozzle using the adjusting lever (Fig. 3).

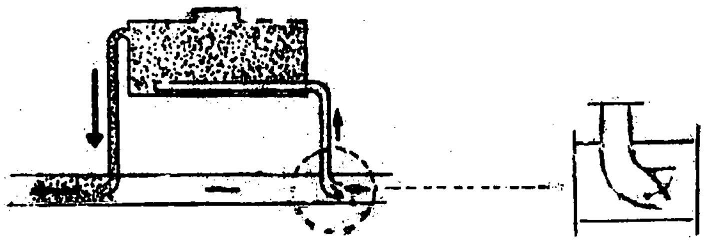


Fig. 3

3rd Step - *Take the machine* to the field.

4th Step - *Start dusting* thus:

a) Place the tractor where dusting is to begin.
b) Lower the machine to the necessary height.
c) Engage the power take-off shaft to put the fan in motion.
d) Begin the runs and open the air inlet.
e) Carry out dusting in lateral runs until work is completed.

OBSERVATION

At the end of each run disengage the power take-off shaft when turning.

SAFETY MEASURES

1) *DUST WHEN THERE IS LITTLE WIND AND IN THE OPPOSITE DIRECTION TO IT SO AS NOT TO POISON YOURSELF OR DAMAGE NEARBY PLANTS AND ANIMALS.*

2) *USE SAFETY GLOVES AND MASK.*

5th Step - *Park the machine* thus:

a) Take it to the maintenance area.
b) Carry out maintenance.
c) Take it to the parking area.
d) Unhitch the machine.
e) Move the tractor.

SAFETY MEASURE

ONCE THE TASK IS COMPLETED, BATHE TO AVOID POISONING.

CBC

OPERATION:

OPERATING THE POTATO HARVESTER

This is to remove tubers from the soil, separate them from the dirt and leave them ready for collection. This operation includes adjusting the machine.

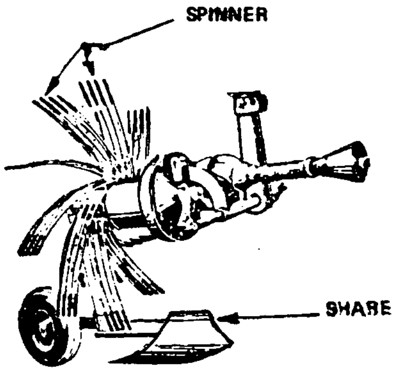


Fig. 1

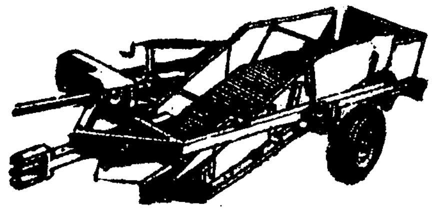


Fig. 2

PROCEDURE

1st Step - *Hitch the machine.*

2nd Step - *Take the machine* to the working site.

3rd Step - *Adjust the machine* thus:

CASE I - INTEGRAL-MOUNTED DIGGER (Fig. 1)

a) Adjust the depth of the lifting share.

b) Adjust the working height of the spinner and the check screen.

CASE II - TRAILED DIGGER (Fig. 2).

a) Adjust the depth of the share.

b) Adjust the speed of the elevator web.

4th Step - *Operate the digger* thus:

a) Place the tractor above the row.

b) Lower the machine and the check screen and engage the power take-off shaft.

c) Lift the tubers by driving the tractor over the row.

d) Check the adjustments and correct them if necessary.

e) Lift the machine when a row is finished and place it in the next row. Continue doing so until the work is completed.

OBSERVATION

Disengage the power take-off shaft when turning.

SAFETY MEASURE

IF THE DIGGER IS STUCK, STOP THE TRACTOR. DISENGAGE THE POWER TAKE-OFF SHAFT AND REMOVE THE OBSTACLES.

5th Step - *Park the machine* thus:

a) Take it to the maintenance area.

b) Carry out maintenance.

c) Take it to the parking area.

d) Unhitch the digger.

e) Move the tractor.

CBC

OPERATION:

OPERATING THE SICKLE MOWER

This is to cut forage to be used immediately to feed the cattle, to be stored in silos or prepared for the process of haymaking. This operation includes the necessary adjustments of the implement to ensure its correct functioning.

PROCEDURE

1st Step - *Hitch the machine.*

2nd Step - *Adjust:*

a) Throw or register of the knives (Fig. 1).

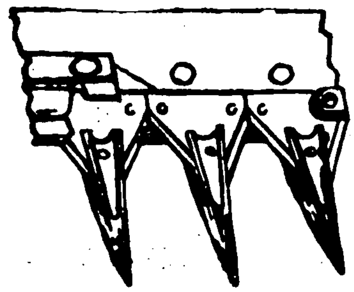


Fig. 1

b) Tilt of the cutter bar (Fig. 2).
c) Speed of the cutter bar.
d) Tension of the safety mechanism (Fig. 3).

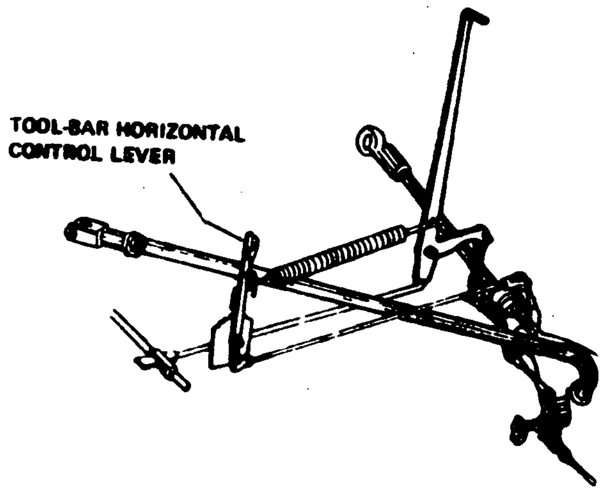


Fig. 2

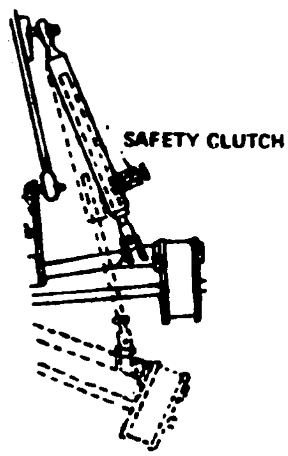


Fig. 3

OBSERVATION

There are many models of mowers. The above-mentioned adjustments vary from one model to another. Consult the operator's manual.

3rd Step - *Transport the mower* with the cutter bar lifted.

4th Step *Mow* thus:

a) Place the mower in working position.

b) Engage the power take-off drive shaft.

c) Check the adjustments.

d) Start mowing at one side of the field.

SAFETY MEASURE

WHEN MAKING ANY ADJUSTMENTS, STOP THE ENGINE.

OBSERVATION

Reduce the speed of the tractor at the corners.

5th Step - *Park the mower* thus:

a) Take the mower to the maintenance area.

b) Carry out maintenance.

c) Take it to the parking area.

d) Unhitch the mower.

e) Move the tractor.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: ( )
Level: 2
Subject: 1.5-75

This is to mow and cut forage with the harvester for ensilage or for immediate animal feed. The machine should be properly adjusted in order to operate correctly.

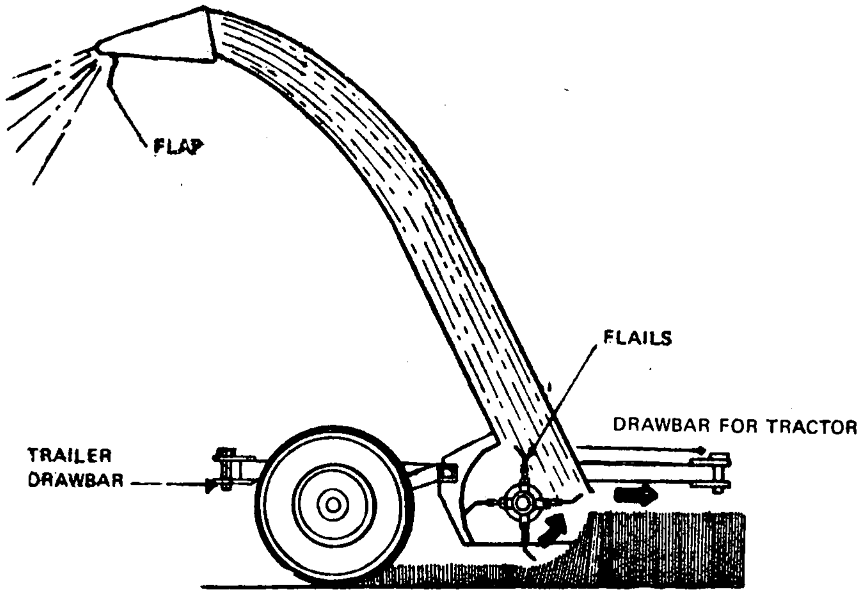


Fig. 1

PROCEDURE

1st Step - *Hitch the machine* (Fig. 1).

2nd Step - *Take the machine* to the work site.

3rd Step - *Adjust* thus:

a) Adjust the cutting height with the height adjustment crank.

b) Adjust the working position by hitching the drawbar of the machine to the appropriate point (Fig. 2). The different positions allow working with tractors of different track widths.

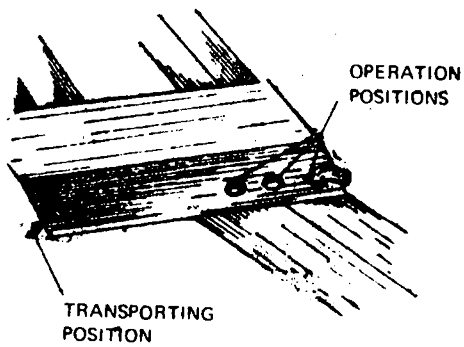


Fig. 2

CINTERFOR 1st. Edition

c) Adjust the direction of the delivery chute (Fig. 3) and the inclination of the flap.

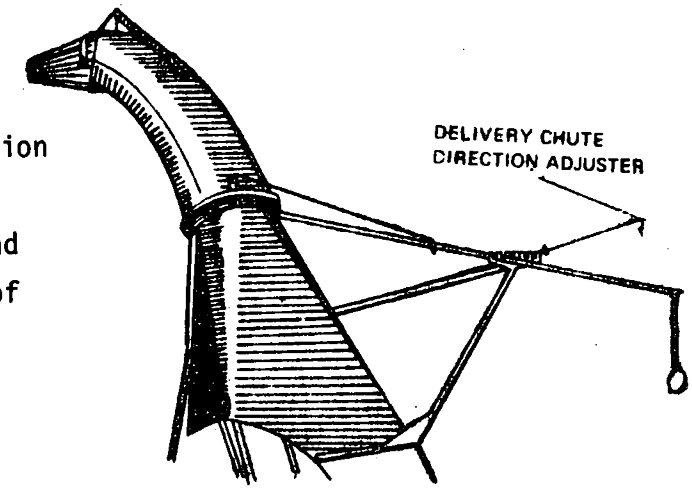


Fig. 3

4th Step - *Harvest* thus:

a) Place the harvester on the spot where harvesting will begin.
b) Check the adjustments.
c) Engage the power take-off shaft.
d) Cut in spirals, from the outside inwards leaving the uncut forage to the right.

SAFETY MEASURE

e) During work, actuate the flap so that the cut forage falls into the trailer and the load is uniformly distributed.

5th Step - *Park the machine* thus:

a) Take the machine to the maintenance area.
b) Carry out maintenance.
c) Take the machine to the parking area.
d) Unhitch the machine.
e) Move the tractor.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 1.5-73

This is to place the cut crop or forage in rows for ensilage, baling, immediate feeding of animals or for making harvesting easier.

This operation also includes the adjustments of the machine (Fig. 1).

Fig. 1

PROCEDURE

1st Step - *Hitch the machine.*

2nd Step - *Take the machine* to the work site.

3rd Step - *Make adjustments* thus:

CASE I - INTEGRAL-MOUNTED HAY RAKE

a) Crosswise, with the lower arm of the three point system.
b) Lengthwise, by shortening or lengthening the third point of the tractor.
c) Height of the tines, with the hydraulic system.
d) Angle of tines.

CASE II - TRAILED HAY RAKE

Height, by actuating the height adjustment cranks (Fig. 2).

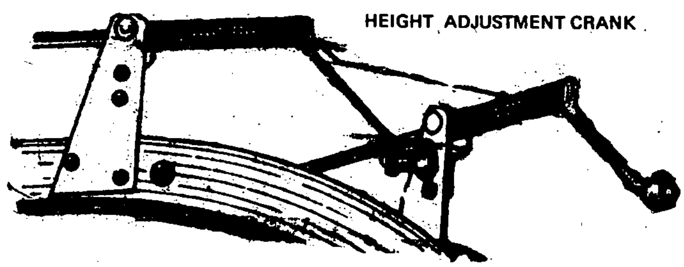


Fig. 2

b) Angle of tines (Fig. 3)

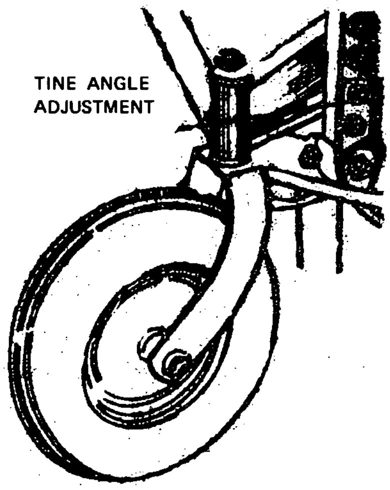


Fig. 3

OBSERVATION
Adjust the track width of the tractor to keep it from treading on the swaths.

4th Step - *Begin raking* thus:

CASE I - INTEGRAL-MOUNTED HAY RAKE

a) Place the machine at the side of the field.
b) Lower the machine to the necessary height.
c) Engage the power take-off shaft and begin the first run following the same mowing direction.

d) Continue raking until the work is completed.

CASE II - TRAILED HAY RAKE

a) Place the machine at the side of the field.
b) Engage the clutch.
c) Work the first swath.

OBSERVATION
If the machine is driven by the power take-off shaft, engage it.

d) Apply the clutch to stop the movement at the end of each swath.
e) Continue working the swaths until the work is completed.

5th Step - *Park the machine* thus:

a) Take the machine to maintenance area.
b) Carry out maintenance.
c) Take the machine to the parking area.
d) Unhitch the machine.
e) Move the tractor.

TECHNICAL VOCABULARY

Third Point = Top link

This is to break and crush the stalks of the mowed forage so they will dry at the same rate as the foliage. Thus, a uniform product is obtained which retains all its leaves. When operating the conditioner, leaves should not break off nor should loss of plant juices occur.

PROCEDURE

1st Step - *Hitch the machine.*

2nd Step - *Take the machine* to the work site.

3rd Step - *Adjust:*

a) The pressure between rollers, as indicated in Figure 1.

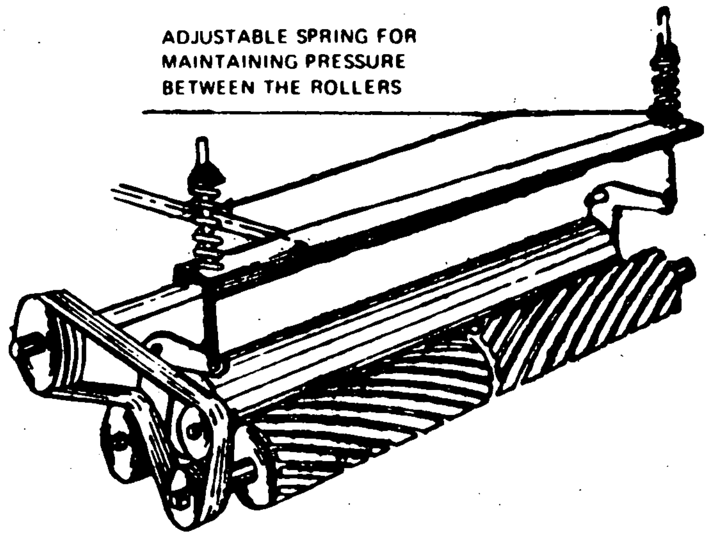


Fig. 1

b) The height of the rollers by means of the corresponding mechanism.

OBSERVATION
Consult the operator's manual to make the adjustments.

4th Step - *Begin conditioning* thus:

a) Check adjustments.
b) Engage the power take-off shaft.
c) Runs should be done in parallel rows until the work is completed. They should also be done in the same direction in which mowing and raking were done.

5th Step - *Park the machine* thus:

a) Take the machine to the maintenance area.

b) Carry out maintenance.

c) Take it to the parking area.

d) Move the tractor.

This is to adjust the machine in order to obtain well-tied and uniform sized bales. This makes the transportation and storage of bales easier.

PROCEDURE

1st Step - *Hitch the machine.*

2nd Step - *Load the boxes with twine or wire (depending on the machine).*

3rd Step - *Place the twine in the tying mechanism.* thus:

SAFETY MEASURE

FOR 2ND AND 3RD STEPS THE BALER SHOULD BE STOPPED.

OBSERVATION

Adjust the track width of the tractor to keep the wheels from treading on the swath.

a) Place the twine following the path from the box to the needle (each side separately (Fig. 1).

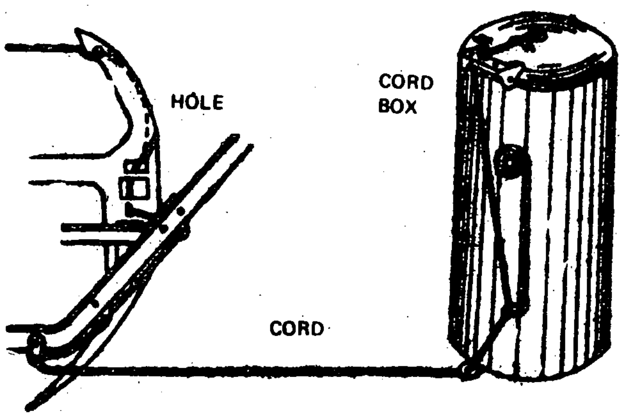


Fig. 1

b) Thread the needle.

c) Tie the end of the twine to the frame of the machine and check for correct tension.

d) Lift the trip mechanism.

e) Turn the flywheel by hand to check the functioning of the mechanism.

f) Remove the pieces of twine and check whether the knots are well made.

OBSERVATION

There are several models of balers. For each model consult the operator's manual.

4th Step - *Make adjustments,* thus:

a) Height of the pick-up reel (Fig. 2).

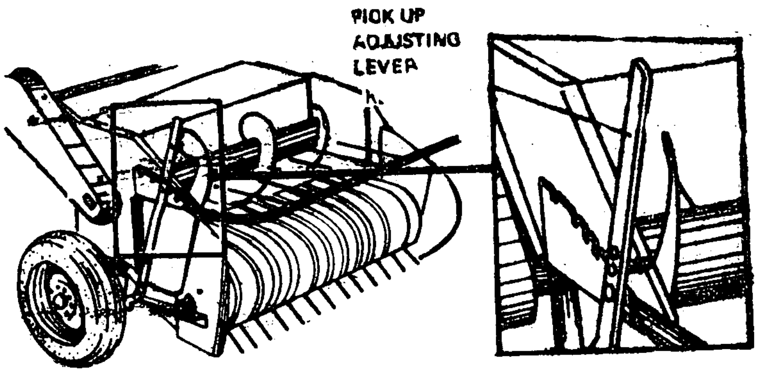


Fig. 2

b) Check the synchronization of the plunger.

c) The plunger knife. Check the clearance between the knife and the shear-plate at the opening side of the bale-chamber.

d) Speed of the plunger, by correcting the revolutions of the power take-off shaft.

e) Tension of the twine or wire.

f) Density of the bales, by reducing or increasing the dimensions at the end of the bale-chamber.

g) Length and weight of the bales, by modifying the run of the metering wheel.

OBSERVATION

Consult operator's manual for making adjustments.

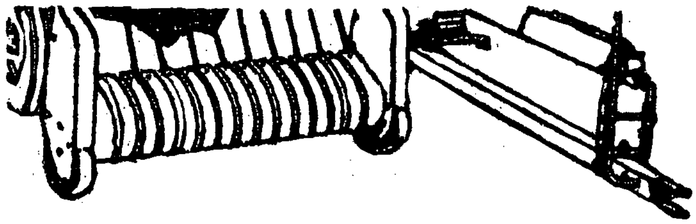
OPERATION:

OPERATING THE BALER

This is to make uniform bales of straw or hay for storing. The straw will later be used as cattle bedding. The hay will be used as fodder during the seasons when natural fodder is scarce.

PROCEDURE

1st Step - *Take the machine* to the work site with the draw bar in "transport position" as shown in the figure.



TRANSPORTING POSITION

2nd Step - *Begin baling* thus:

a) Place the machine where baling is to begin.
b) Actuate the mechanism to set it in working position.

OBSERVATION
Follow the same direction in which the raking was done.

c) Engage the power take-off shaft.

OBSERVATION
Check adjustments.

d) Carry out baling by driving the machine to the end of each swath.
e) Continue baling until the work is completed.

3rd Step - *Park the machine.*

a) Take it to the maintenance area.
b) Carry out maintenance.
c) Take it to the parking area.
d) Unhitch the machine.
e) Move the tractor.

This is to use the digger to make holes of a given diameter and depth in the ground. This is done when planting certain crops or posts (Fig. 1).

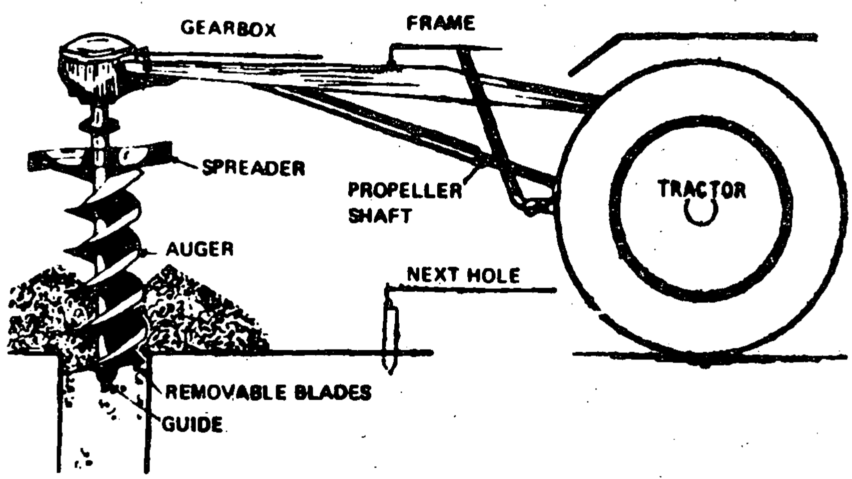


Fig. 1

PROCEDURE

1st Step - *Hitch the machine.*

2nd Step - *Adjust crosswise* by lifting or lowering the tractor's lower lift arm.

3rd Step - *Install the appropriate auger* (Fig. 2)

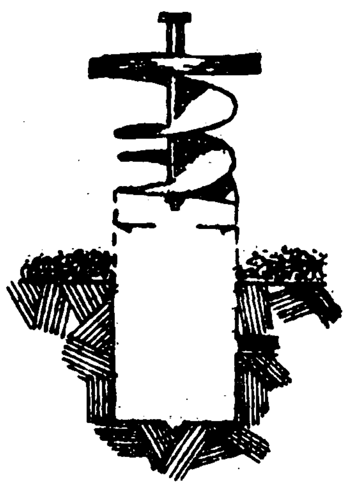


Fig. 2

4th Step - *Take the machine* to the field.

5th Step - *Bore the hole* thus:

a) Place the guide of the auger on the indicated spot.
b) Engage the power take-off shaft.
c) Lower the machine using the lever of the hydraulic system.

OBSERVATION

Lower the machine slowly until the auger has bored 20 centimetres into the ground.

d) Lift it to remove the soil.
e) Introduce the auger again.

OBSERVATION
The auger can be withdrawn several times according to the conditions of the soil, until the required depth is reached.

f) Withdraw the auger completely.

6th Step - *Park the machine* thus:
a) Take it to the maintenance area.
b) Carry out maintenance.
c) Take it to the parking area.
d) Unhitch.
e) Move the tractor.

This operation consists of using different machines which can be driven with the pulley or with the power take-off shaft to perform the sepcific tasks for which they are designed.

PROCEDURE

1st Step - *Take the machine* to the work site.
Carry out lengthwise and crosswise levelling and block it.

2nd Step - *Mount the pulley on the tractor* (if necessary) thus:

a) Remove the upper arm from the hydraulic system.
b) Remove the nuts from the anchoring points of the safety chains and take the chains off.
c) Lift the arms of the hydraulic system of the tractor and block them.
d) Remove the drawbar of the tractor.
e) Take out the bolts and remove the cover and guard from the power take-off shaft.
f) Place the pulley according to the required rotation (right or left).
g) Replace the bolts and secure the operator's manual.

3rd Step - *Place the tractor in working poisition,* thus:

a) Correctly align the tractor with the machine (Fig. 1).
b) Mount the belt and tighten if (if the pulley is used).
c) Couple the drive shaft of the machine to the power take-off of the tractor (if the power take-off is used).

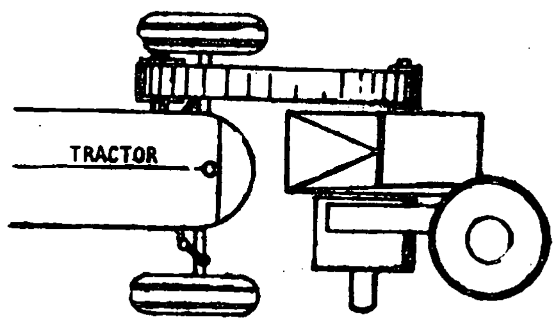


Fig. 1

OBSERVATION
The power take-off shaft of the tractor should be disconnected for sub-steps b and c.

d) Block the tractor by chocking the wheels and applying the hand brake (Fig. 2).

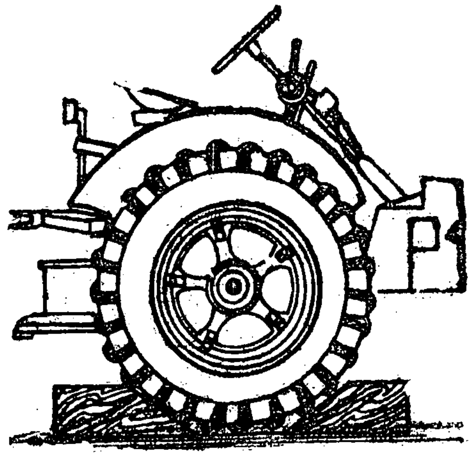


Fig. 2

SAFETY MEASURE

CONNECT AN EARTHING CHAIN TO THE TRACTOR AND ANOTHER TO THE MACHINE TO DISCHARGE STATIC ELECTRICITY GENERATED BY FRICTION.

4th Step - *Operate the machine* thus:

a) Start the engine of the tractor.

b) Engage the clutch of the power take-off shaft of the tractor or drive pulley.

c) Gradually accelerate until operating speed of the machine is reached.

OBSERVATION

Consult the operator's manual for sub-step c.

d) Carry out the work.

5th Step - *Park the machine,* thus:

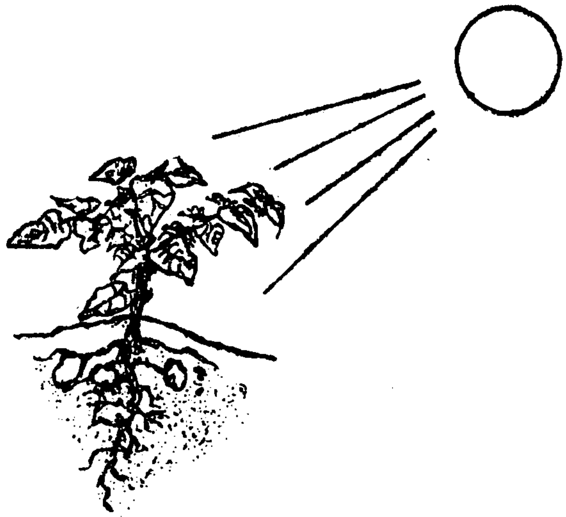
a) Take the machine to the maintenance area.

b) Carry out maintenance and take it to the parking area.

c) Unhitch the machine and move the tractor.

TECHNOLOGICAL INFORMATION SHEETS

Without green plants there would be no life on earth. The plant kingdom determines the existence of animal life. Without crops mankind would die of starvation. Green plants are able to use solar energy with a high degree of efficiency. Man's life depends on the energy stored in grains, roots, fruits, and other parts of plants.



For plants to exist it is necessary that they obtain *light, heat, nutrients, water and air*. Having a good crop depends on the harmonious proportions in which the plants obtain these factors.

Light and Heat

These are climatic agents which, in general, do not depend on the farmer.

Nutrients

The farmer controls these by fertilizing, amending and handling of the soils.

Water

The farmer influences the water content when tilling, irrigating crops and draining his lands.

SUMMARY

Man's life depends on crop production. In order to produce good crops he procures the appropriate conditions for the plants, acting on the plants themselves, on the climate and on the soil.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 2.3-12

It takes nature centuries to form a few centimetres of soil, while tons of soil can be lost in a matter of seconds because of incorrect agricultural practices.

SOIL

Soil can be defined as a living medium, a mixture of rock fragments more or less pulverised, decomposed organic matter, water and air. Soil provides support and part of the nutrients needed by plants.

SOIL FORMATION

This is the gradual process of transformation which rocks undergo (parent rocks) under the action of physical, chemical and biological agents.

The agents in the formation of soils also contribute to the loss or decrease of the agricultural value of the said soils.

	AGENTS		
	Physical	Chemical	Biological
FACTORS	*Climate Topography Age*	*Decomposition*	*Flora Fauna Man*

AGENTS AND FORMATION FACTORS

Physical

Climate. It comprises *temperature, rain, humidity, light* and *winds*.
The combined action of these contributes to desintegrate and dissolve the parent rock.
Topography. Depending on it are the exposure to the sun, the washing away of materials by water running on the slopes, the formation of deposits in the valleys, the drainage, etc.

Age. Time determines the existence of:

- *young soils,* in which the characteristics inherited from the parent rock are dominant over the acquired ones,
- *mature soils,* which have developed profile and the acquired characteristics are dominant over the inherited ones,
- *old soils* which have no inherited characteristics; the acquired ones are completely dominant.

Chemical

Without chemical agents physical forces in nature could not produce an agricultural soil.

Biological

Biological agents are indispensable in the formation of soils because they supply organic matter which later decomposes.

Flora. (plant life) Bacteria, fungi, lichens and higher plant forms. *Vegetation is a factor in the formation of soils and these determine the vegetation.*

There is a close interrelationship and a reciprocal effect between the soil and plants.

Fauna. Worms, ants, and higher animal forms.

Man. He influences by modifying natural conditions. *His most notorious action is to accelerate the process of erosion or loss of soil.*

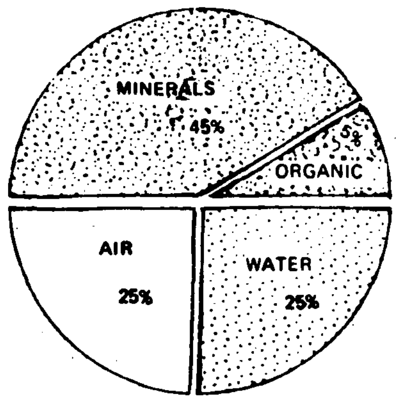
SUMMARY

The soil is a medium (a mixture of minerals, organic matter, water and air) in continuous transformation involving:

- *parent rock,*
- *physical and chemical agents,*
- *living beings.*

An agricultural soil is formed by minerals and organic matter, air, and water, in varying amounts which help to determine its productive capacity.

The porous spaces between the solid particles are occupied by gases and vapours (air) and by liquids (water).
Fig. 1 shows the relative volumes of the components of average soil at a given time.



Solids 50%

Porous Space 50%

AGRICULTURAL SOIL	Solids	*Mineral* *Organic*
	Porous Space	*Soil solution* *Air of the soil*

Solids

Minerals

These come from the decomposition and alteration of the parent rock. Together with being the main components of the soil they provide the soil solution with most of the vegetable nutrients.

Organic
They are derived from plant and animal residues, and they can be found in varying stages of transformation. This is the so-called humus. Humification occurs through the action of micro-organisms which feed on organic waste. Humus is the storage and supplier of nutrients while it also gathers soil particles in aggregates which make it workable, less subject to erosion and more productive.

OBSERVATION
The transformation of a mass of mineral particles into a living soil depends on organic matter.

Pore space

Approximately half of the volume of any soil is occupied by air and water.

Soil solution
Part of the water which penetrates the soil is retained in it, dissolving minerals which nourish the plants.

OBSERVATION
From the soil solution crops obtain water and most of their nutrients.

Soil air
There is a gaseous exchange between the soil and the atmosphere. The root has to breathe to absorb the solution from the soil, and humus-forming organisms need oxygen to carry out their task.

OBSERVATION
When the gaseous exchange between the soil and the atmosphere stops, as in the case of soils crusted by the effect of the rain, the farmer intervenes by breaking the impermeable layer with harrows, cultivators and other mechanical implements.

SUMMARY

All arable lands contain solid matter, gases and water. The relative amounts in which the components can be found determine the existence of soils:

- *that stick to the implement,*
- *easy or hard to work,*
- *poor or very fertile and productive,*
- *hard, dry, etc.*

The farmer can modify the composition of his soils in order to obtain greater benefits, or alter them impoverishing his lands through incorrect handling.

This is a physical property determined by the size and amount of mineral particles in the soil.
Different textures demand different agricultural particles. Both texture and particles can determine the yield of the crop.

CLASSIFICATION
These particles are classified according to their size. They are called granules. These granules in descending order are called gravel, sand, silt and clay. The following table shows the size limits of each granule.

GRANULOMETRY

Granule	Diameter limit (in mm)	Visible with
1. Gravel	Greater than 2.0	the naked eye
2. Sand	2.0 to 0.02	the naked eye
3. Silt	0.02 to 0.002	microscope
4. Clay	Smaller than 0.002	not visible with common microscope

OBSERVATION
Sand, silt and clay are the only granules considered when determining the texture of the soil.

CHARACTERISTICS OF THE GRANULES AND PROPERTIES THEY IMPART TO THE SOIL

GRAVEL
The proportion of gravel in a soil is not used to determine texture.
Its abundance in certain soils impose the adoption of special cultivation practices and/or the selection of agricultural equipment with characteristics of their own, such as planters with a single disc coulter.

OBSERVATION
It imparts to the soil a very low water retention capacity.

SAND

The relatively large size of the pores between sand particles gives the soils a low water-retention capacity, good aeration and low plasticity.
The soils in which sand prevails will then be easy to work, loose, friable and will have good drainage and aeration.
During dry seasons, crops on sandy soils are the first to suffer the effects of the drought. Sandy soils are also poor in nutritive elements.

Plasticity: it is the capacity to adopt different forms and keep them. A plastic body is one which can be easily shaped.

Friable: means that they are easily crumbled.

OBSERVATION

There are different types of sandy soils depending on the fineness of the particles and their mixture with organic matter and minerals.

SILT

It is made up of irregular, rough granules of different shapes. It is plastic and tenacious.
Soils in which this granule is predominant, have a low air and water permeability and are more difficult to cultivate than the sandy ones.

Tenacious: resistant to be broken or deformed.

CLAY

Clay particles when kneaded with sufficient moisture show a great plastic adhesiveness and impermeability. On drying they contract and when again moistened, they swell giving off heat.
The capacity for the retention of water and nutrients of clay soils is very great. Thus, in general, they tend to be fertile.

When farmers refer to *heavy* and *light* soils, they are speaking of the clay and sandy ones respectively. These terms are not related to the weight of the soil, but refer to the ease with which they are tilled or worked.

TEXTURAL CLASSES

The class indicates the proportion of sand, silt and clay.
A few classes of texture and their names are given in the following table.

PERCENTAGE LIMITS OF GRANULES FOR DIFFERENT TEXTURAL CLASSES

TEXTURE	SAND	SILT	CLAY
Sandy	---85		
Silty		--80	12-0
Clay	45--	40---	---40'
Loam	25--	50-28	27-7
Clay-Loam	45-20	52-15	80-55

DETERMINING THE TEXTURE

The textural class can be exactly determined by means of laboratory analyses and tests, but, generally speaking, the field appreciation is enough.
In the field the class is determined by touch. The texture can be judged by feeling the soil between the fingers.

OBSERVABLE RELATION BETWEEN TEXTURE AND SOIL PRODUCTIVITY

There is a relation between soil texture and productivity. Soils having much sand and little clay generally have low fertility and water retention.

Sandy soils easily absorb water and they are well aerated, but they do not retain moisture and they are low in nutritive elements. With irrigation and fertilization they can become highly productive.

The smaller the fractions, the higher the rate at which nutritive elements are supplied to the soil solution.

Too much clay may imply excessive water retention and therefore a defective aeration.

SUMMARY

To obtain good crops from any soil it should have an appropriate combination of:

- *water retention capacity;*
- *aeration;*
- *rate at which organic matter and minerals are supplied to the soil solution.*

The perfect combination is the goal of the farmer in the handling of his lands. This handling is determined by the texture of the soil.

CINTERFOR
1st. Edition

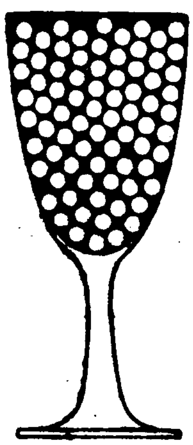
RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 2.3-12

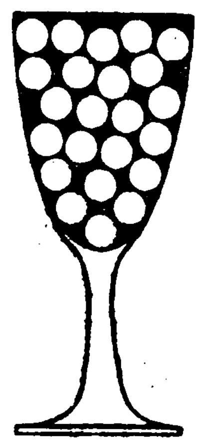
POROSITY

Because of its close relationship with water retention capacity and aeration of the soil porosity is a physical property which determines productivity.

Figures 1 and 2 show vessels containing marbles of different sizes. In Fig. 1 it can be seen that to small particles correspond small spaces, and by comparing we can see that when the particles are larger (Fig. 2), the pores are also larger.
By comparing both figures it can be seen that the total volume of pores is relatively larger in the case of the smaller marbles with respect to the larger ones.



SMALL PORES
LARGE POROUS VOLUME



LARGE PORES
SMALLER POROUS VOLUME

OBSERVATION
There are no agricultural soils made of particles of one single size.

GENERAL RULES ON SOIL POROSITY

1. To finer textures correspond greater total volume of pores and pores that are individually smaller. Clay soils have greater porosity than the sandy ones, but in the sandy ones the size of each pore is larger.

2. The lost of humus in a soil diminishes the porosity.

3. Virgin soils have greater porosity than those which have been cultivated. This greater porosity is due to:

   - *Compactness produced by heavy machinery, and*
   - *the loss of organic matter which results from cropping.*

4. A soil may have a high porosity and still be poorly aerated, since the degree of aeration depends on the water content of the soil. The penetration of the roots and thus the yield of the crop also depend on the aeration.

5. Soil porosity also determines the resistance to cultivating equipment; porous soils are more easily worked than the compact ones. The porosity of a soil partially determines its *colour.*

COLOUR

This important characteristic results from physical properties and chemical composition of the soil and indicates how to handle it. The following chart gives a general idea on colour and the condition of the soil.

COLOUR	GENERAL INFORMATION
Dark, brown and black	Indicates organic matter content
Red	Indicates, generally, good drainage
Grey, yellow, light brown	Drainage problems

Field interpretation of the colour of a soil allows us to know features such as:

- *humus content*
- *aeration*
- *moisture*
- *solubility of nutrients,*
- *temperature.*

TEMPERATURE OF THE SOILS

On this depends the germination of seeds, the depth of the roots, micro organism activity and the growth of the crop.
Knowing the temperature of the soil helps to decide on the following:

- *dates for sowing on different fields,*
- *most appropriate depth for ploughing,*
- *convenience of works for improving drainage, and*
- *change permeability conditions.*

PERMEABILITY

It is the capacity of the soil to let air and water through.
It determines the renewal of the air needed for aerating the roots and for the solubility in water of the plant nutrients.

OBSERVATION

The farmer modifies the permeability of soils in different ways, mainly with agricultural equipment.

SUMMARY

Porosity, colour, temperature and permeability are characteristics which relate to productivity and determine how to handle the soils. After interpreting these characteristics the farmer makes decisions with respect to crops, agricultural operations and the conservation of soils.

This is the property of the soil which is determined by the grouping of particles into aggregates. While the texture or relative size of the particles is determined by the process of formation of each soil, the *structure* or grouping of these particles into aggregates can be modified by agricultural practices.

OBSERVATION
There are no soils with good productivity and poor structure.

A soil has a good structure when the particles form lumps or aggregates called granules. When the particles of clay are mixed with those of sand and silt to form clods, the soil has the proper porosity. This porosity determines a good permeability for air and water. On the other hand, if the clay had not been retained in the aggregates, it would have been moved down clogging the pores.

Soils with good structure are not easily eroded. In these, rain water soaks into the land, instead of running over it, washing away its components.

In soils with a good structure, the roots of the plants grow easily.

A soil with a good structure dries and gets heated faster than a compact one.

Soils with poor structure are:

- of *slow drainage* and therefore of poor *aeration*,
- *hard* when dry, *sticky* when wet and therefore always *difficult to work*.
- *easily eroded*, that is, since the particles are not strongly bound to form clods, they are swept away by water and wind.

THE STRUCTURE CAN BE DAMAGED

When someone gets mud on his shoes what really happens is that he kneads the soil which has an excess of water, breaks the clods and causes the mixed particles to form a compact mass called mud.

By ploughing or cultivating an excessively wet soil, the structure is being damaged; mud is produced.

Any practice which causes decrease or loss of organic matter (humus) damages the structure.

THE STRUCTURE CAN BE IMPROVED

The best aggregation agent is organic matter.

Any agricultural practice which increases the amount of organic matter incorporated in the soil favours the structure.

These practices may be:

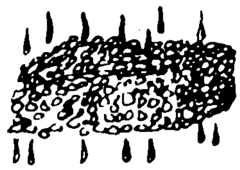
- *of a direct effect:*
  adding organic matter as in the case of buried crop; a process which is called green manuring or adding manure to soil.
- *of an indirect effect:*
  encouraging the development of better crops by fertilizing and by the appropriate agricultural practices (weeding, sanitary attention, etc.) which will leave the land with more plant residues.

COMPOSITION OF AN AGGREGATE

It consists of larger elements (sand and silt), pore spaces with water and air and the aggregating element which is known as clay-humic complex. The coarse elements are joined by means of a kind of cement formed by clay and humus.

TYPES OF STRUCTURE

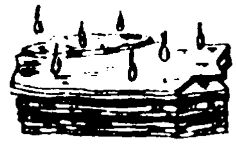
There are seven structural types comprised within the two possible non-structural states known as: *simple* (Fig. 1) and *massive*.



SIMPLE

The seven types of structure are: *platy, columnar, prismatic, blocky, nuciform, granular and crumb.*

Platy structure. These are particles which are organized around a horizontal plane, having the form of horizontal plates or small leaves (Fig. 2).



PLATY

Prismatic structure. These are particles which are organized around a vertical axis. They are columns or pillars with angular vertices (Fig. 3).

PRISMATIC

Columnar structure. As above, but with rounded vertices.

Blocky structure. These are particles which are organized around a given point with flat and sharp surfaces (blocks Fig. 4) or blunt (nuciform).

BLOCKY

Spheroid structure. In these the aggregates are organized around a given point, are rather round, and are known as granules or crumbs depending on the porosity.

OBSERVATION

For any given soil the structure should be as perfect as can be made.

To *improve and maintain the structure*, the farmer can:

- carry out *humus corrections*, that is, to add organic matter to the soil,
- carry out *lime corrections*, that is, to add calcium which increases the aggregating power of the clay and the humus,
- tilling the soil *while mellow*, that is, at the appropriate time in accordance with its moisture and its own characteristics.

SUMMARY

SOILS	with good structure	are more productive are easily ploughed the roots penetrate easily and deeply
	with poor structure	are more erodible are hard when dry are sticky when wet

THE STRUCTURE

is improved by:	is harmed by:
- *the incorporation of organic matter*	- *the decomposition of the humus*
- *ploughing when mellow*	- *ploughing with excessive moisture*
- *fertilization*	- *the cropping process*
- *humus corrections*	- *the withdrawal of products (milk, meat, etc.)*
- *lime corrections*	- *the compactness of the soil produced by agricultural equipment*
- *green manuring*	- *the erosion processes*
- *the addition of manure*	- *the destruction of plant residues (fire).*
- *soil conservation practices*	

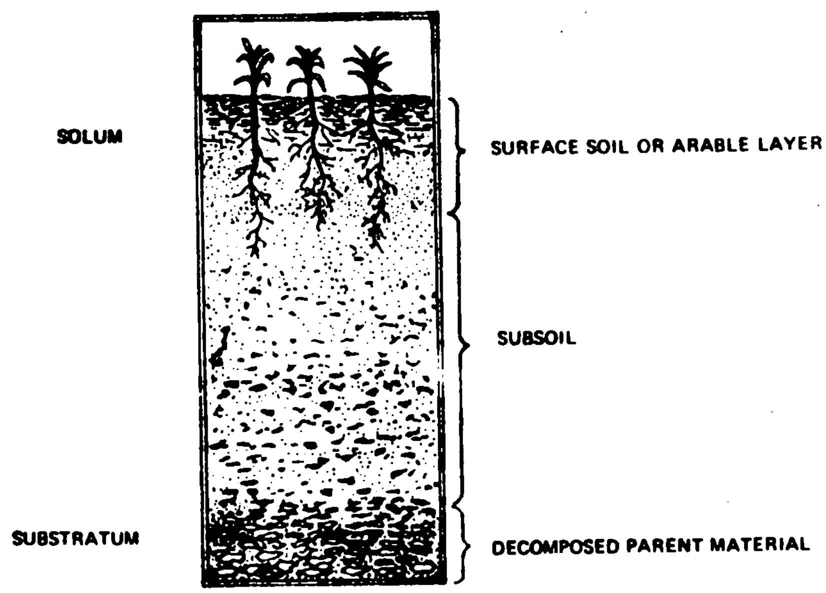
When a pit is dug in a given land, it is possible to observe relatively clearly defined horizontal layers. These layers vary in width and have different physical characteristics. They are called *horizons*.
The group of horizons looked at orderly from the surface of the soil to the rock layer makes up the profile of the soil.

The Profile is the vertical section or cut of the soil in which the different horizons are identified.

OBSERVATION
It is important for the farmer to know the profile of his soil for the following reasons:

- when the experimental stations offer their recommendations on fertilization, appropriate crops, sowing seasons, ploughing depth, etc., they do so for different types of soils. These soils are identified by their profiles.
- the profile tells him the degree of erosion that has been reached, the depth at which he should plough and other characteristics that will enable him to get a greater yield from his lands.

Fig. 1 shows the outline of a profile with the names most commonly used.



SURFACE SOIL

This is the zone on which ploughing tools (ploughs, harrows, etc.) mainly work. For this reason, it is also called *arable layer*. It is in the arable layer where the seeds are planted.
Because it is the zone of greater content of organic matter it is generally the darkest one.

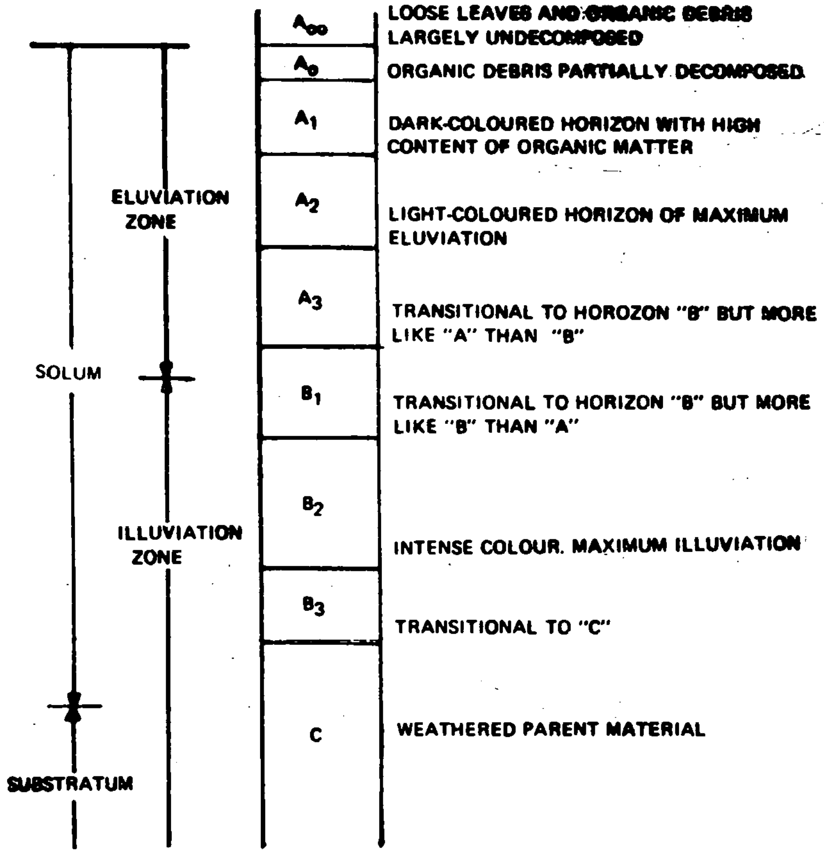
SUBSOIL

It contains a smaller amount of organic matter and, therefore, its colour can be lighter. However, this does not mean that it is poorer in nutrients. It generally contains components which were washed away and dragged from the higher layer through a process known as *eluviation* and retained in it by a mechanism known as *illuviation*.

The decomposed parent material together with the rock make up the *substratum*. They have undergone, in varying intensity, the weathering *process*, that is, the disintegration of rock and minerals by physical and chemical agents. The roots of the plants penetrate this horizon in lesser amount. However, they do penetrate.

The farmer when referring to the horizons, instead of using terms such as arable layer, subsoil and parent layer, he calls them horizons A, B, and C respectively. He also recognizes *sub-horizons* to which he appoints subindices, for example, A_0, B_2, B_3, etc.

The following diagram is a synthesis of an ideal soil.



OBSERVATION

The various horizons and sub-horizons cannot be identified in all soils. In a few soils some sub-horizons do not exist.

SOIL AND SUBSOIL. Both interact, thus determining the productive characteristics of the soil.

Even when the cultivation can be limited, in certain cases, to the surface soil portion, the sub-soil is still important.
The lower horizon can determine aeration and drainage conditions, thus causing an excess of moisture or a low water retention capacity which affect the vegetation.

The major part of agricultural practices such as, ploughing, cultivating, fertilizing, etc. are done on the arable layer. However, occasionally, works are carried out on horizon B; for example, working the sub-soil and deep ploughing are common to certain crops and soils.

Organic matter is the life of the soil. The agricultural soil is a living medium; without it, it is dead and therefore, not suitable for agriculture. It is a small but very important fraction on which the yields of the crops depend. It includes the recent and decomposed residues of plants and animals, the live and dead micro-organisms of the soil and the final product or humus.

The organic matter in the soil feeds the micro-organisms, provides nutrients for the crops, improves farming conditions, fixes elements by detaining leaching, improves the structure and with this the aeration and penetration of the roots, increases water retention and affects the temperature. All in all, it turns a sterile medium into an agricultural soil.

ACCUMULATION

The depositing rythm depends as much on the speed with which organic residues are incorporated as their decomposition or mineralization. It accumulates during the formation of the soil depending on different factors. *Temperature, moisture, vegetation, drainage, fertility, texture and topography are the most important.*

TEMPERATURE

Among the climatic factors, this is the most important.
The soils with the greatest accumulation of organic matter belong to the cold climate regions where if the aggregated residues are small, the mineralization is very slow.
The decomposition is a biochemical process carried out by micro-organisms, and these work slowly at low temperatures.

MOISTURE

The greater the moisture due to climatic, topographic or drainage conditions, the greater the content of organic matter in the soil.

VEGETATION

Pastures supply great quantities of organic compounds to the soil. Trees do it to a lesser extent.
The reason for this is that the supply from the roots of the pastures is done on the surface horizon, while the leaves of the forest remain wet on the ground and decompose rapidly.

DRAINAGE

The decomposition of the organic matter requires oxygen. Therefore, whatever contributes to better aeration, accelerates the process of loss or mineralization.

FERTILITY

A higher fertility produces more vegetation, better crops and therefore, more residues.

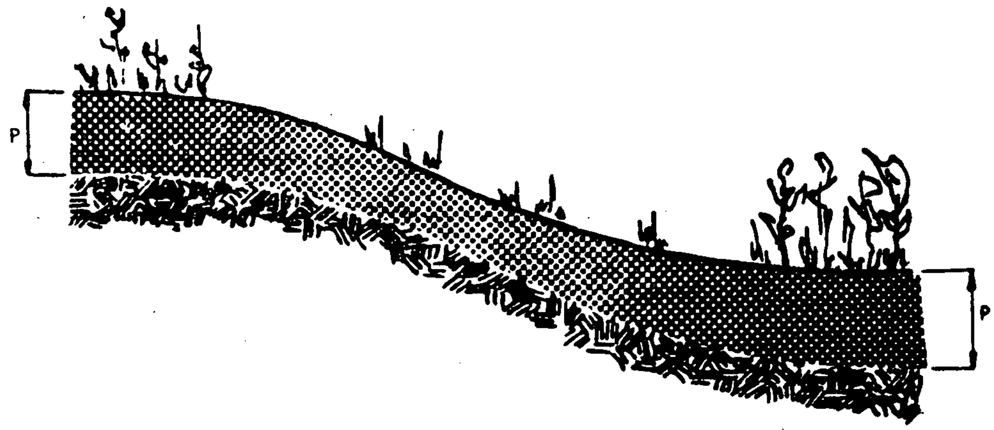
TEXTURE

This is important to the extent to which it affects aeration and therefore, the biological activity. The fine textured soils (clayey) will have a greater accumulation of organic matter than the coarse ones (sandy).

TOPOGRAPHY

On this depend to a certain degree two factors already considered: temperature (interception of solar energy) and aeration (seepage and drainage).

Figure 1 shows the content of organic matter (the amount accumulated and the depth) for a soil under the different topographic conditions of table-land slope and low-land.



P indicates the relative depth reached by the organic matter.

The intensity of the greying represents the amount of accumulated organic matter.

Fig. 1 - Effect of drainage, vegetation, insolation and temperature on the accumulation of organic matter for different topographies.

ORGANIC MATTER AND FARMING

An adequate content of organic matter improves the structure and therefore makes the farming operations easy.

The so-called *"farming capacity"* of soils is only obtained in a satisfactory way, above certain minimum contents of organic matter.
Nevertheless, when ploughing, harrowing and cultivating, the mineralization process of the organic matter is accelerated. It happens so because the decomposition of the organic matter requires oxygen; therefore, the speed of the process depends on the amount of air available. The above-mentioned agricultural operations incorporate air to the soil.

ORGANIC MATTER AND CROPS

To the extent to which a crop requires less farming operations, the soil will be more enriched in organic matter. This enrichment will be proportional to the amount of incorporated residues.

In this sense the permanent crops (forests and pastures) will contribute more than the annual ones (wheat), and these more than the annual ones which must be weeded (corn).

Also the losses will depend on the protection which the different crops offer the soil; row crops, weeded or not, expose the soil more to the physical agents like rain and sun than those which form a uniform carpet.

SUMMARY

The humus affects the physical chemical and biological aspects of the soil, resulting in an increase of the production capacity.

It is generally admitted that the humus is the basis of fertility.

The *productivity* of a soil also depends on the amount of nutritive elements which it supplies to the plants. The main factor is not the amount of elements which the soil may have but the speed with which it supplies them to the crop. This is the meaning of *fertility*.

CHEMICAL ANALYSIS

This tells what elements and in what quantities they are found in a given sample.

FERTILITY

This expresses the quantity and balance of the plant nutrients necessary and available in the soil for the growth of the crops.

PRODUCTIVITY

This results from the concurrence of various factors - light, temperature, physical conditions of the soil, adequate supply of nutrients, etc.

It is gathered from the above-mentioned:
That the chemical analysis is not a test of the fertility of the soil. That fertility and productivity are different concepts, the supply of nutrients being one of the factors which conditions the volume of production per unit of soil.

ESSENTIAL ELEMENTS

Each essential element has a specific and different role in the plant. There are 16 nutritive elements necessary for the development of plants. These are obtained from the air, water or soil; although in relatively larger or smaller quantities, they are always essential.

CINTERFOR
1st. Edition

ESSENTIAL NUTRITIVE ELEMENTS

MACRONUTRIENTS*	MICRONUTRIENTS**	OBSERVATIONS
Carbon C Hydrogen H Oxygen O		The plant obtains them from the air and the water
Nitrogen N Phosphorous P Potassium K		Called *major elements*. These are the most frequently found in insufficient quantities
Calcium Ca Magnesium Mg Sulphur S		Called *secondary elements*. The soil may have them in insufficient quantities.
	Iron Fe. Manganese Mn. Boron Bo. Molybdenum Mo. Copper Cu. Zinc Zn. Chlorine Cl.	Called *trace or minor elements*. Rarely the supply is not adequate. Special soils and crops may require a greater supply.

* Macronutrients are the nutrients used in relatively large quantities.

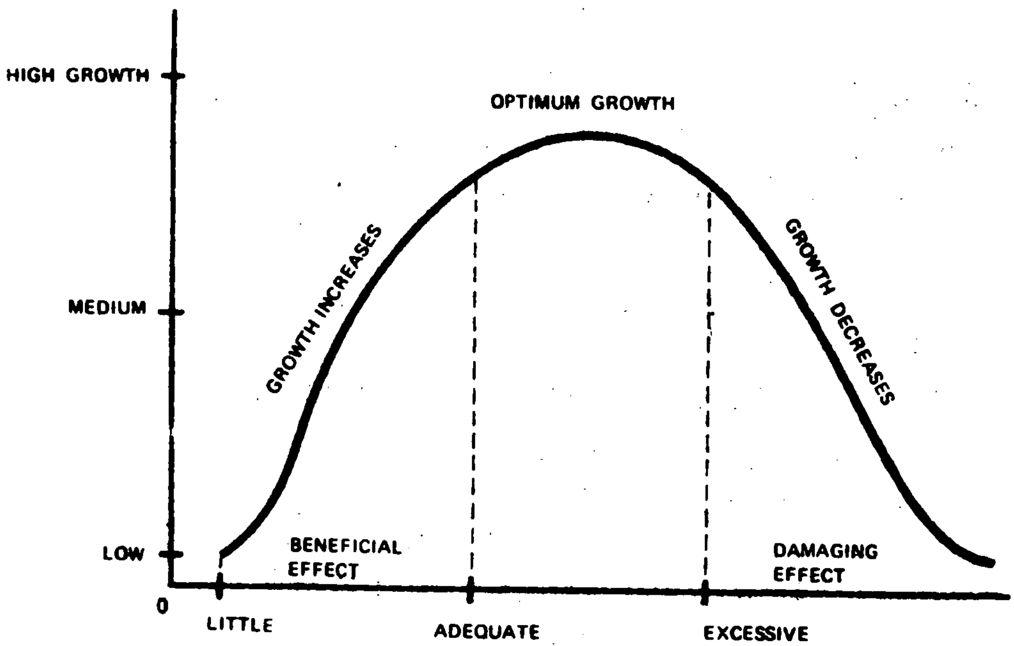
** Micronutrients are the essential elements used in relatively small quantities.

Carbon, hydrogen and oxygen are obtained from air and water by the plant. The supply of the remaining nutritive elements depends on the solids which are previously dissolved in the soil solution.

The available quantity of nutritive elements affect the development and growth of the plants and therefore the output of crops.

STUDY OF A NUTRIENT

The relation between the plant growth and the amount of nutritive element is shown in the following graph. *It is assumed that all the other conditioning factors are in an optimum state.*



AMOUNT OF NUTRIENT

Two conclusions are obtained from the graph:

- *greater amounts of nutrients result in better growing conditions* up to a given limit when:

- *the quantity of the element is excessive and harmful for the plant growth.*

Both conclusions have practical validity:

- *for economic reasons;* when deciding whether to use fertilizers or not, or on the amount of them to be used.

- *for operation reasons;* what may happen if a fertilizer distributor distributes half of the amount intended by the producer? What happens if it sprays much more?

CONSIDERING VARIOUS NUTRIENTS

The degree of growth of a plant or crop is determinedby the relatively scarcer element. It will be great or small according to the greater or lesser available amounts of that nutrient. This is the *minimum law* and the scarce element is called the *limiting factor*.

OBSERVATION
The minimum law is of general application and the limiting factor may be a nutrient or any other factor of production (light, temperature, etc.).
It is gathered from the law that the factors of production interact among themselves, meaning that they do not act in an independent way.

THE FARMER AND THE NUTRIENTS

A good supply of nutrients is fundamental to obtain high-yield crops.

The nutrients taken from air and water (C, H, and O) are found in practically unlimited amounts. Taking full advantage of these is usually impossible for the farmer.
On the other hand, the nutrients extracted from the soil, (N, P, K etc.) are found in limited quantities and the farmer may and should intervene so as not io impoverish his lands by depleting the reserves of elements which they have.

The farmer intervenes favourably by adding nutritive elements or fertilizing, through practices such as amendments which better the physical, chemical and biological conditions, and by carrying out adequate soil conservation.

The objective of *fertilization* is to maintain and better the fertility of the soils.

The purpose of the *amendments* is to better the physical, chemical and biological conditions of the soils.

The purpose of *erosion control* is to maintain the productive capacity. That is why it is also called soil conservation.

The practices of fertilization, amendment and erosion control contribute to the production of crops of high quality and greater quantity.

LOSS OF FERTILITY

There are four different ways in which the soil is depleted of its nutrients, and so reducing its fertility and therefore its productivity. They are:

Reduction of the amount of organic matter in the soil by decomposition. The micro-organisms fundamentally destroy the humus, but the agricultural work of soil tilling (ploughing, harrowing, etc.) and cultivating (cultivators, harrows, etc.) accelerate the process.

Loss of nutrients by washing or leaching. Leaching is the removal of materials from the soil by the waters which percolate or drain. The drainage of the excess water is necessary for the growth of the crops. Drainage is also needed for the transport of materials such as the washing away of nutrients.

There is loss of nutrients when agricultural products are sold. Grains, animals, milk and wool, for example, are products which when extracted remove nutritive elements from the farm.

Erosion. This is the most important nutrient-losing mechanism because of the amount removed and its effect on other factors which affect productivity.

SUMMARY

When increasing the availability of a nutrient, the product is increased, if this was the limiting factor.

The agricultural practices increase or decrease the availability of the essential elements for plant nutrition.

The availability of nutrients	is increased with	fertilization amendments conservation of soils
	is decreased by	erosion loss of organic matter leaching extraction of the product

The mineral salts in solution are dissociated or separated in electrically charged parts named *ions*. The presence of larger or lesser relative amounts of hydrogen ions (H+) in a medium is expressed by a conventional scale called pH.
The soil solution contains free ions, and also there are ions retained by the clay-humus complex. The retention of ions and the pH value bear relation with the availability of nutrients and therefore, with the productivity of the soils.

ANIONS AND CATIONS

A mineral salt in solution is dissociated in:

- a part, with one or many negative electrical charges, named *anions*, and
- another part, with one or many positive electrical charges called *cations*.

The following graph shows some ions which are plant nutrients, with their respective electrical charges. Only those which are commonly used in fertilizing and amendments have been included.

IONS			
Anions		Cations	
Phosphate	PO_4	Calcium	Ca^{++}
Nitrate	NO_3	Potassium	K^+
Carbonate	CO_3-	Magnesium	Mg^{++}
		Ammonium	NH^+

RETENTION OF IONS

The clay humic complex has the property of fixing cations (+) because it has negative electrical charges (-).

OBSERVATION

It should be admitted that the phenomenon occurs because different electrical charges attract each other and similar signs repel each other.

This property, which is represented in the figure and called the *retention capacity* or *absorbing power* of the soil affects the availability of the nutrients.

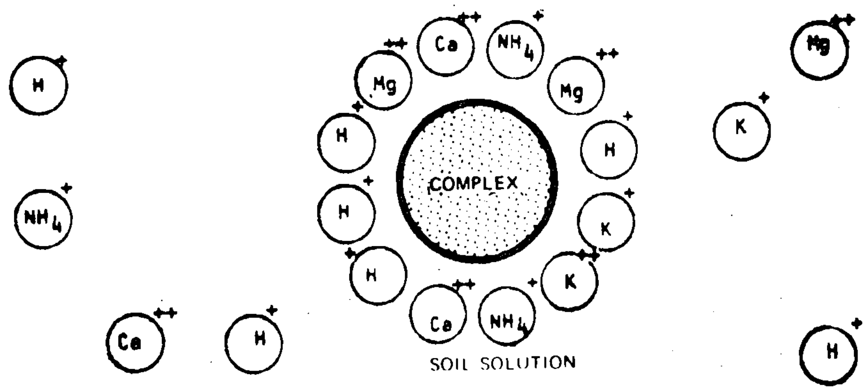


Fig. 1 - Fixation and exchange of cations

The leaching of cations and the benefit derived from the fertilizers depend on the *ionic exchange*.

The exchange occurs between the complex and the soil solution and usually each time a cation is fixed another one is released and goes into the solution. There also exists an equilibrium which is manifested in the following:

- if we add a given cation to the soil (fertilize), part will be retained in the soil and the rest will remain in the solution;
- when the crop extracts nutrients from the soil solution, the absorbent complex releases some of the cation that was retained.

These characteristics have lead to naming the clay-humus complex, the *fertility regulator*.

pH

This is the scale which expresses the relative amounts of the hydrogen cation (H+) in a medium. When the amount of H+ is equal to that of OH- (hydroxyl anion) the pH acquires a value of 7 and we say that the reaction of the medium is neutral.

If the OH^- are more than the H^+, the reaction is alkaline, and the value of the pH varies between 7 and 14. If there is an excess of H^+ with respect to those of OH^-, the pH is lower than 7, and the reaction is acid.

The following figure summarizes these concepts.

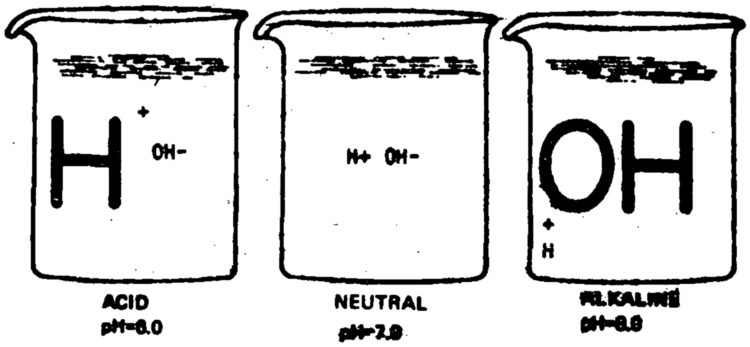


Fig. 2 - H^+/OH^- Reaction and pH

OBSERVATION

The pH scale includes the values between 0 (zero) and 14, but for agricultural soils 4 and 10 are the practical limits.

A scale of values applicable to soils is represented in Fig. 3.

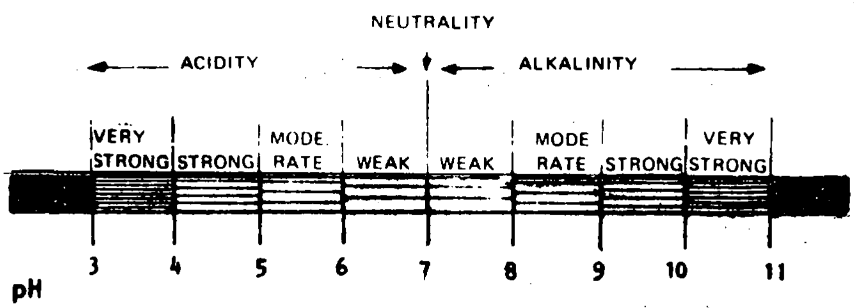


Fig. 3

FREE AND TOTAL ACIDITY

The pH is expressed by the free H^+ in the soil solution. It can be called free acidity (Fig. 4). In the clay-humic complex there is retained hydrogen which represents the acidity potential.

It has already been said that the "free" and "reserve" amounts are in equilibrium. If H^+ ions are removed from the solution, hydrogen from the complex will pass into it. In such a case:

- The free acidity or pH is not modified.
- The reserve and total acidity decrease. This resistance to modify the pH is known as buffer capacity.

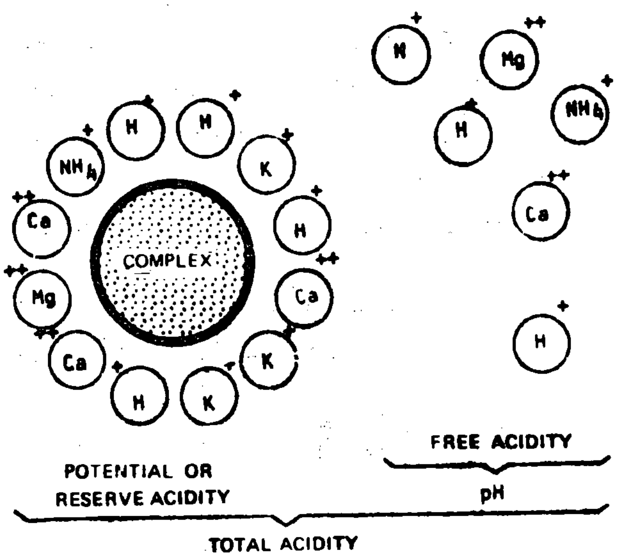


Fig. 4

OBSERVATION
The buffer capacity is the property which the soil has for resisting variations of its pH.

BUFFER - TEXTURE - HUMUS

The richer a soil in clay-humic colloids, the greater its buffer capacity.

pH and NUTRIENTS

The pH affects the availability of nutrients. This is because:

- the equilibrium between the cations (Ca^{++}, K^+, etc.) in the soil solution and the retained cations moves with different amounts of hydrogen ion, and
- the different nutrients form different compounds that are more or less soluble at different pH values.

The availability of nutrients for the crop and its relation with the pH of the medium are shown in the following figure.

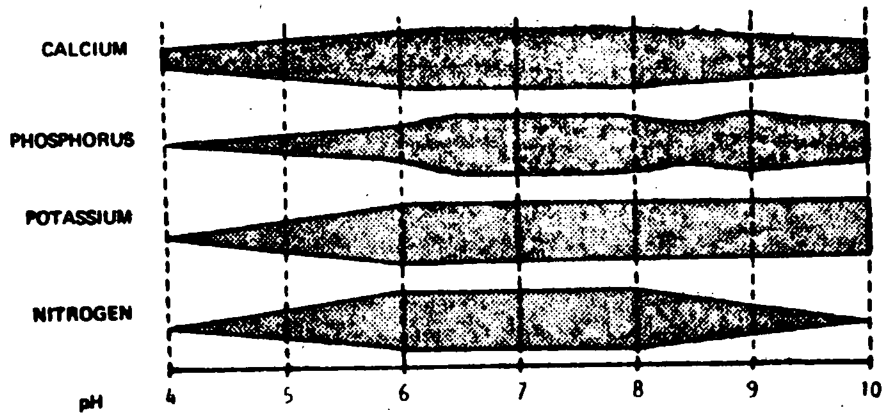


Fig. 5 - Relationship between the availability of different nutrients and the pH.

OBSERVATION

The availability shown in Fig. 5 is true for the nutrients of the soil and also for those which we had as fertilizers.

pH AND CROPS

Some crops (potatoes) develop conveniently in acid soils; others in alkaline ones (alfalfa).
In general, plants grow adequately in a soil of 6.8 pH. Their needs are not absolute being able to grow between very wide limits.

SUMMARY

The plant absorbs the nutrients in the form of ions.
The nutrients of the soil, including those which we add as fertilizers, may be:

- as free ions, assimilable, forming part of the solution,
- retained by the clay-humic complex,
- forming more or less soluble compounds.

The pH or relative amount of H^+ affects the production of crops because:

- it allows an interchange between free and retained nutrients,
- it determines the formation of more or less soluble compounds,
- each plant species develops within a certain range of values and has an optimum point.

The farmer may modify the reaction of his soils, through practices called liming or lime amendments.

Sixteen chemical elements are necessary for the growth of plants. The lack of one of them can seriously reduce yields and profits.

NITROGEN (N)

It communicates an intense green colour.
It encourages rapid growth.
It increases leaf production and improves the quality of leafy plants.
It increases the protein content of grain.
When excessive it delays flowering, fruiting and maturation.

Its deficiency produces:

- *yellowish-green colour,*
- *slow and scanty development,*
- *dryness of the leaves.*

Its presence in the soil increases the activity of micro-organisms and therefore humus formation.

PHOSPHORUS (P)

It stimulates the formation and growth of the roots.
It causes rapid and vigorous initial growth.
It contributes to the formation of the seed and accelerates maturation.

Its difficiency is shown by:

- *leaves and stems having a purple colour,*
- *late development and ripening,*
- *low yield of grain and low seed germinating power.*

POTASSIUM (K)

It furnishes plants with vigour and resistance to pests and diseases.
It increases the size of grain and seeds and improves the quality of fruit.
It gives the stems elasticity thus making them resistant to uprooting.
It assists in the transfer of sugars and it contributes to the development of tubers.
It contributes to the production of proteins and pigments.

Deficiency in potassium produces:

- striped, stained, burnt, rolled-up and torn leaves.
- poor root development, loss of leaves and falling fruit.

CALCIUM (Ca)

It stimulates the initial growth of the root system thus furnishing the crop with vigorous growth.
It increases grain production.

In the soil it improves the structure and corrects the pH.

Deficiencies do not occur often but this condition manifests itself with young rolled up leaves and withered shoots.

MAGNESIUM (Mg)

It is a constituent of chlorophyll; it is necessary for photosynthesis; it regulates the absorption of other nutrients.

In the soil it improves the structure and neutralizes the pH.

The lack of it causes loss of green colour and weak stems.

SULPHUR (S)

It is a constituent of proteins; it stimulates seed production and vigorous growth.

In the soil:

- it activates the formation of nodules in the leguminous plants which fix atmospheric nitrogen.
- it is used to correct alkaline soils.

The lack of it causes slow and poor development of the crop.

BORON (B)

It increases the yield of seed and leaves; its deficiency facilitates the spreading of diseases.

COPPER (Cu)

It is rarely scarce.

IRON (Fe)

It is related to the production of chlorophyll; its deficiency is shown by the pale colour of leaves.

MANGANESE (Mn)

It contributes to the acceleration of germination and maturation of crops.

MOLYBDENUM (Mo)

It is essential for the fixing of atmospheric nitrogen by the radicular micro-organisms of leguminous plants.

ZINC (Zn)

It is necessary for the synthesis of chlorophyll.

CHLORINE (Cl)

It is rarely scarce.

CARBON (C), HYDROGEN (H) and OXYGEN (O) are obtained from air and water.

These compounds are used to supplement the nutrients given by the soil to the crops. When the amount of nutrients obtained by the plant does not allow it to reach its maximum capacity of production, fertilizers which supply the limiting elements are added. The greater availability of nutrients can be achieved by incorporating in the soil solid, liquid or gaseous compounds containing them or spraying them over the leaves dissolved in water.

SOIL AND FERTILIZERS

The soil is the natural source for the supply of nutrients. In the continuing process of soil formation, elements are dissolved and absorbed by the root system of the plant.
The soil solution can, with the required speed, supply the crop with the necessary nutrients in balanced amounts, in which case fertilization is not advisable.

FERTILIZATION

The practice of fertilizing is recommended when one of the following circumstances affects the supply of nutrients:

- it is not sufficiently fast,
- it is not balanced.

To fertilize in excess or when it is not necessary is harmful for the following reasons:

- *economic*
  - it does not increase production; it may decrease it,
  - the excess not absorbed by the crop or retained by the soil is lost by leaching.
- *agronomical*
  - the excessive consumption of a nutrient can diminish resistance to disease and to adverse climatic conditions.
  - the excess of a given nutrient could mean the inability to absorb another nutrient in the adequate amounts causing a lack which affects the development.
  - the addition of mineral compounds to the soil may contribute to decrease the amount of humus and harm the structure.

FERTILIZERS

Products used as fertilizers can be solid (powder or granular), liquid or gaseous.
Under any of the three physical forms, on coming into contact with the seed, seedling or the crop treated, they can be harmless or harmful. This prescribes certain conditions for the farmer to consider.
On the physical and chemical properties of the particular product will also depend:

- whether it is retained by the soil or leached to lower horizons,
- whether it is easily dissolved and, thus quickly absorbed, or whether it takes a long time to become useful.

The different combinations of the above factors and conditions require various forms of applying the fertilizers.

FORMS OF FERTILIZING

Whichever is the method used to apply fertilizers its objective will be a quick and complete beneficial use of the product by the crop.

The different ways and occasions in which the fertilizations should be carried out will depend on:

- the chemical compound itself:
  - its solubility,
  - whether it is retained or not by the soil,
  - whether it can harm (burn) the seed.

- the physical state of the product:
  - solid, powder or granular,
  - volatile or stable liquid,
  - gas.

- the crop in question:
  - annual or perennial.
  - sowing by spreading or in rows,
  - weeded or not,
  - with shallow or deep roots.

- season for application:
  - temperature affects the solubility and volatility of the compounds,
  - moisture affects the leaching of the product.

- time for incorporation:
  - when ploughing the lands,
  - when sowing,
  - pre-emergence
  - when covering

- condition of the land:
  - moisture affects the volatility of several gaseous products (ammonia),
  - a stony condition limits the use of certain equipment.

APPLICATION OF SOLID FERTILIZERS

- These can be uniformly distributed on the surface of the field and left there (Fig. 1). They can also be incorporated at different levels of the soil simultaneously while doing other works on the land or later (Fig. 2).
- These can be applied in bands.

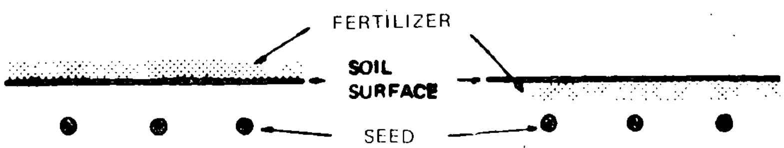


Fig. 1 Fig. 2

APPLICATION OF LIQUID AND GASEOUS FERTILIZERS

These are applied in bands at varying depths depending on the product, the characteristics of the soil and the crop, and the covering is done immediately.

BAND APPLICATION

It is mainly done under the following circumstances:

- scarcely fertile soils or with a great capacity for fixing the nutrient, in which case the plant would be unable to make use of it.
- lands with much weed. The aim is to fertilize the crop not the weed.
- crops with far apart rows (corn, tobacco).
- application "at the beginning", that is, to favour the growth immediately after germination.

In any of the cases the distance between the band and the seed or crop is important.

When the application is simultaneous with the sowing it is common to apply the fertilizer in one (Fig. 3) or two bands (Fig. 4) arranged beside the seed and at an equal depth or somewhat below or above its level. Distances are particular to each possible combination of crop and fertilizer. In certain cases depending on the chemical product and on the seed, they are distributed together in a single band (Fig. 5).

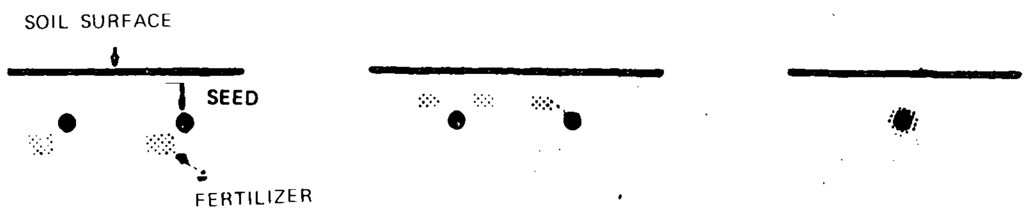


Fig. 3 Fig. 4 Fig. 5

On some occasions it is desirable to place the fertilizer deeply. In these cases the incorporation in the soil is done after the surface distribution with regular ploughs or ~~subsoilers~~. When a subsoiler is used, fertilizing is done in bands (Fig. 7).

Fig. 6

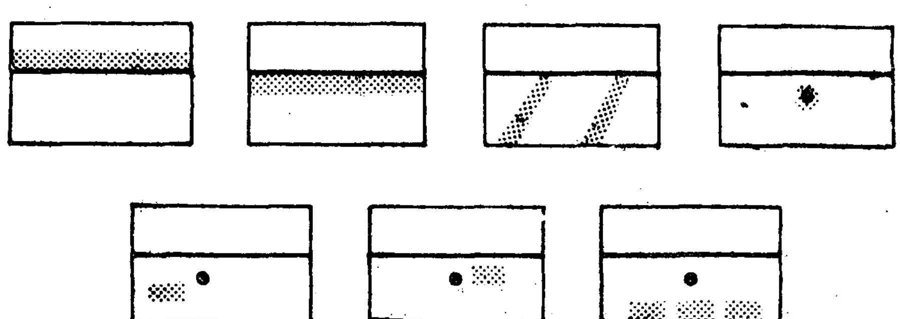
Fig. 7

SUMMARY

Fertilizers: objective - to supplement soil nutrients for crops
goal - to increase production in quantity and to improve quality.

Physical states
- Solid
  - powdery
  - granular
- Liquid
- Gaseous

Placement



This consists of various operations to which the soil is subjected making it more suitable for the growth of crops.

THE OBJECTIVE OF CULTIVATING IS:

1. The destruction of existing vegetation in order to eliminate competition between it and the crop to be established.

2. To obtain a total burying of the underbrush or plant residues, thus favouring their decomposition (humification).

3. To increase aeration without leaving large spaces (pockets) of air which dry the land.

4. To increase water infiltration.

5. To obtain a greater capacity of moisture retention.

6. To propitiate a close contact between the seed and roots with the soil.

7. To facilitate the development of the roots.

8. To facilitate the next sowing operations and cultivation works.

TIME FOR CULTIVATING

This refers to the most convenient conditions of the soil for its cultivation in a given season. These conditions determine the most suitable time and depend mainly on the moisture content although organic matter and clay also affect cultivation.

Soil with a high water content is viscous and flows; as it dries it stiffens, becomes sticky and later, plastic. If it continues to dry, it reaches the *friable* state in which it crumbles easily under any pressure. When it dries more, it becomes hard.

The same cultivation done under different conditions of moisture produces different results:

- little moisture (hard soil). Cultivating produces large clods.
- more moisture (friable soil). Optimum conditions for cultivating.
- excessive moisture (plastic soil). Cultivating produces kneaded lumps which become large and hard aggregates when dry.

The following chart summarizes the relationship between the state of the soil, its consistency and the conditions for cultivating.

State of the soil	Consistency	Conditions for Cultivating
Dry	Hard	Large clods
Moist	Friable	Optimum
Wet	Plastic	Large and hard aggregates
Water-logged	Viscous	Flows in a continuous mass

The tendency among farmers is to cultivate when there is excessive moisture; when the effort necessary for traction is small.
In dry soils the traction necessary is greater and the tools do not penetrate easily.

CHOOSING THE RIGHT MOMENT

A few hints will help to determine the right moment for cultivating:

- An excess of moisture in a recently cultivated soil is seen in that the soil shines. A soil which shines was cultivated when too wet.

- If a handful of earth is taken at shallow depth (10 cms) and is squeezed the results could be:

    - the earth is kneaded and sticks to the fingers; there is excess moisture.
    - it crumbles, it breaks down into granules; satisfactory conditions.
    - the granules do not break when squeezed with the fingers; extremely dry.

- When sinking a shovel into the soil, it should enter with relative ease and when it is withdrawn there should be no mud sticking to it if the conditions are appropriate for working.

The purpose is to maintain productive capacity while producing.
Soil conservation practices are equivalent to good agriculture.
To counteract erosion, which is the principal enemy of productivity, is one of the objectives.

EROSION

Erosion is the wearing of the exposed surfaces and the transportation of the separated material. It is caused by water *(water erosion)* and wind *(aeolian erosion)*.

Water erosion; It is prevalent in places with intense rains in which the quantity of water cannot be completely absorbed by the soil and consequently there is an abundant surface run-off.

Aeolian erosion; It occurs in arid or semi-arid regions with little vegetation in which the unprotected soil remains exposed to the action of the wind.

Erosion takes place at all times on all soils but in varying intensity, which makes it possible to distinguish the following:

- *normal erosion,* which occurs in balance with the environment and the formation of the soil. We will not be concerned with this one.

- *accelerated erosion,* which occurs because of intensive production. This eliminates the natural protection given by the vegetation. It is caused mainly by man.

The process of erosion comprises the disintegration of the soil aggregates and the transportation of the particles. Some of the factors that determine the intensity of the phenomenon are:

- *the climate,* fundamentally; rain, temperature and winds.

- *the topography;* configuration of the land, degree and length of the slope, exposure to the climatic agents, etc.

- the *vegetation*, which protects the soil by intercepting rain and wind, by strengthening the structure and by increasing permeability.

- the *soil;* its capacity of infiltration and the stability of its aggregates determine whether the risk of erosion is high, medium or low.

SOIL CONSERVATION

This results from the combination of various practices which could be grouped in:

1. Cultivation practices.
2. Mechanical practices.

CULTIVATION PRACTICES

These form part of the good handling of the soil and include aspects such as tilling, fertilizing, rotating crops, handling of water, corrections, etc.

Tillage. Its purpose is to prepare the land for sowing. It increases the porosity and infiltration with which the risks of erosion are reduced. However, the size of the aggregates is also reduced as well as the amount of organic matter, bringing about a decrease in the stability.

Tillage is a necessary evil. To reduce its harmful effects the following should be done:

- carry out only the necessary works and
- work the lands when they are mellow.

Fertilizing. From the point of view of the conservation of soils the growth of the crops incorporates more organic matter and run-off is reduced.

Vegetation and rotation of crops. The system of crop rotation refers to the type and sequence of crops grown on the same soil.

The type of crop is important with respect to loss of soil. A list in decreasing order with respect to soil protection, follows:

Permanent vegetation	- 1. Forests and mountains.
	- 2. Natural meadowland.
Semi-permanent vegetation	- 3. Perennial artificial meadowland.
Dense crops	- 4. Annual meadowland.
	- 5. Cereals (Wheat, oats, etc.).
Row crops (weeded)	- 6. Cotton, potato.
	- 7. Soy, corn, sorghum.
Cropless land	- 8. Naked soil

Controlling of water. For soil conservation the speed and amount of run-off water should be reduced.
The amount of water is reduced by increasing infiltration (cultivation, organic matter, vegetation).
The run-off speed is reduced by mechanical practices.

MECHANICAL PRACTICES

These include contour and band cultivation and the construction of terraces, diversion canals, etc.

Contour cultivation. It consists of performing works on the land (ploughing, sowing, etc.) following the contour lines, that is, crosswise to the slope. In this manner the run-off is reduced.

Contour line is the line which joins all the points which are at the same level.

Band (strip) cropping. It consists of planting alternate bands of different crops. It is the systematic planting of band crops to serve as plant barriers against erosion.

Each band can serve one or more purposes, such as:

- intercepting bands,
- infiltration bands,
- breakwind bands, etc.

A permanent band (pasture) is alternated with one of the weeded row crops type (corn) and with another intended for dense crops (wheat).

The crop could be planted level or on a slope:

- Band and contour crops. This is the production of crops following the contour lines and in bands.
- Sloped band crops is a variation of the previous one. It is planted on a moderate slope (1% or less) to counteract erosion and to obtain drainage.

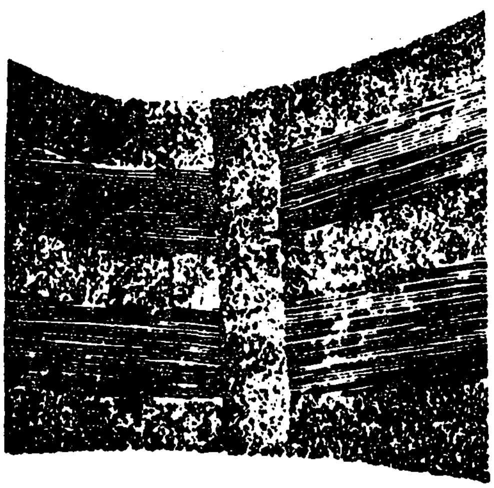


Fig. 1

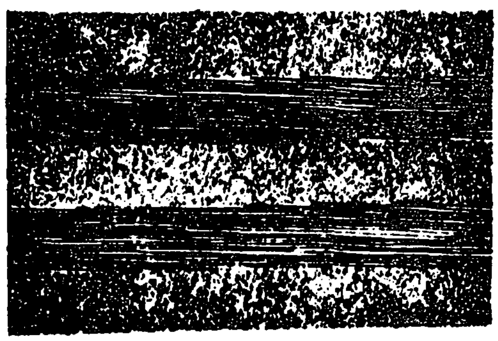


Fig. 2

Terraces. These are embankments or land ridges built on a slope to control run-off and reduce erosion to the minimum. It is a combination of ridge and furrow. The most common are:

- drainage terraces, and
- absorption terraces.

Drainage terraces have a slight slope allowing slow run-off.
Absorption terraces are built on a level to avoid run-off and increase infiltration. These are used in arid zones.

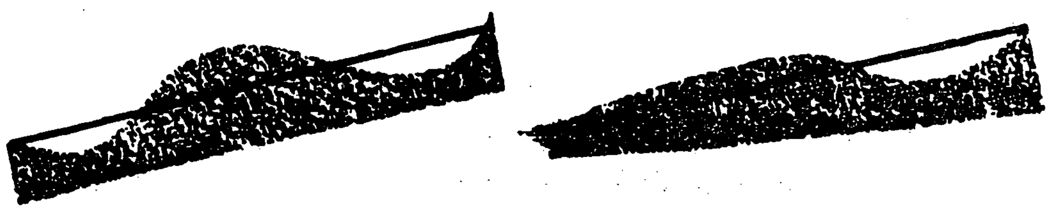


Fig. 3 - The figures show the cross section of two types of terraces which differ with respect to the original slope of the land.

CONTROL OF TRENCHES AND GULLIES

These demand special methods of control. Efforts should be made to divert the water before starting any practice.
If they are small, the water causing them can be diverted. They may be ploughed, levelied, fertilized and densely planted or turfed.
If the trenches are large, the refilling can be aided by dams built every few metres to stop the water and favour sedimentation. These dams are built with stones and/or branches and wire. The side-slope are smoothed out and protected with transplanted grass.

Fig. 4 - Here a trench can be seen and the retaining works done to encourage the sedimentation of the materials carried by the water.
In B, a cross section of A.

They belong to the plant kingdom and carry out the cycle of living beings: be born, grow, develop, reproduce and die.

Among the higher plants are the phanerogams which reproduce sexually through flowers and have a characteristic structure formed by roots, stem, leaves, flowers, fruits and seeds.

The parts of the plant carry out the functions of nutrition which ensures growth and development and reproduction which implies the conservation of the species.

DESCRIPTION OF THE ORGANS

Among the parts or organs which constitute the body of the plant are the *root*, the *leaves*, the *stem*, and the *flowers* from which *fruits* and *seeds* derive.
Not in all plants we find these organs, and neither do they have the same structure in all species.

ROOT

Absorption and fixing organ or mouth and anchor of the plant. Through innumerable ramifications it establishes a close contact with the soil to obtain the necessary water and nutrients.

STEM

Supporting and conducting organ. It supports the leaves, flowers and fruits. The conduction ensures the exchange of nutritive substances. The leaves are inserted on it, allowing them to intercept the solar energy for the photosynthesis function.

It provides the ducts which transport to the leaves the water and minerals absorbed by the root, and distribute to the rest of the organs the food elaborated at leaf level.

LEAF

It synthetizes the nutritive elements which the plants need. For this purpose it uses the energy of the sun.
Starting from basic nutrients (water, carbon dioxide, mineral elements) in the presence of solar energy it elaborates the compounds needed for the vital functions of the plant.

FLOWER

It is an organ adapted for the reproductive function. It is proper to higher plants which reproduce sexually. Flowering come from the development of the flower buds. A flower is formed by modified leaves which evolved adapting themselves to the said function of perpetuation of the species.

FRUIT

This organ contains and protects the seeds. It results from the development of the flower parts (the ovary) after fertilization. It facilitates the dispersion and propagation of the species.

SEED

This organ allows to reproduce and perpetuate the species. It results from the transformation of the ovule (flower part) after the fertilization process.

FUNCTIONS OF THE ORGANS

In the plant are carried out different functions which allow it to live and develop *(nutritive functions)* and form new individuals *(reproductive functions.)*
The different organs allow these functions to be carried out.

FUNCTION OF THE ROOT

To the specific functions of *fixing* the plant and *absorbing* the water and mineral salts are added those of *circulation* of the gross and elaborated sap, *respiration* and *accumulation* of reserves.

The root of the sugar beet or the carrot are examples of nutritive reserve storing organs. This accumulation of substances in the roots allows many plants to subsist after losing their leaves in the winter season or because of weeding, sprouting later. Many weeds may persist like that during long periods in spite of the cultural practices on the soils.

FUNCTIONS OF THE STEM

It has *supporting, conducting, reserving, respiration and assimilation* functions.

- *Supporting;* branches, leaves, flowers and fruits.
- *Conducting;* water and minerals (gross sap) from the roots to the leaves, and the elaborated foods (elaborated sap) from the green parts to the rest of the plant.
- *Reserving;* accumulating substances, whether elaborated (sugar, e.g. sugar cane) or gross (water, e.g. tunas).
- *Respiration;* which consists of absorbing oxygen and eliminating carbon dioxide, releasing energy used in the vital functions.
- *Assimilation;* when it has chlorophyll (green pigment) it carries out photosynthesis receiving solar energy and producing elaborated sap used in plant nutrition.

FUNCTIONS OF THE LEAF

The vital processes require energy. The energy which comes from the sun trapped in the leaf *(photosynthesis)* in the form of chemical compounds.
Later, these compounds are oxidized (respiration) releasing the energy retained in them and so allowing the processes of nutrition and reproduction.

The leaf carries out the functions of ***photosynthesis;*** *assimilation; transpiration; respiration and circulation.*

FUNCTION OF THE FLOWER

Its purpose is to ensure the *sexual reproduction* of the species through the formation of the fruit and the seed.
For reproduction two different phenomena are necessary: *pollination* and *fertilization*.

Pollination

It consists of the transport of pollen. This transport may be carried out by the wind (anemophily) or by insects (entomophily).

Fertilization

It is the union of the male gamete contained in the pollen with the female ovule.
If both gametes come from a same flower the phenomenon is called self-pollination, while if they come from different flowers it is called cross-pollination. When the fertilization is done, certain flower parts wither and fall off while others transform into fruits and seeds.

FUNCTION OF FRUITS AND SEEDS

The fruits contain and protect the seeds and are adapted to ensure their *dispersion*, that is, to be transported, moving far away from the mother plant and so avoiding the competition for the natural resources (light, nutrients, etc.). In that way they ensure the *propagation* and *survival* of the species.

SUMMARY

	Organ	- primary function
Phanerogam plants	Root	- mouth and anchor
	Stem	- support and conduction
	Leaf	- traps energy
	Flower	- reproduction
	Fruit	- protects and disseminates the seed
	Seed	- propagates and perpetuates the species.

The various organs of plants are adapted to perform different functions which complement each other.
Each organ is made up of different parts. The organ and the parts adopt different forms which allow them to carry out their functions by adapting to the conditions of the environment in which each plant species lives.

STRUCTURE AND CLASSIFICATION OF THE ORGANS

ROOT

It comprises several parts: neck, root hair zone, naked zone, root cap.

Neck; the point where the root and the stem join.
Pilferous zone; formed by root hairs through which the dissolved nutrients penetrate.
Naked zone; the one between the piliferous zone and the neck.
Cap; it allows the root to deepen without harm to the meristem which it protects.

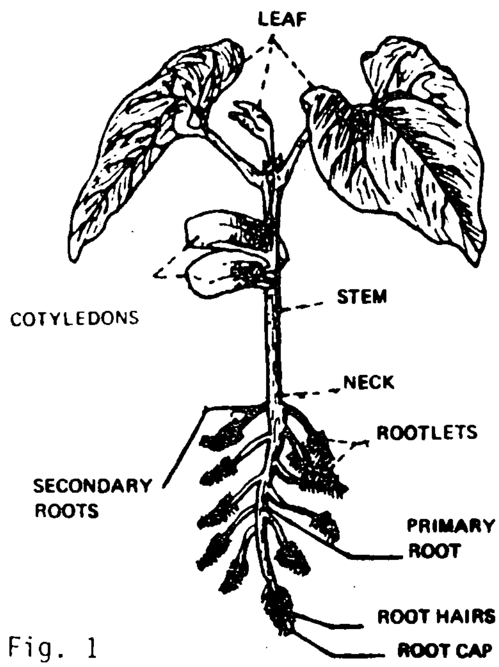


Fig. 1

The primary root of the plant ramifies and causes the formation of rootlets (or secondary roots) which again can give rise to tertiary ones, and so on.

CLASSIFICATION OF THE ROOTS

By their origin they are divided into normal and adventitious:

- *normal roots;* they originate from the development of tne radicle of the embryo.
- *adventitious roots;* they are born from other vegetative centres - stem or leaves.

By their form these can be typical or **fascicled.**

- *typical* or pivotal are those in which the development of the primary root prevails over that of the ramifications. For example, the coffee plant, the kidney bean, the alfalfa (Fig. 2).

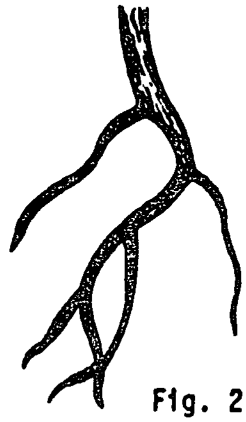


Fig. 2

- *fascicled* are those in which the secondary roots have a development similar to the primary one. e.g. wheat and corn (Fig. 3).


Fig. 3

The typical as well as the fascicled roots can become enlarged due to the storage of reserve substances. They are then called *fascicled tuberous* (e.g. dahlia and cassava) or *typical tuberous* (e.g. carrot) (Fig. 4).

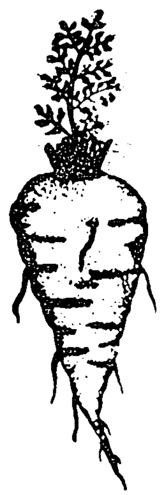


Fig. 4

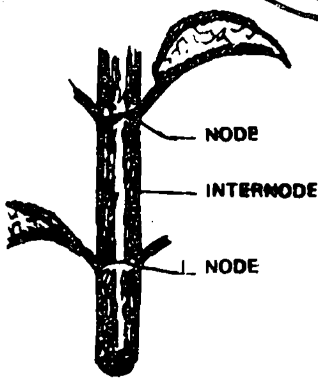
SUMMARY

ROOT	by its origin	normal adventitious
	by its form	typical fascicled
	being a storage	tuberous
	by its environment	subterranean aerial aquatic

STEM

Limited at its lower end by the neck it comprises: *nodes, internodes, apical buds and axillary buds.*

- *Node* is the protuberant portion in which the leaf is inserted.
- *Internode* is the space between two consecutive nodes.
- *Bud* is the enlarged protected portion made up by young cells (meristems) from which the stems or flowers grow.



OBSERVATION

The buds which develop at the end of the stem and of the branches are called *apical or terminal,* and the growth depends on them. Those on the axils of the leaves are called *axillary,* and from them originate branches or flowers.

CLASSIFICATION OF THE STEMS

Depending on the medium in which they live the stems are classified in aerial, subterranean and aquatic.

AERIAL STEMS are those which grow above the ground and they can be free or selfbearing. They can be trunks (poplar) shafts (palm trees), canes (hollow and partitioned) and bulrushes (hollow and non-partitioned).

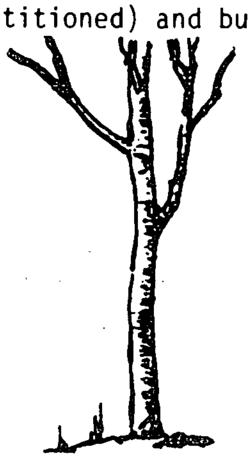


Fig. 6

Fig. 7

Fig. 8

Fig. 9

Climbers. They rise supporting themselves by claws, tendrils or adventitious roots, e.g. vines (Fig. 10).

Fig. 10

Creepers. They grow at ground level, e.g. joint grass, strawberry.

SUBTERRANEAN STEMS

Rhizomes. These grow horizontally and emit aerial branches, e.g. lilies (Fig. 11).

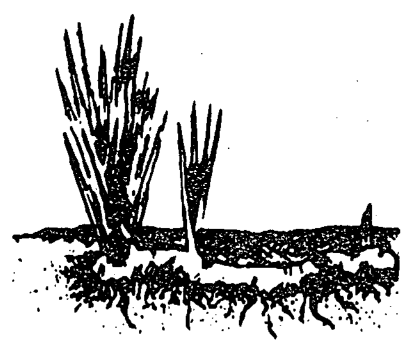


Fig. 11

Bulbs. They emit aerial branches, e.g. onion, garlic.

Tubers. These are storage organs e.g. potato (Fig. 12).

Fig. 12

LEAF

This elaboration organ is composed of blade, petiole, base and veins (Fig. 13).

Blade. It is the largest and main part and intercepts the rays of the sun.

Petiole. It supports the blade and joins it to the base.

Base. It is the enlargement of the petiole at the insertion of the stem.

Veins. The raw and elaborated sap are transported through these ducts.

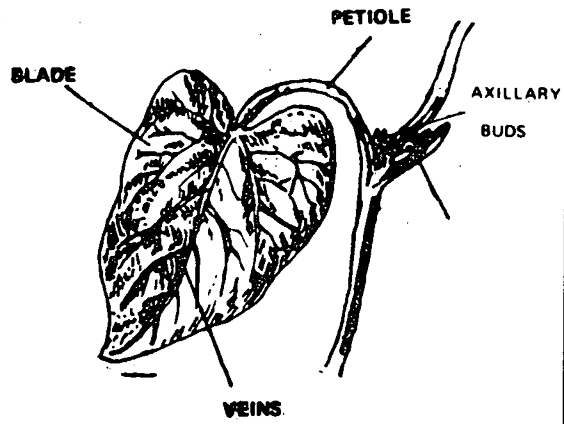


Fig. 13

CLASSIFICATION OF THE LEAVES

The leaves can be classified in accordance with the number and arrangement of their veins whether they are simple or compound, their form and the margin of the blade.

Depending on their veins they can be classified as:

- *single vein,* only one vein e.g. the needles of the pine tree.
- *with parallel veins*, e.g. wheat, corn and grasses.
- *pinnately nerved* as a bird's feather (Fig. 14) e.g. banana leaf and palms.
- *palmately nerved* as the fingers with respect to the palm of the band (Fig. 15), e.g. grapevine, sweet potato.

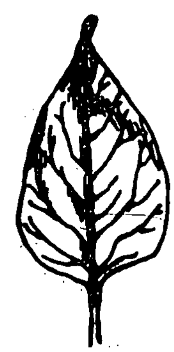


Fig. 14

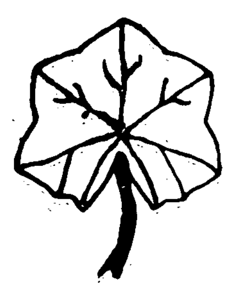


Fig. 15

Simple or compound:

- *simple;* they have only one blade with or without petiole (Figs. 13 and 14).
- *compound;* these consist of one petiole and two or more blades called petiolate leaflet or not petiolate leaflet, but without buds at their base (Fig. 16).

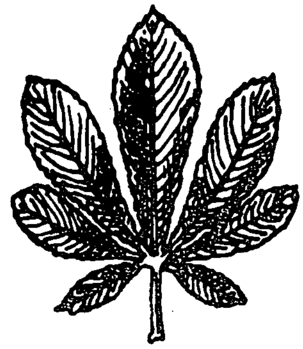


Fig. 16

Depending on the form of the blade, there is a great diversity:

- *acicular;* e.g. pine tree.
- *lanceolate;* e.g. willow.
- *laminar.*
- *reniform.*
- *orbicular.*
- *etc.*

Depending on the edge, they may be:

- *entire* (Figs. 13 and 14) and
- *notched,* among which are:
  - the serrate (e.g. the rose)
  - the dentate (Fig. 17)
  - the lobed (grapevine).

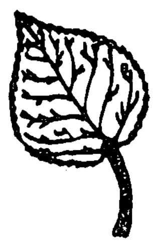


Fig. 17

SUMMARY

- LEAF
  - depending on their veins
    - single veined
    - parallel veined
    - pinnately veined
    - palmately veined
  - simple or compound
  - blade
    - form
      - lanceolate
      - laminar
      - reniform
      - orbicular
    - edge
      - notched
        - serrate
        - dentate
        - lobed
      - entire

SECTOR RURAL
Agriculture

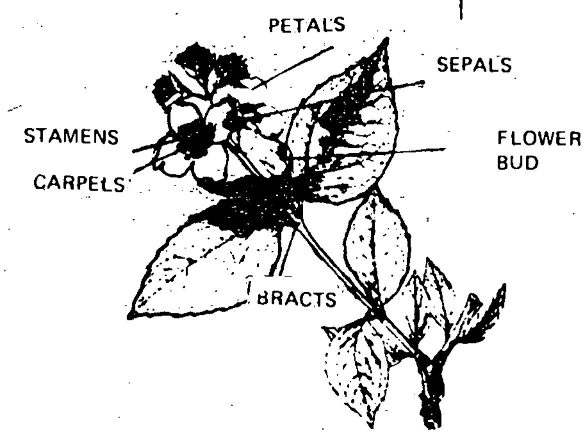
SUBJECT CLASSIFICATION
Plant: G
Level: 2
Subject: 2.1-24

The reproductive organs of higher plants are flower, fruit and seed.

THE FLOWER

Complete flowers consist of protection and reproduction elements.

THE FLOWER	protection elements	calyx - consisting of sepals corolla - consisting of petals
	reproduction elements	androecium - consisting of male organs called stamens gynoecium - consisting of the pistil and the ovary which is the female organ



CALYX. It is the most external part of the flower. It covers and protects the reproductive organs. It consists of modified leaves called *sepals* which are generally green.

COROLLA. It consists of all the *petals* or modified leaves of various colours.

ANDROECIUM. It consists of all the *stamens* or male organs. Each stamen consists of a *filament* and *anther*. The grains of pollen which will later fertilize the female *ovules* are formed in the anther.

GYNOECIUM. It is the female reproductive organ also called *pistil.* It is formed by *carpels* which constitute the *ovary* where the *ovules* are formed.

Once the union of the pollen and the ovules (fertilization) occurs, the ovary is transformed into a fruit which protects the ovule which will form the seed.

THE FRUIT

Depending on its characteristics, they are classified as dry, succulent and semi-dry or drupes, which may be dehiscent or indehiscent depending on whether they release the seed or not.

- Fruit
  - simple
    - dry
      - indehiscent
        - caryopsis ______ wheat
        - achene ______ lettuce
        - samara ______ elm
      - dehiscent
        - capsule ______ poppy
        - pod ______ pea
    - succulent
      - pome ______ pear
      - berry ______ grape, tomato
      - hesperidium ______ orange
    - semi-dry-drupe ______ peach
  - compound
    - syconium ______ fig
    - pineapple ______ pine, araucaria
    - sorosis ______ blackberry

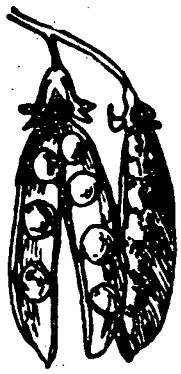


Fig. 2

Fig. 3

SEED

It consists of a protective wrapping, *reserve substances* and an *embryo* or small plant in a state of latent live (Fig. 4).
The *embryo* (Fig. 5) consists of: the *radicle* which will give origin to the root; the *thallus* which together with the bud when grown will produce the stem and leaves, and the *cotyledons* or small leaves of the embryo.

The reserve substances will supply the embryo during germination.

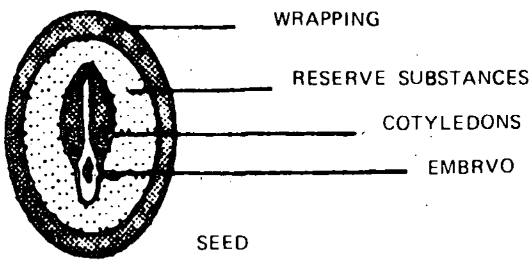


Fig. 4

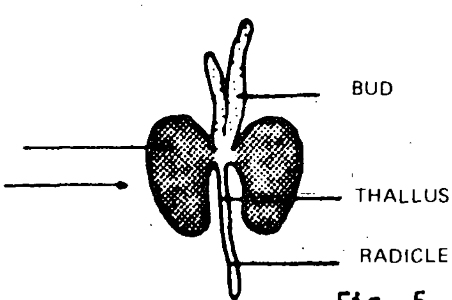


Fig. 5

OBSERVATION
Latent life refers to the period of rest between maturation and germination of the seed, in which vital activities are reduced to a minimum.
It allows waiting for favourable germination conditions.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: G
Level: 2
Subject: 2.1-23

These are the functions which allow the plant to live and develop.
The following are known as nutritive functions: *photosynthesis* or the assimilation by chlorophyll, *respiration, transpiration, absorption, and circulation.*
They are closely related to each other and the intensity of any single one is limited by the other functions.
The success of the crop depends on them and many of the practices performed by the farmer tend to facilitate or benefit them.

PHOTOSYNTHESIS

It is the function by which green plants in the presence of sunlight, carbon dioxide from the atmosphere and water taken from the soil are capable of creating or synthesizing organic substances which contain energy.

RESPIRATION

It is a function by which the plant absorbs oxygen from the atmosphere with which it oxidises organic substances resulting from photosynthesis, thus freeing energy for the vital processes and exhaling carbon dioxide and water vapour.

TRANSPIRATION

It is the process by which the plant eliminates the excess of water it has absorbed. The excess of water taken in is necessary for the adequate supply of the mineral nutrients which come from the soil, but it must be eliminated. During transpiration water is eliminated in the form of vapour.

ABSORPTION

It is the function carried out by the root hairs. It consists of providing the plant with water and mineral salts which constitute the raw sap.

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CIRCULATION

It is the transportation of raw sap and transformed sap. The raw sap is taken to the green parts where photosynthesis occurs. The transformed sap is distributed to all the organs of the plant.

SUMMARY

	Takes in	Exhales	Function
PHOTOSYNTHESIS	- solar energy - carbon dioxide - water	Oxygen	- produces organic substances (transformed sap)
RESPIRATION	- oxygen	carbon dioxide water vapour	- supplies energy
TRANSPIRATION		water vapour	- elimination of excess water
ABSORPTION	- water, mineral salts (raw sap)		- supplies mineral nutrients
CIRCULATION			- transports and distributes

It is characteristic of living beings to be able to reproduce themselves, that is, to give origin to new individuals of their own species.
Plants reproduce in various forms which could be divided into two large groups: *vegetative or asexual multiplication* and *sexual reproduction.*

VEGETATIVE OR ASEXUAL MULTIPLICATION

This consists of the division of the plant body or part of it. From this division the remaining parts will regenerate to complete the new plant. This will be identical to the one from which it originated.

Certain plants are capable of producing new ones from stems, roots and buds. The farmer takes advantage of this characteristic in numerous crops, such as irish potato, strawberry and many species of flowers.

SEXUAL REPRODUCTION

There are various forms of sexual reproduction in the plant kingdom. We will deal in this sheet with that of the higher forms of plants or phanerogams, that is, those having flowers. From these flowers will derive seeds which will reproduce the species.

When a given stage of growth and development has been reached, the plant issues flowers which contain one or both sexes. Depending on this we have:

Flowers
- *monosexuals*
  - male, with stamens (androecium)
  - female, with ovules (gynoecium)
- *hermaphrodite* with androecium and gynoecium

In any of these cases two successive but different phenomena will occur: *pollination and fertilization.* These phenomena will give origin to the seed or propagation organ.

POLLINATION

This is the transportation of pollen from the anthers of the stamens to the stigma of the pistil.

Hermaphrodyte flowers can self-pollinate although it is most frequent for cross pollination to occur. This means that pollen of one flower is taken to other flowers.

FERTILIZATION

This is the union of the gamete or male cell with the female ovule. The gamete is contained in the grain of pollen. The female ovule is located within the ovary of the flower.

From the union of both gametes or fertilization, a fertilized ovum or ovule results. When developed this becomes the seed.

GERMINATION

It is the passing of the embryo from the state of dormancy to active life. In other words, it is the development of the embryo contained in the seed. In order for this development to take place certain conditions of the seed itself, the plant species in question and of the medium surrounding it, should be met.

OBSERVATION

- In plant multiplication the offsprings are portions of the parent plant and therefore they are identical to the original plant.
- In sexual reproduction the offspring inherits the characters of both parents.

This is the phenomenon of plant multiplication, whether through sexual or vegetative reproduction. In both cases certain conditions in the propagation element itself (cuttings, seed, etc.) and in the medium are necessary. The success of the farmer in establishing the crop depends on the knowledge of said conditions.

PROPAGATION BY SEEDS

For the germination of the seed to be possible various conditions have to be met. These conditions depend on the seed itself (intrinsic) and on the medium (extrinsic).

INTRINSIC CONDITIONS

The seed should *be mature*, or its equivalent; the embryo should be completely developed and ready to abandon its dormancy (latent life) and to begin its development (to germinate).

The seed should have a *good constitution*. This means it should have a viable embryo and reserve nutritive substances to feed on.

The seed should *be alive*. The seed may die from aging (particular to each species), from mechanical disturbances of the embryo and from inadequate storage conditions (humidity, toxic elements, etc.).

EXTRINSIC CONDITIONS

When the seed germinates it breathes intensely. During dormancy breathing is attenuated. When the process of germination begins the demand of oxygen is high. The farmer should foresee this need when planting and prepare an appropriate seedbed and place the seed at a suitable depth.

Water softens the seed coat allowing the embryo to emerge. It also penetrates making soluble the reserve substances which nourish the growing embryo. However, an excess of moisture is harmful because it prevents breathing and facilitates the development of fungi and other organisms which rot the seed.

Each plant species requires a given *temperature* for optimum development, and it only prospers within certain limits.

VEGETATIVE PROPAGATION

Multiplication through plant cuttings consists of arranging them in a favourable medium to encourage the development of adventitious roots or stems of the same origin.

For this to happen, it is necessary that the cutting be fresh, conserving moisture and transformed sap which will nourish the buds of the shoots.

The extrinsic conditions for the development of these new plants are similar to those indicated for the multiplication by seeds.

Stolons, or lateral branches with buds, when separated from the main body and in the appropriate conditions, emit roots and leaves. e.g. strawberry (Fig. 1)

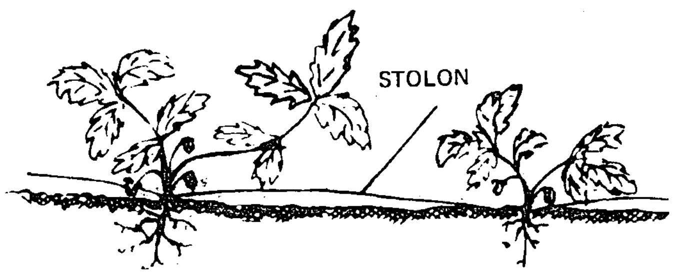


Fig. 1

Tubers, or storage underground stems with buds reproduce the original plant. e.g. potato (Fig. 2).

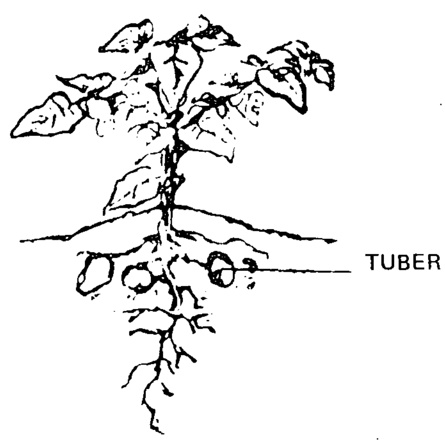


Fig. 2

Cuttings, or pieces of stems emit roots. e.g. willow, poplar, rose.

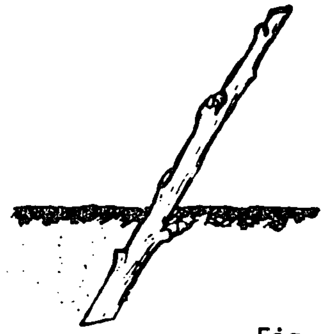


Fig. 3

Layering, a partially buried branch not being separated from the original plant, takes root (Fig. 4). e.g. carnation, rubber tree.

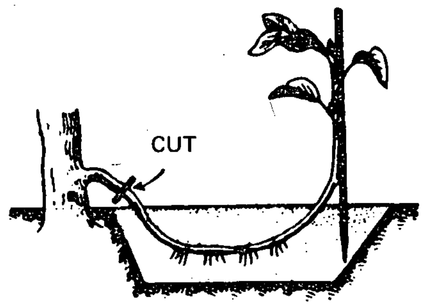


Fig. 4

Shoots, plantlets which grow on the leaves or roots and when separated from them, develop into identical plants (Fig. 5).

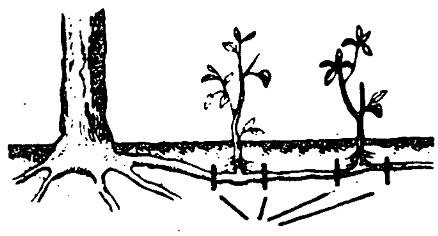


Fig. 5

Bulbs, or underground stems on the base of which adventitious roots grow. e.g. onion, hyacinth (Fig. 6).

Fig. 6

Grafting is the insertion of a bud (Fig. 8) or a piece of branch with a bud (Fig. 7) into a growing stock of another plant.

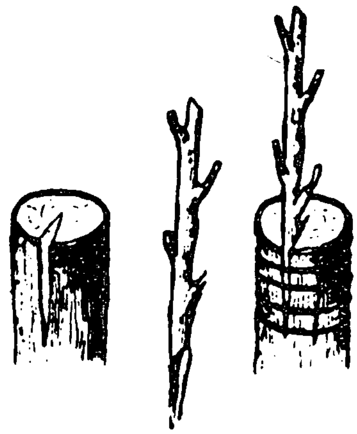


Fig. 7

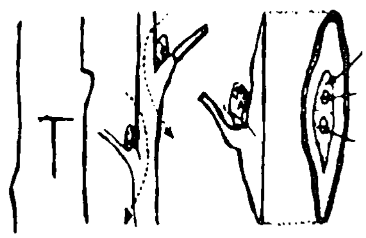


Fig. 8

PROPAGATION AND SPECIES

Several are the reasons why man uses different methods of propagation.

Some plants can only reproduce easily vegetatively (potato, sugar cane); others only through seeds (corn, tobacco) and others share both forms of multiplication (onion).

The advantages of asexual reproduction are:

- speed in the development of large plants (sugar cane, reproduced by cuttings),
- conservation of the particular characters; a very important characteristic when selecting fruit trees, ornamental plants and in general, crop plants in which it is desired to keep a certain outstanding characteristic.

Disease is all organic or functional alteration, more or less serious, in the life of the plant.
Its economic and social importance is given by the fact that: "man reaps only what the parasites leave for him".

CLASSIFICATION

According to their origins they may be grouped in:

- Parasitic diseases, caused by the action of plant or animal parasites such as fungi, bacteria, lower plants and nematodes.
- Diseases caused by virus.
- Diseases, the causes of which are physiologic, and produced by the following factors: climatic (humidity, temperature, insolation), edaphic (absence or excess of one or more nutritive elements) or internal (metabolic).

CAUSING AGENTS

Pathogenic. All living organisms causing disease.

Fungi. Lower organisms, generally microscopic without chlorophyll, which feed on organic substances.

Bacteria. Unicellular micro-organisms without chlorophyll which reproduce rapidly in an asexual form by simple division.

Nematode. Worms of different sizes. These vary from microscopic to 1-2mm. They are an important part of normal soil fauna.

Viruses. Infectious agents of a nature still undetermined and of a size which is not visible through common microscopes.

OBSERVATION
Not all agents of the above mentioned groups cause damage (are pathogenic). There are the *saprophytes*, which do not cause alterations.

PROPAGATION OF DISEASES

Diseases spread by the parasites' own means as well as with the help of external conditions or agents which transport and distribute the organisms which cause the alterations.

The external propagation agents are:

- air or wind (anemophilous diffusion).
- water (hydrophilic diffusion) in the form of rain, irrigation or natural streams.
- animals (zoophilic diffusion),
- man.

There is also diffusion by plant to plant contact, be it by their roots or their aerial parts.

CONTROL

This is a group of measures which are taken to fight against diseases and also to reduce the damage they may cause.

The control is based on four fundamental principles: *exclusion, eradication, protection and immunization.*

Exclusion. This is to prevent the penetration of a pathogen into a non-infected geographic area. Prevention of pests.

Eradication. Is the complete elimination or destruction of a pathogen after it has established itself in a determined area. An example is the sterilization.

Protection. This is to establish some kind of effective barrier between the plant and the disease-causing organism. The application of fungicides is related to this principle.

Immunization. This is the development of a population of immune or resistant plants. The selection of varieties (natural selection) justifies this principle.

FUNGICIDES

These are products used to combat the enemies of the cultivated plants. The commercial forms are powder, liquid or gas and should possess the following characteristics:

- effective action on the pathogen. It is called lethal, if it causes death.
- does not damage or is innocuous to the plants.
- low toxicity to man and fauna.
- good diffusion capacity, if it is a gas, and distributes itself homegeneously.
- sufficient adhesivity.
- economical and easy to use.

APPLICATION OF FUNGICIDES

According to the physical state they may be applied by dusting, pulverizing or fumigating.

PRECAUTION

THE HANDLING OF FUNGICIDES DEMANDS SPECIAL CARE. SEE TECHNOLOGICAL INFORMATION SHEET ON APPLICATION OF PESTICIDES, TIS 024.

These are measures taken to protect the crops from harmful organisms and to prevent their propagation and dispersion.

Not all insects are harmful. There are beneficial insects which often contribute to the control of the harmful ones.

PESTS

These are all harmful agents which may cause damage or destruction. Among the pests are included the harmful insects. The methods of control most used are chemical, physical or mechanical and biological.

> OBSERVATION
> The term "insects" is generally used because it is the most numerous and important animal group. However, the aspects which were studied are applicable to mites, nematodes, molluscs and rodents which affect agricultural production.

PEST CONTROL

This depends basically on the knowledge of the factors which cause and favour the presence and abundance of each harmful species in particular.

To be successful, the direct or indirect control methods demand complete knowledge of the life and habits and the responses to the environment.
A good knowledge, vigilance and speed in combating are the basic ingredients for effective pest control.

MECHANICAL CONTROL

This is the destruction of the harmful organism through physical actions. Among them the most outstanding are:

- cultivation practices, such as ploughing, weeding, etc. (For example, control of the Rhinoceros beetle).

CINTER
1st. Edi

- Mechanical devices which interfere with the movement of the insects: ditches, checking barriers, etc. In this way grasshoppers and locusts have been controlled.

The physical means used to interfere in the life of the insect include aspects such as temperature, electricity, sound, radioactivity, humidity, light, odours, etc.

CHEMICAL CONTROL

This is a group of preventive or curative measures based on the use of chemical substances called pesticides or insecticides when applied to insects.

Pesticide. A chemical substance used for altering the activity of a live organism and being able to kill it.

Insecticide. Pesticide applied to control insects.

Application of chemical pesticides. Depending on the physical state of the product, they may be fumigated (gases and volatile vapours), dusted (powders) or pulverized (liquid solutions).

If the product is dissolved to be applied (liquid), the operation is called *spraying*.

When the powdered substance is distributed by means of a flow of air which transports it in suspension, the operation is called *dusting*.

If the liquid products are transported by a flow of air, the operation is called *misting*.

There are certain general norms on the application of pesticides. These are:

- Having a complete knowledge of the pest to be controlled and being well-informed about the proper time to carry out the treatment.

- Choosing the most suitable pesticide. If possible, use selective products of low toxicity and moderate residual effect, which do not present toxic residues with cumulative effects for man and hot blooded animals.

- Following the recommendations on doses and application intervals. Different doses may be inefficient or may cause toxicity in the plants.

- When mixing products for combined treatments reading the instructions on compatibility.

- Respecting the recommended interval between the last treatment and harvesting of the crop. This ensures that the product is free of residues when consumed.

- When pulverizing using equipment which is in good condition, with good agitation and adequate pressure.

- Wetting the plants to be treated as necessary, observing the doses indicated for a surface unit.

- Not carrying out treatments with excessive wind, on damp foliage or on very hot days with strong sun.

- When the work is finished, washing the equipment with detergents.

BIOLOGIC CONTROL

This consists of the introduction of natural enemies for the eradication of certain harmful organisms. It uses and encourages nature's own resources to combat pests.

INTEGRATED CONTROL

This consists of controlling a plague by using mechanical, chemical and biological resources. The selection of resistant plants, the production of natural enemies, the use of pesticides, soil and water management, crop rotation, the elimination of weeds which protect the pathogenic organism, are elements or tools of the integrated control.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 4.5-11

PRECAUTIONS IN THE USE OF PESTICIDES

CAREFULLY READ THE LABEL OF THE PRODUCT TO BE USED, PAYING ATTENTION TO CAUTIONS AND WARNINGS. IN CASE OF DOUBT, ASK FOR SUPPLEMENTARY INFORMATION.

STORE THE PESTICIDE IN A SAFE AND LOCKED PLACE. KEEP IT OUT OF THE REACH OF CHILDREN AND ANIMALS. DO NOT STORE WITH OR NEAR FOODS, RATIONS, FORAGE, ETC.

KEEP THE PRODUCTS IN THEIR ORIGINAL CONTAINERS. DO NOT DIVIDE OR PACK IN CONTAINERS WITHOUT LABELS.

USE PROTECTING EQUIPMENT AND ADEQUATE CLOTHING. PESTICIDES MAY PENETRATE BY INGESTION, CONTACT WITH THE SKIN OR INHALATION. DEPENDING ON THE PRODUCT USE GLOVES, HAT, MASK WITH FILTERS, BOOTS, ETC. THESE PROTECT YOU AGAINST INHALING, INGESTING OR TOUCHING THE PESTICIDES.

DO NOT USE MACHINES WHICH LEAK.

SCALES, MEASURES AND OTHER EQUIPMENT USED FOR MEASURING DOSES SHOULD BE USED ONLY FOR THAT PURPOSE.

DO NOT CLEAR THE NOZZLES BY BLOWING WITH YOUR MOUTH, NEITHER MIX THE PRODUCTS WITH YOUR HANDS. USE GLOVES WHEN PREPARING AND APPLYING THE PRODUCTS.

DO NOT SMOKE OR EAT DURING THE APPLICATIONS. WHEN THE WORK IS FINISHED, THOROUGHLY WASH FACE AND HANDS WITH SOAP AND WATER.

THE CLOTHING SHOULD BE ONLY FOR THAT USE AND WASHED DAILY.

DESTROY THE EMPTY CONTAINERS. THE CONTAINERS SHOULD BE BURIED IN PITS MADE FOR THAT PURPOSE FAR FROM WATER SOURCES. BREAK UP GLASS OR METAL CONTAINERS AND BURY THEM. BURN BAGS FAR FROM ANIMALS, CROPS AND FACILITIES AND BURY THE ASHES.

WASH EQUIPMENT USED AND CONTAINERS. KEEP THE RESIDUES OF THE PRODUCT AND WASHING WATER FROM REACHING THE WATER SOURCE.

DO NOT ENTER TREATED CROPS UNTIL A FEW DAYS AFTER THE APPLICATION.

OBSERVE THE PERIODS BETWEEN THE LAST TREATMENT AND HARVESTING.

DO NOT ALLOW THE PASTURING OF TREATED MEADOWLANDS UNTIL THE SPECIFIED SAFE TIME FOR THE PRODUCT HAS PASSED.

DO NOT	DO
Do not smoke.	Follow the instructions.
Do not eat.	Store conveniently.
Do not get wet.	Use protecting equipment.
Do not touch.	Wash everything.
Do not pasture.	Destroy containers.
Do not remove the labels.	Respect time periods.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: ( )
Level: 2
Subject: 1.8-4 3.5-1 3.5-62 4.1-81

Weeds are all plants which are out of place. A corn plant in a soya field is a weed.

DAMAGE CAUSED BY WEEDS

They reduce the output of the crops. When competing for water, light and nutrients with the cultivated species, they reduce the possibility of production. Some comparative advantages of the weeds over the cultivated plants such as fast growth and resistance to drought, help them to share with advantage the limiting factors.

They reduce the quality of crops. The hay or silage mixed with weeds, the cereals with foreign seeds, obtain lower prices when marketed because they are of inferior quality. They transmit flavour to the milk of animals which consume the dirty hay. Grains should be sorted so as not to sow the new lands with weeds when these grains are used as seeds.

They increase production costs. A greater number of agricultural operations are necessary in weed-affected lands. Therefore, more labour and more equipment-hours are used. The greater part of the cultivation is done to destroy weeds.

They are hosts of diseases and insects. Many pests survive for years protected by the weeds. There they carry out their biologic cycle, waiting for the crop which is specific to them.

Some weeds are poisonous to cattle.

They obstruct drainage and irrigation ditches.

They reduce the value of the lands as a consequence of all the above-mentioned aspects.

WEED PROPAGATION

The preventive measures to stop the propagation of weeds of non-affectd lands are simple and economical. Fighting weeds is more complex and costly than preventive measures.

PREVENTIVE MEASURES

- Use clean seeds, free of weed seeds.
- Hay to be fed to cattle should not contain propagation organs (stolon, rhizome, seeds, etc.) of weeds.
- Use fermented manure in the soils. Fermentation prevents the development of the propagation elements which the material could contain.
- Do not move cattle directly from weed-covered zones to clean ones. The animals carry adhered to their bodies or in their digestive system elements of weed dissemination.
- Carefully clean the agricultural equipment before moving item. Particularly, the grain and forage harvester (mowers, balers, etc.).
- Keep the edges of the irrigation ditches clear of weeds; likewise, the sides of the roads and the perimeter of the farms, even under the fences.

WEED CONTROL

For the control of weeds, mechanical, cultural, biological and chemical methods are employed. These methods complement each other and form part of the dissemination and propagation preventive measures.

The best control is obtained by the practice of good agriculture which includes: the preparation of soils, water management, rotations, use of pure and vigourous seeds, cultivation works, application of fertilizers in the rows, adequate density of the crop, etc.

MECHANICAL METHODS

These consists of different practices such as plucking the weeds or using hand tools (hoes, weeding hoes, etc.), using implements, mowing or flooding the lands.

CHEMICAL METHODS

By means of certain substances or products of phytotoxic action (plant toxics) called herbicides or weedkillers, the desired control is achieved.

Herbicides. Products of known toxic effect used for exterminating weeds. They may be grouped in selective and non selective or total.

A selective herbicide is the one which when applied on a group of different species, in different doses or known quantities have a harmful effect on some while others are immune to the application. They are used to fight given weeds in certain crops without damaging them.

The selection of the herbicide depends on the amounts in which it is used also on the development of each plant in particular and the moment of application (temperature, humidity, etc.).

Non selective herbicides also called total herbicides are intended to destroy a wide range of species.
The selective herbicides used in greater doses may act as non-selective.

Application of herbicides

This is done with equipment intended for the broadcasting of liquids, powdered or granulated solids, on the foliage or ground.

This equipment should meet the following requirements:

- distributes the products uniformly,
- can be regulated to allow the application of pre-determined doses per surface unit which depends on:
    - the travelling speed of the implement,
    - the work pressure,
    - the covering width of each nozzle,
    - the discharge per nozzle.

Care in the use of herbicides

- Store far from seeds and chemical products (fertilizers and pesticides).
- Do not use the equipment intended for herbicides in the application of other products (insecticides, fungicides, etc.).
- Do not wash the equipment in water sources used by animals or which carry the residues to agricultural lands.
- Do not apply herbicides during strong winds which might carry the product to crops susceptible to it.

CAUTIONS

AVOID CONTACT WITH SKIN, EYES AND MOUTH.
KEEP THE CONTAINERS WELL COVERED.
DO NOT DESTROY THE LABELS OF THE CONTAINERS.
DO NOT SMOKE OR EAT UNTIL AFTER HAVING WASHED AND CHANGED CLOTHES.
DESTROY THE EMPTY CONTAINERS.
USE SAFETY GLOVES AND MASKS.
READ THE TECHNOLOGICAL INFORMATION SHEET; APPLICATION OF PESTICIDES, TIS. 023.
READ AND FOLLOW THE INSTRUCTIONS SUPPLIED BY THE MANUFACTURER OF THE PRODUCT.

The reason for classification is to form orderly groups in accordance with common characteristics.
The classification of plants can be done following botanical characteristics biologic cycles, cultivation requirements, etc.

The aim of these groups is to facilitate the study and application of techniques for all those engaged in agricultural or related works.

BOTANICAL CLASSIFICATION

Depending on the place occupied by several cultivated species (wheat, corn, tomato, irish potato and larch) in the botanical classification, the reason for this grouping can be understood.

Kingdom	Plant				
Division	Tracheophyte				
Subdivision	Angiospermae				Gymnospermae
Class	Monocotyledon		Dicotyledon		Coniferous
Family	Gramineae		Solanaceae		Pinaceae
Genus	Triticum	Zea	Solanum	Lycopersicon	Pinus
Species	Vulgare	mays	tuberosum	esculentum	Pinea
Variety					
Common name	wheat	corn	irish potato	tomato	larch

The usefulness of the knowledge of botanical classification is made evident when observing that the species of one family or genus often have the same response to the application of a given selective weed-killer, are susceptible to the same pest, or require similar cultural practices.

BIOLOGICAL-CYCLE CLASSIFICATION

Plants are grouped according to their biological cycle as annual, biennial and perennial.

ANNUAL

These germinate, grow, reproduce, mature and die in the same agricultural year. Many of the cultivated plants belong to this group: corn, rice, soya, as well as some of the most common weeds: "bedstraw", carline thistle, etc. They can be winterly and aestival depending on the season of the year in which they develop.

Annual aestival. These germinate at the end of spring. They grow during the summer and harvesting starts with the beginning of the cold season or before. Corn and sunflower are good examples.

Annual winterly. These begin to develop in autumn or before. They grow or remain latent during winter. Once the rigours of winter have passed, they quickly complete their cycle. Wheat, barley, flax and oats are typical examples.

BIENNIAL

During the first year they grow and accumulate reserves. In the second year they bloom, reproduce and die. The red clover is an example, while the sugar beet which is also biennial, is cultivated in certain regions as if it were annual.

PERENNIAL

These live for more than two years and they include trees, forage (alfalfa) and horticultural crops (strawberry, asparagus). Also weeds, such as lantana (black sage) and sorghum (guinea corn).

AGRICULTURAL CLASSIFICATION

All species can be grouped according to the use given to the crop, as follows:

GRAIN CROPS

These are all crops grown for seeds. They can be subdivided into smaller groups.

Cereals. This group includes wheat, rice, rye, etc. which are also called minor grains. It also includes corn and sorghum which cannot be grouped with the minor grains.

Oil-bearing. This group includes species from different families. Their purpose is the industrial extraction of oils; sunflower, peanut and flax are examples. Extracted oils are not for food purposes, they are generally known as industrial oil.

FORAGE

It is produced from the leaves and vegetative organs of plants and are used as cattle fodder. Depending on how they are supplied they could belong to one or more of the following classes:

- direct grazing
- cutting for direct supply, hay or silage.

ROOT AND TUBER CROPS

Many plants are cultivated for their underground organs which may be either roots or modified stems. Beet, turnip and carrot are roots.
Potato is a tuber.

FIBER CROPS

This crop mainly includes cotton and flax.

SUGAR CROPS

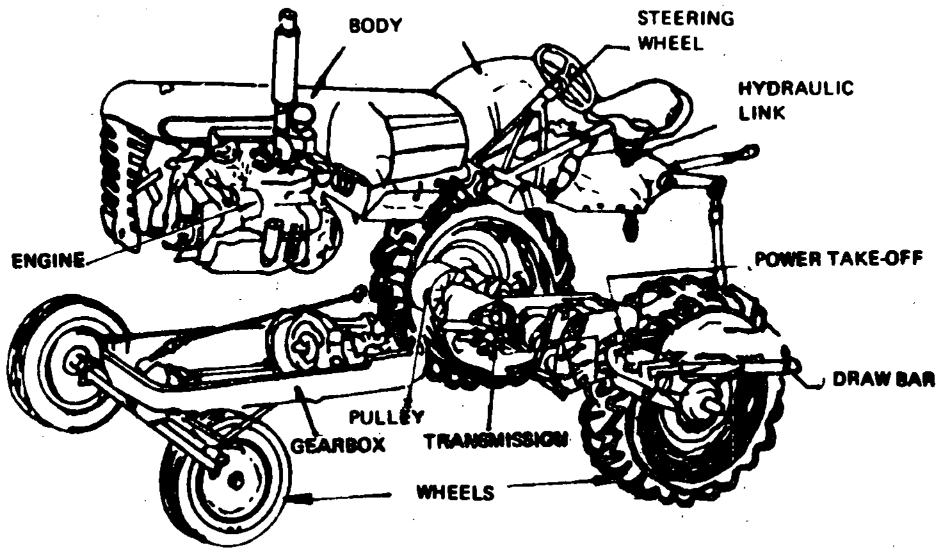
They are grown for the extraction of sugar, e.g., beet and sugar cane.

The expert and the farmer have devised other useful classifications, such as dry farming and low irrigation crops, or dense and row crops (weeded or not). They are all intended to facilitate the application of the acquired knowledge.

This is a selfpropelled amchine, strong in structure, designed to use the power produced by its engine for towing or for moving other machines and implements.

DESCRIPTION

Every tractor is made up of the fundamental parts seen in the figure.



A frame supports the entire set of elements which form a rigid structure comprising the engine, transmission, the steering and braking systems, and the wheels. All these are protected by parts of the body.

PARTS OF THE TRACTOR

CHASSIS

This is the frame or rigid skeleton on which the transmission, steering and other mechanisms are mounted.

ENGINE

It is the source of mechanical power.

TRANSMISSION

This is a group of elements which transmit the power from the engine to the drive wheels. It comprises:

- *the clutch,* which permits engaging and disengaging the drive from the engine to the
- *gear box* where the power can be transmitted to suit the required working speed. It also determines the direction of the motion (backward or forward) transmitted to the
- *rear end,* which transmits the motion to the wheels and contains the
- *differential,* which enables each wheel to turn at different speeds. This is necessary when turning and cornering.

STEERING

This consists of a steering wheel mechanism which allows the tractor to be guided while moving and is controlled by the operator.

BRAKES

This system reduces and stops the movement of the tractor. In the case of agricultural tractors, it assists the steering mechanism when turning.

POWER TAKE-OFF

This is an auxiliary mechanism which transmits movement to the machines which are simultaneously towed by the tractor (forage harvester, fertilizers, distributors, etc.). It can be used to operate parked or stationary machines.

PULLEY

It transmits movement to stationary machines (grain mills, irrigation pumps, etc.).

HYDRAULIC LIFT

It allows the implement coupled to the tractor to be lifted and lowered. When operated while moving, it allows for adjustments (subsoiling depth, land levelling, etc.).

DRAWBAR

The implements to be towed are coupled to it.

OBSERVATION

It has been agreed that when referring to a tractor or to an agricultural equipment expressions such as to the left, front, back, to the right, refer to the position of the operator in the driving position.

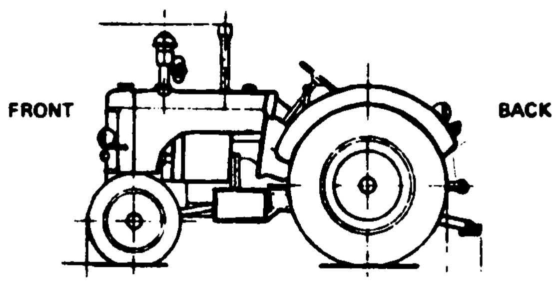


Fig. 2 - Left side view

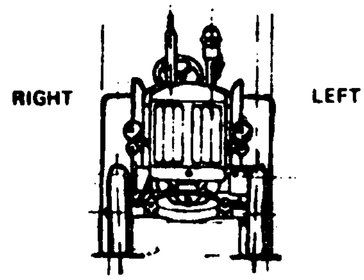


Fig. 3 - Front view

Designed at first for towing implements to replace animal haulage, it was seen by the farmer as a means of doing more in less time. Later, many accessories were added to it which improved the quality of the work and at the same time made it cheaper, freeing man from the heavier tasks.

Engineers, farmers and manufacturers have contributed to its perfection and to make it suitable for each kind of crop, work, soil, climate and economy. Thus the different of solutions have demanded the design of different types and models of tractors.

TYPES OF TRACTORS

These can be divided into two large groups depending on the form of traction:

- *crawler tractor,*
- *wheel tractor*
  - plow handle tractors, 2 wheels;
  - tricycle tractor, with 3 wheels,
with 4 wheels;
  - standard tractor, simple transmission,
double transmission.

The crawler tractor has been displaced by the wheel tractor in different agricultural tasks. This has not happened when dealing with important land movements (clearing) or industrial tasks. The following chart compares both traction systems:

CRAWLER TRACTOR	*WHEEL TRACTOR*
Too high initial cost and high maintenance cost.	Less initial and repairing costs.
Slow, approximately 3 Kms/hour	Speeds between 1 and 20 Kms/hour
Great grip, little skidding and better use of power.	Less grip. Loses power when wheel slip occurs.
Non-adjustable track width.	Adjustable track width.
They turn on spot (short turning circle).	They do not turn on spot. (Wide turning circle).
They produce less soil compaction	They produce greater soil compaction.
Not suitable for row crops.	Suitable for cultivation work.
Appropriate for high power.	Suitable for transportation on country roads and public highways.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 1.4-11

TRICYCLE-TYPE TRACTOR

These allow the operator to have a better view of the field and plants, thus making cultivation works easier (weeding, application of herbicides, etc.) (Fig. 1). They may have a single front wheel or twin wheels very close to each other.

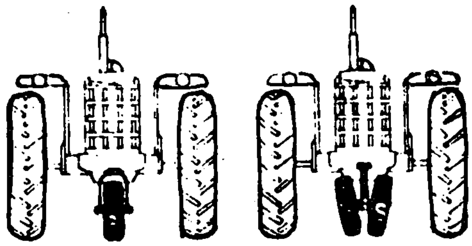


Fig. 1

CAUTION

THE TRICYCLE-TYPE TRACTOR CAN EASILY OVERTURN. THEY DEMAND SPECIAL CARE WHEN BEING DRIVEN.

STANDARD TRACTOR

These have a standard track width. They usually have a low clearance (distance from part under tractor to the ground). They are used for general purposes (tilling, towing, etc.).
The distance between wheels (track width) can be varied by inverting the position of the rims.

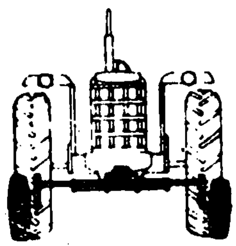


Fig. 2

WALKING GARDEN

These are usually low powered (up to 12 HP). They are used for small plots, nurseries and special crops. Each trademark has a set of mounted implements and their coupling is not universal. This means that different trademark implements cannot be coupled to different tractors without making changes.

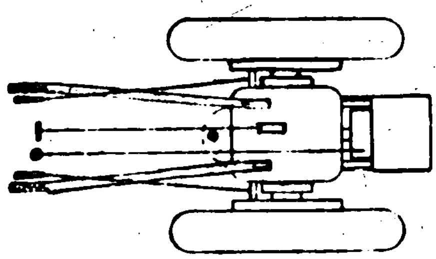


Fig. 3

According to their use and to the special design suitable for that use we have the following tractors:

- *Horticultural;* these are used in orchards. They have a special body which avoids breaking the branches while travelling near to the trunk of the trees.

- *Vineyard;* these have a narrow track width and can easily move between the rows of the vineyard.

- *Cane;* these have great clearance and the adequate power for sugar-cane work. They can be fitted with extra-wide wheels in order to avoid compaction in the irrigation lands.

- *Cultivators;* these are designed to carry out all agricultural works and especially those of cultivating between the rows of the crops.
  They are characterized by:

  - having a variable track width adjustable to the requirements of the crops,
  - they can manoeuver easily between rows (they have a small turning radius),
  - having a greater clearnance than the standard ones.

  Among these are the tricycle-type tractors and standard front width tractor.

- *Garden;* suitable for small distances and winding paths.

Tractors are also classified according to the fuel used by their engines. Thus, we have gasoline, kerosene, natural gas and gas oil (Diesel engine) tractors.

Tractors can also be grouped according to the size or power, which can be expressed in horse power (HP) available at the pulley, the draw bar or the fly wheel of the engine. The three powers are measured with dynamometers and they have different values for the same tractor.

Power of the engine. This is a measure of the work done by the engine in a given unit of time.

Power at the pulley. It is smaller than the above mentioned, since the transmission uses part of the power developed by the engine. This is the kind used for stationary works.

Power at the draw bar. It is the remainder of the power which results form substracting what the tractor uses to propel itself from the power developed by the engine. It is the power used for towing.

Depending on the power at the drawbar there can be the following types of tractors:

- *garden* (up to 12 HP).
- *small* (up to 35 HP).
- *medium* (35 to 65-70 HP).
- *large* (over 70 HP).

Liquid fuels like gasoline, kerosene and gas oil are obtained from the distillation of petroleum.
Each engine has been designed to obtain the maximum output by using a fuel with certain characteristics. It is not within the reach of the operator to modify these properties, but it is, to obtain the most suitable one and keep it completely clean.

When acquiring a new engine, the characteristics of the fuel recommended by the manufacturer should be compared with the products on the market. Once the selection is made it should be kept clean and stored safely.

STORAGE

The purpose of the correct storage is:

- to avoid getting moisture into the fuel,
- to keep it free of impurities,
- to avoid fire hazards.

The best solution is to have a tank (Fig. 1) of a size appropriate to the consumption requirements of at least one month.

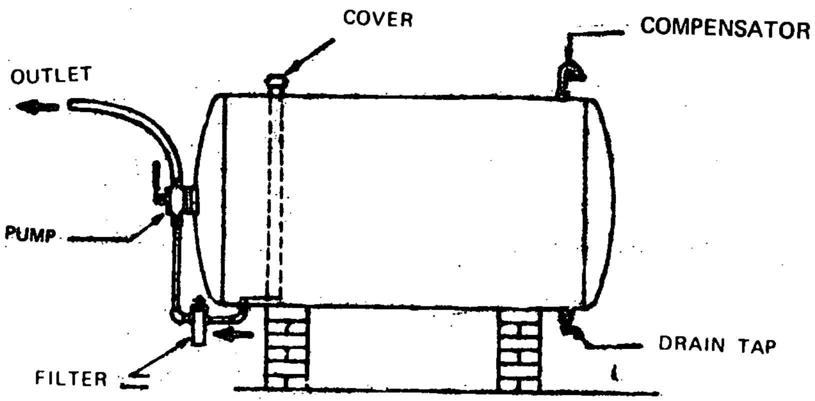


Fig. 1

The tank in question should have the following characteristics:

- it should be *stationary* in order to allow the impurities to settle or float. It should be made of a suitable material (generally metal).

- *its bottom should be slanted,* with the lower part opposite the outlet.

- it should have a drain tap or valve at the lowest end,

- *it should have a cover* to allow cleaning and inspection and an air inlet with a water trap and a filter for impurities,

- it should be located so that it experiences the minimum of temperature changes. This avoids condensation. This is the purpose of underground tanks. If they are built above ground level it is convenient to have a roof over them.

it should have a filter at the discharge outlet.

If permanent tanks are not available, drums kept under a roof should be used and kept in an inclined position.
They should not be moved when extracting fuel and preferably a pump with a filter should be used (Fig. 2).

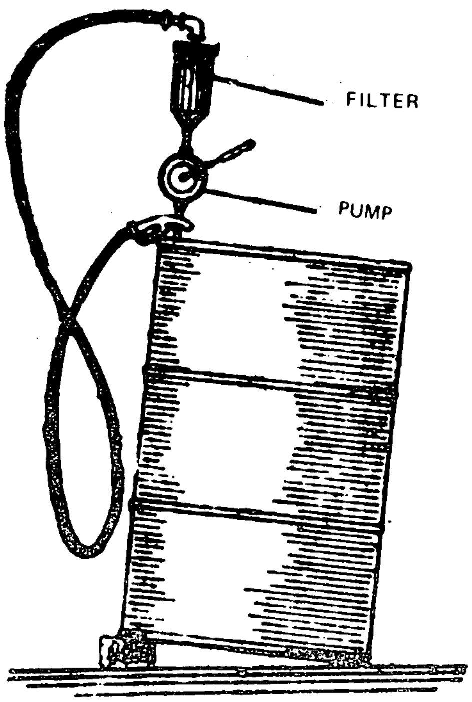


Fig. 2

Water. If water should get into the fuel, this would imply costly repairs of injection pumps and injectors. Water enters the tanks in the form of vapour contained in atmospheric air. Figure 3 shows how water condensation occurs and why tanks should have a drain valve.

Impurities. These obstruct important parts of the engine (carburettor, injectors, etc.), wear them by friction and clog the elements.

OBSERVATION
When a new supply of fuel is received it should be allowed to settle for at least 36 hours before using it.

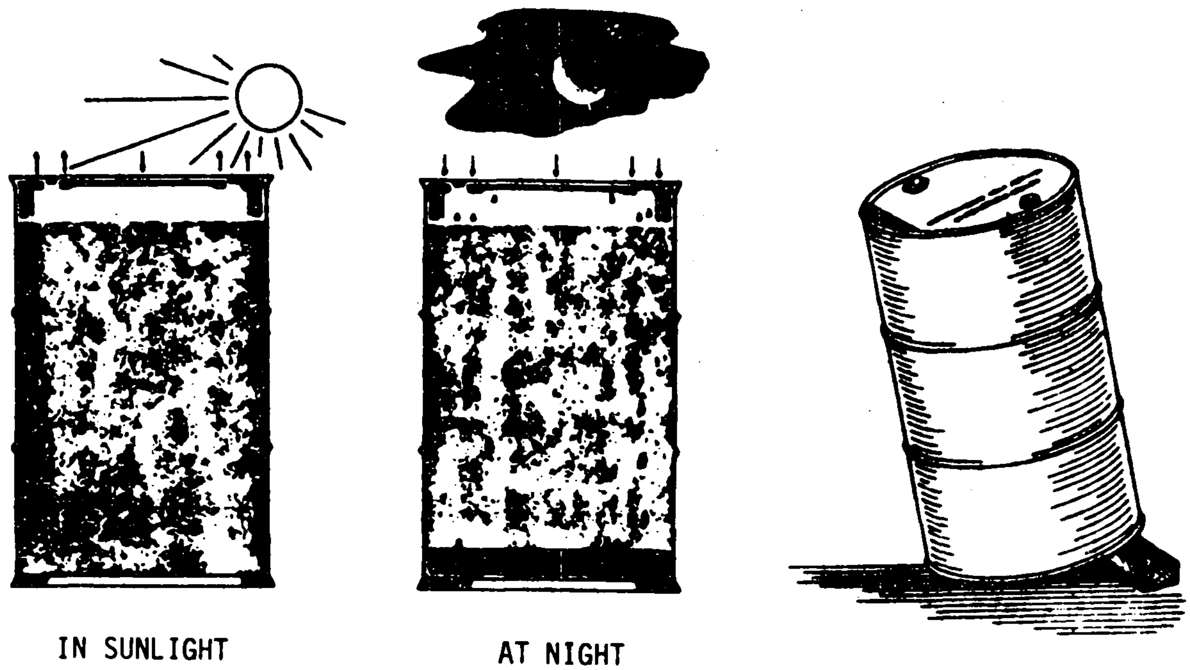


Fig. 3

REFILLING TANKS

When refilling the following should be observed:

1. Do not move the tank.
2. Use clean vessels and funnel. The filter should be clean.
3. Clean the tank of the tractor externally before taking the cover off.

It is better to refuel at the end of the work day. In this manner the condensation of water which occurs in partially full tanks is avoided. The following morning, drain and clean the fuel bowl before starting the engine.

These are electromechanical devices connected to different systems of the tractor (transmission, lubrication, etc.). They indicate the functioning of the said systems and are arranged on a panel within the line of vision of the operator.

There is a control panel on tractors grouping the function controls.

OIL PRESSURE

With it the pressure in the lubrication system can be known. There are two types:

Pressure Gauge (Manometer)

This is a mechanical instrument connected to the main oil conduit. The indicator travels over a dial divided into green and red zones with or without a numerical scale (Fig. 1).

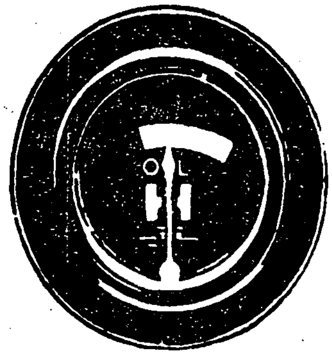


Fig. 1

The engine functions correctly when the indicator is on the green area or for values over 1 kilogram per square centimetre or its equivalent, 14 pounds per square inch.

Warning Light

It comes on when the lubrication pressure is low.

OBSERVATION

No oil pressure indicator shows the level of the lubricant in the sump of the engine.

TEMPERATURE

The electromechanical indicator for this purpose is connected by means of a sensor or bulb to the water cooling system. The dial can be divided into the following zones:

- green: normal operation; white: engine cold; red: temperature too high.
- numerically; temperatures between 75° and 95°C are for normal functioning.
- letters; these indicate: Cold
  Normal
  Hot

Fig. 2

OBSERVATION
An engine running cold wears excessively and may suffer damage.

GENERAL CHARGE
It indicates the electrical current generated and the actual consumption. There are different types:

Warning Light
It comes on when contact is made and turns off when the engine is accelerated. If it comes on while working, it is indicating an electrical failure.

Ammeter
An indicator runs over a graduated dial with positive (+) and negative (-) values or marked with the letters C and D corresponding to charge and discharge.

FUEL
It indicates the approximate amount of fuel in the tank.

HOUR METER
It allows us to know the hours an engine has been functioning at normal speed. It is useful for determining when to carry out preventive maintenance.

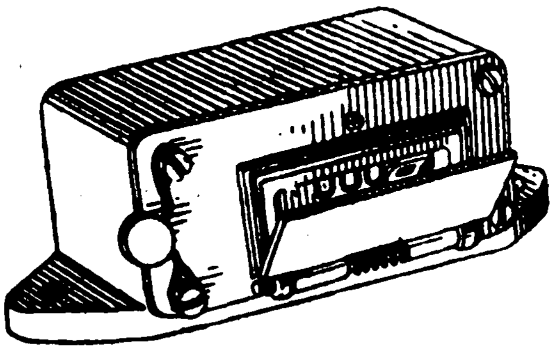


Fig. 3

TACHOMETER
It indicates the number of revolutions per minute at which the engine is turning. It is necessary for determining the working speed of the pulley and of the power take-off shaft.

SPEEDOMETER
It indicates the speed at which the tractor moves. It is measured in kilometres per hour, or miles per hour.

PROOFMETER

It is an instrument which is a combination of several others: odometer, speedometer and tachometer. It consists of several superimposed dials and an indicator.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 1.4-16

The track width is the distance between wheels on the same axle. Varying that distance is called adjusting the track width and its purpose is:

1. To get the wheels to roll in the furrows between the ridges of the crops when doing cultivation works (weeding, thinning, etc.).
2. To position the tractor in relation to a trailed implement and the work (plough).
3. To increase the stability of the tractor.

DEFINITION OF THE TRACK WIDTH. It has been agreed that the track width is the distance measured between the centres of the wheels (Fig. 1).

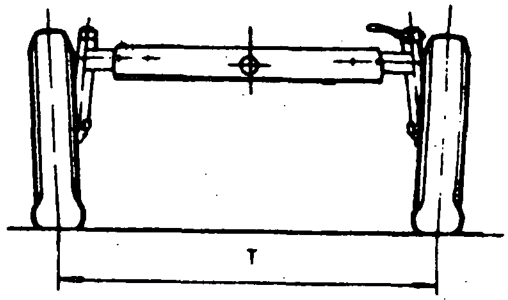


Fig. 1

FRONT TRACK WIDTH. It is adjusted by similar procedures in all tractors. They consist of adjustable semiaxles which are fixed by nuts and bolts screwed to the front end which pivots on the frame. When adjusting the front track width the length of the telescopic bars of the steering system should be changed accordingly.

REAR TRACK WIDTH. There are different designs. Some of them are:

Adjusting the hub on the rear axle.

- by shifting its position on the axle (Fig. 2),
- by rack and pinion (Fig. 3),
- by mechanical adjustment; the hub and the axle form a worm gear which after removing a stop bolt, allows the wheels to separate or come close to each other when the tractor is moved forward or backward.

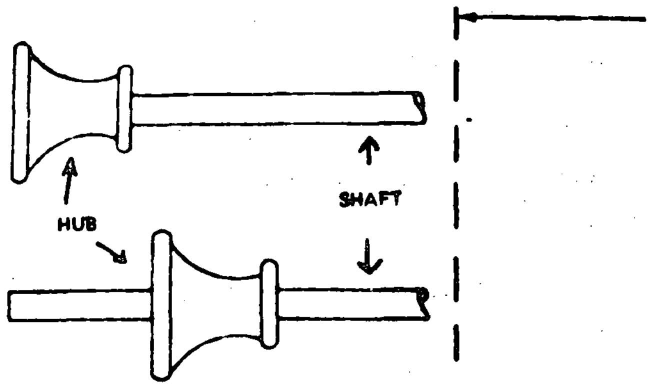


Fig. 2 The hub of the wheel moves along the left rear axle of the tractor.

Changing the position of dics and wheels:

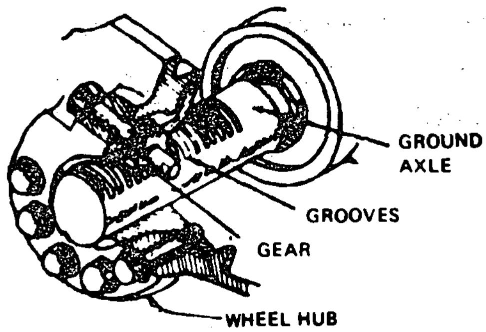


Fig. 3

- The disc is placed with its concave side facing inwards or outwards and the wheel is mounted on it in 4 different forms. In this way 8 track widths are obtained.

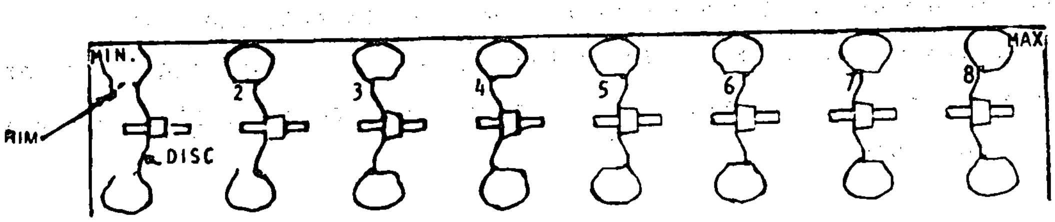


Fig. 4

- If the position of the hub is changed with respect to the axle, 8 new positions are added totalling 16 possible track widths.

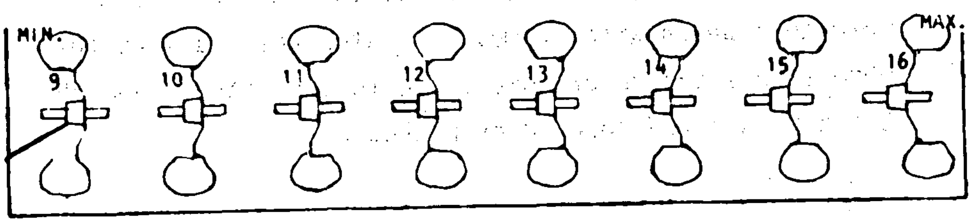


Fig. 5

OBSERVATION

The tread of tractor tyres follow one specific pattern. Some of these changes demand removing and mounting the tyre on the wheel in its correct position.

ADVANTAGES AND DISADVANTAGES

The operations of point 1 are easily and rapidly done when compared to wheel changing.

The major defect of shifting the hub on the axle is that when working with narrow track widths, the axle protrudes dangerously. The operations which require removing the wheels are made difficult when these have been ballasted with water.

Tyres are formed by layers (casing plies) of cotton, nylon or rayon cords impregnated with rubber and an edge reinforced with steel wires which gives rigidity (Fig. 1). The casing plies are covered with rubber walls and the tread. Then the group is vulcanized to form one unit. Also a special pattern is given to the tread to obtain better traction or grip.
The characteristics and dimensions of the tyres are marked on the walls. These indicate section of the tyre, interior diameter and the number of plies. Some machines are equipped with tyres which do not use inner tubes (Fig. 2). In this case the rim has an air valve.

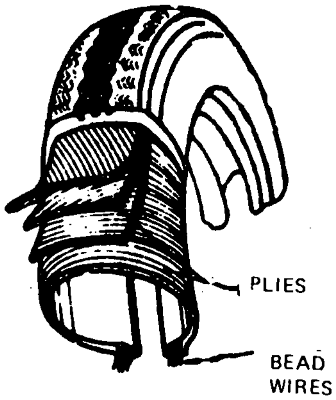


Fig. 1

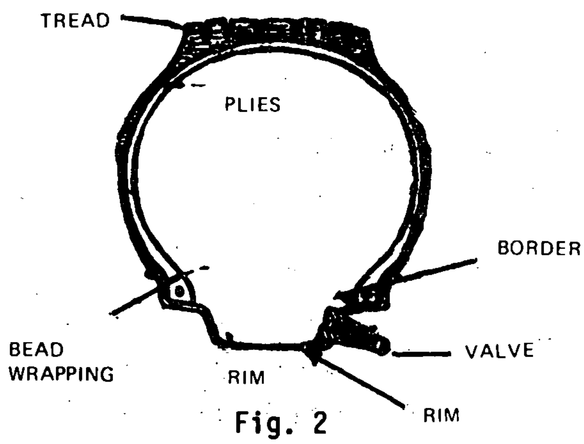


Fig. 2

The bead of the tyre is reinforced so that it squeezes firmly against the flange of the rim thus retaining the air pressure.

Inner tube

This is placed inside the tyre and is inflated to a specified pressure. This causes the tyre to resist any change of shape. It has a valve which allows air into the tube but does not allow it to escape.

MAINTENANCE

Excessive or insufficient pressure ruins the tyre.
Excessive inflation causes rigidity and lessens the resistance to impacts causing ruptures in the cord.

Under-inflation (Fig. 3) causes the walls to flex and there is overheating of the material which results in rupture of the plies.

Fig. 3

UNFAVOURABLE CONDITIONS

The useful life of the tyre is reduced by:

1. Under-inflation (Fig. 4a).
2. Over-inflation (Fig. 4b).
3. Valve cap missing.
4. Misaligned axles.
5. Defective rims.
6. Defects in the steering system of the tractor.

a. UNDER-INFLATED WALLS RUPTURE

b. OVER-INFLATED EXCESSIVE WEAR

c. NORMAL PRESSURE

Fig. 4

INFLATION

The recommended pressure (Fig. 4c) for rear tractor tyres is 12 pounds per square inch except in special cases. They require more if:

- They transport integral mounted machines .
  In that case consult the load and pressure chart.
- When ploughing, the right wheel is in the furrow. This adds more load on it. It is recommended to raise the pressure until the lateral flexing disappears or a maximum of 16 psi is reached.

When mounting the rear tractor tyres, these should be inflated to 30 psi to attain a correct seating with the rim. Then immediately reduce the pressure to 12 psi, or normal pressure. The pressure should be checked weekly with a hydroinflation gauge (Fig. 5). The standard gauges are ruined with the water. If an antifreeze solution is used, wash the instrument with abundant water immediately after use.

CAUTION

EXCESSIVE INFLATION CAUSES THE TRACTOR TO REBOUND AND MAY THROW THE DRIVER.

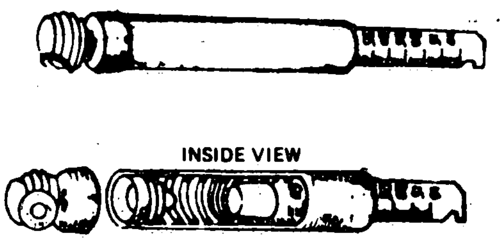


Fig. 5

OBSERVATION

A kilogram per square centimetre is equal to 14 pounds per square inch (psi).

1 k/cm^2 = 14 psi.

K/cm^2 x 14 = pounds per square inch.

psi ÷ 14 = kilograms per square centimetre.

The following table gives the pressures recommended by the manufacturers for different sizes of tyres, number of plies and load.

SIZE	PLIES	PRESSURE		LOAD
		POUNDS	KILOGRAMS	KILOGRAMS
4.00 - 12	2 - 4	20 - 28	1.40 - 2	150-180
4.00 - 15	4	28	2	215
5.00 - 15	4	28	2	300
5.50 - 16	4	28	2	360
6.00 - 16	4 - 6	28 - 36	2 - 2.50	415-480
6.50 - 16	6	36	2 - 2.50	550
7.50 - 16	4 - 6	28 - 36	2 - 2.50	610-710
7.50 - 18	4 - 6	28 - 36	2 - 2.50	660-770
4.00 - 19	4	28	2	260
6.00 - 19	4	28	2	500
6.00 - 20	4	28	2	550
6.50 - 20	6	36	2.50	650
7.00 - 20	6	36	2.50	700
7.50 - 20	6	36	2.50	830
1.40 x 40	4	22	1.50	400
17 x 40	4	28	2	500

HEAT. The wear of the tyres in summer doubles the wear in winter. Store the spare tyres and the tractor in shaded and ventilated places.

PETROLEUM PRODUCTS. Lubricants and fuels attack the rubber. Keep the tyres clean.

CARE. When mounting and dismounting the tyres use the proper tools. Do not hit them. Be careful with the disc of the wheel and the bead of the tyre.

CUTS. Repair deep openings which allow the entry of dust and water. These destroy the plies and wires.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 1.4-16

The object of this operation is to increase traction capacity and/or to produce stability for the tractor. It consists of increasing the weight by adding solid bodies and/or hydroinflating the tyres.

PULLING CAPACITY

It is determined by:

- the power of the tractor,
- the adhesion.

A greater grip or less wheel slip is obtained:

- with a larger rolling radius; wider tyres,
- with heavier weight on the said surface.

The heavier the weight supported by the drive wheels, the greater the traction (Fig. 1).

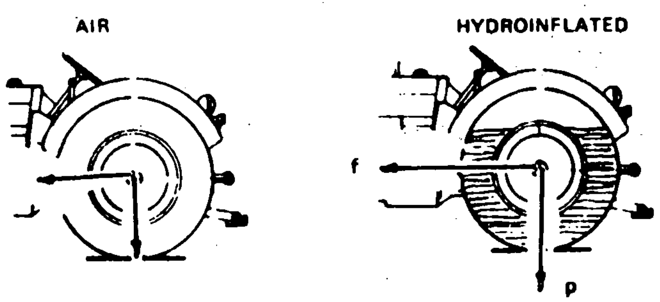


Fig. 1

An increase in weight (p) increases
the traction capacity (f)

For the farmer, loss of traction means:

- loss of speed,
- excessive wear,
- higher consumption of fuel for each task,
- increase in the cost of operation.

100 kilograms in weight distributed on the rear axle of the tractor increase the functional power of the draw bar by an average of:

- 66 kilos if it moves on pavement,
- 55 kilos if it moves on clay soils,
- 40 kilos if it moves on sandy soils,
- 35 kilos if it moves on green alfalfa.

Grip also depends on the soil.

BALLASTING. It can be done on the front end in order to improve the steering or to avoid situations as the one shown in the figure. In it the tractor, unable to move forward turns on spot or on the rear end to reduce wheel slip.

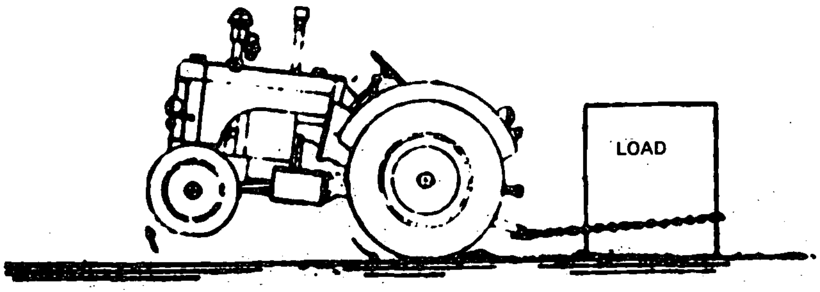


Fig. 2

Up to 15% of wheel slip is considered tolerable when working the soil.
In both cases ballasting can be done:

- *with solid weights*, known as ballasts which are fixed to the rear or front wheels or are hung on the front or rear end of the frame by means of special clamps. Ballasts are:
    - expensive
    - not very practical to fit or remove.

- *by putting liquid* in the tyres which is relatively easy and cheap, but reduces the useful life of the tyres.

HYDROINFLATING. This operation consists of substituting liquid for part of the volume of air (90% as a maximum) which is contained in the tyre. This liquid may be:

- water; in climates of minimum temperatures higher than $0^{o}C$,
- anti-freeze solution (calcium chloride).

The liquid is put in with a hydroinflator which allows the air to leave while the liquid enters (Fig. 3).

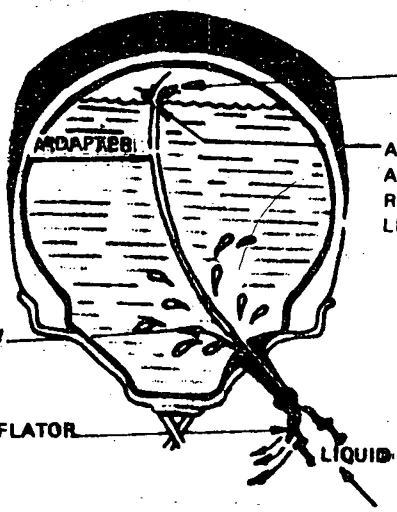


Fig. 3

PROCEDURE

1. Lift the wheel off the ground.
2. Turn the wheel placing the valve in its upper position.
3. Remove the dust cover.
4. Screw the hydroinflator on the valve.
5. Connect the hose and open the tap.
6. Once water without bubbles comes from the bleed valve, close the tap.
7. Remove the hydroinflator and replace the dust cover.

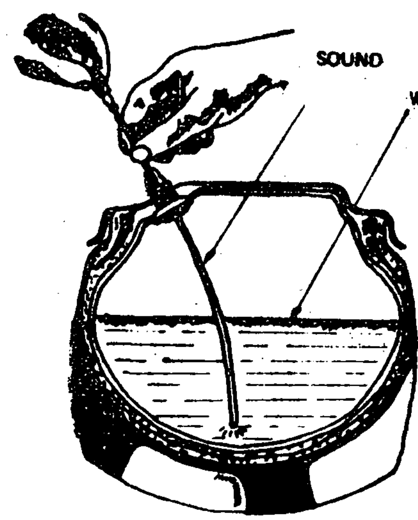


Fig. 4 - When reducing the ballast, air is introduced. This expels the liquid.

Ballasting the tractor is convenient in many circumstances. However, it should be remembered that a heavier weight:

- increases fuel consumption,
- reduces the useful life of the tyres,
- increases the compaction of the soils when ploughing. This is undesirable because:
  - it reduces infiltration,
  - it makes the penetration of the roots difficult,
  - it destroys the structure,
  - it increases erosion.

OBSERVATION

When ballasting check the pressure of the tyres with that recommended in the Operator's Manual.

TECHNICAL VOCABULARY

Hydroinflator - Water valve

CINTERFOR
1st. Edition

TRACTOR DRAWBAR

This is a device to which the implements to be trailed are hitched.
The position of the hitch point allows maximum efficiency in towing as well as safety in the operation.

DESCRIPTION

It is situated at the rear of the tractor, on the centre line parallel to the direction of movement and below the centre of gravity. It is rigidly attached by means of supports to the rear or to the frame.

The coupling device of the trailed implement is fitted in the holes of the drawbar (Fig. 1).
For this purpose a sturdy coupling pin or bolt is used (Fig. 2).

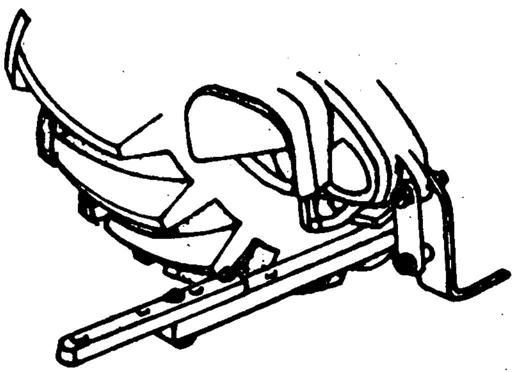


Fig. 1 Straight drawbar

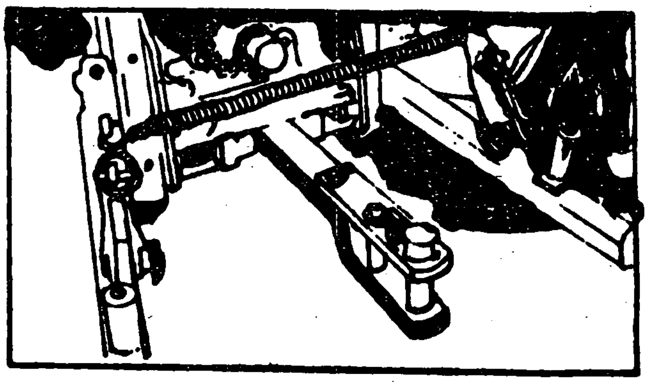


Fig. 2 Drawbar with clevis. See the clamping bolt.

The aim of the different designs of drawbars is:

- **to provide such a coupling of the implement that it will keep it from sw!nging (Fig. 2).**
- **to allow different coupling heights; bent and reversible bar (Figs. 3 and 4).**
- **to facilitate changes in direction or when turning; swinging drawbar.**

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 1.4-15

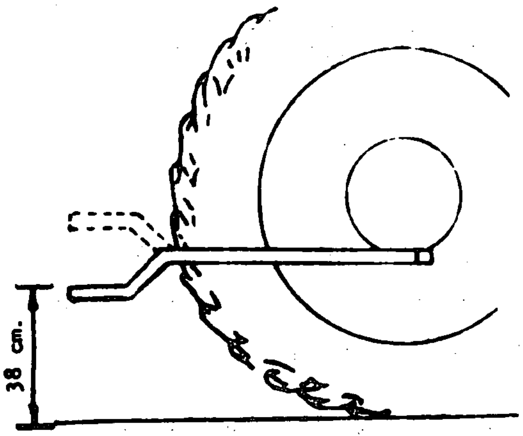


Fig. 3

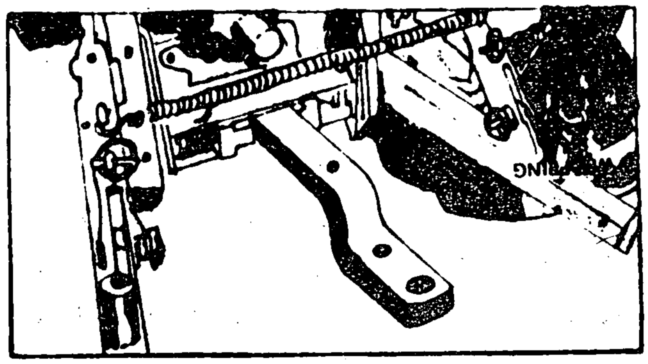


Fig. 4

Some tractors permit, for light work, the inclusion of a bar fixed to the lower arms of the hydraulic lift (Fig. 5).

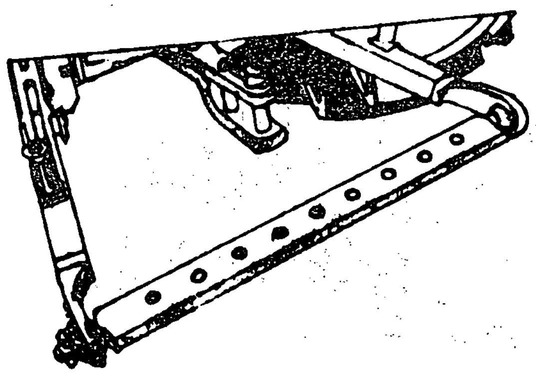


Fig. 5

OBSERVATION
Read the Operator's Manual of your tractor. Avoid breakage and risks.

- **The vertical adjustment of the drawbar allows the proper coupling for each need; relatively low (disc harrow) or high (cereal planter) implements.**

OBSERVATION
Practically all agricultural implements should operate levelled, lengthwise and crosswise.

- **The horizontal adjustment permits the best working position of the implement with relation to the tractor.**

The tractor has replaced draft animals for heavy towing duties.
The hydraulic system replaces man's tiring efforts and complex mechanical systems with:

- *reduction of effort* by applying the power produced by the engine to the performance of different tasks.
- *reduction of costs* by performing the tasks quickly, exactly and efficiently, by requiring simple maintenance and by causing a smaller number of stoppages due to damage.
- *reduction of risks* for the operator because there are fewer moving parts and more secure elements.

APPLICATIONS

To lift or lower ploughs or cultivators and to modify the working angle of the disc harrow or of the levelling blades. These are simple applications of the hydraulic system of the tractor.

Others are:

- to stop the movement by operating the *hydraulic brake,*
- to steer the tractor with the aid of *hydraulic power,*
- to change speeds with *hydristatic transmissions,*
- *hydrodynamic transmissions,*
- *hydraulic motors* which supply the power to the 4 wheels or operate an implement (endless chain),
- *torque converters* which allow to adjust the towing force to the speed while the tractor is moving.
- *remote control cylinders* which allow straight movements in any direction,
- *hydraulic three-point hitch* to operate mounted or semi-suspended implements (ploughs, harrows, hole diggers).

TYPES

Some tractors have more than one hydraulic system and these are independent of each other. Thus, the brake system is independent of the one which works the cultivator or the mowing machine. Other models have a single central system and from it, all the hydraulic accessories are operated.

Whatever the number of applications, the hydraulic mechanism will consist of:

- *sump* or hydraulic fluid reservoir (Fig. 1).
- *hydraulic pump*, which can be of various types and its function is to transport the pressurised fluid.
- *pipes and fittings* through which the fluid runs and which transmit pressures.
- flow control *valves* which modify the direction of flow, amount and pressure of the fluid.

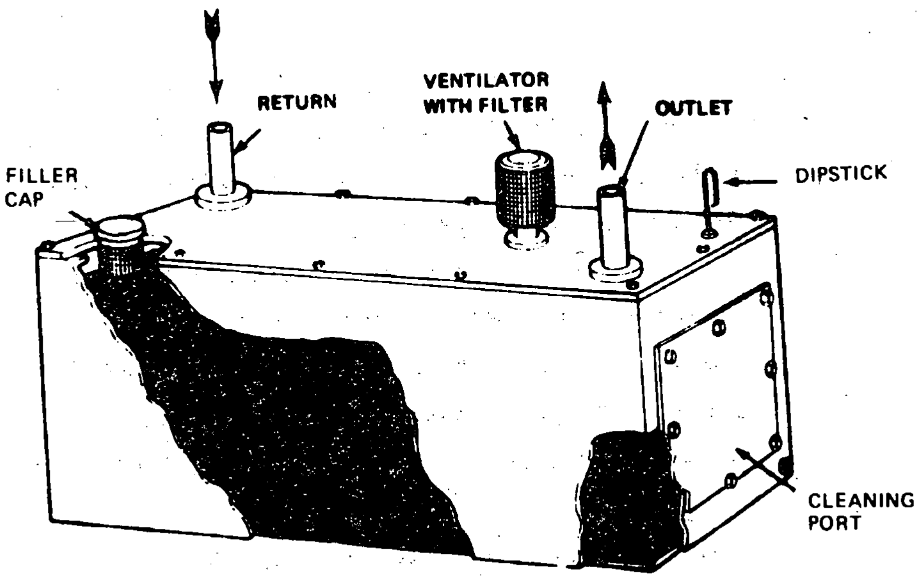


Fig. 1

MAINTENANCE AND OPERATION

The hydraulic mechanisms will function properly if the following rules are observed:

1. Use only hydraulic fluids which have all the characteristics recommended by the manufacturer of the system.
2. Keep the fluid at the correct level.
3. Do not mix different fluids.
4. Replace the fluid and change or clean the filters according to the recommendations given in the Operator's Manual for each particular machine.
5. Avoid getting moisture and foreign particles into the system.
6. Check that there are no leaks in the connections, fittings, etc.

SUMMARY

The diagram shows the parts of a hydraulic system.

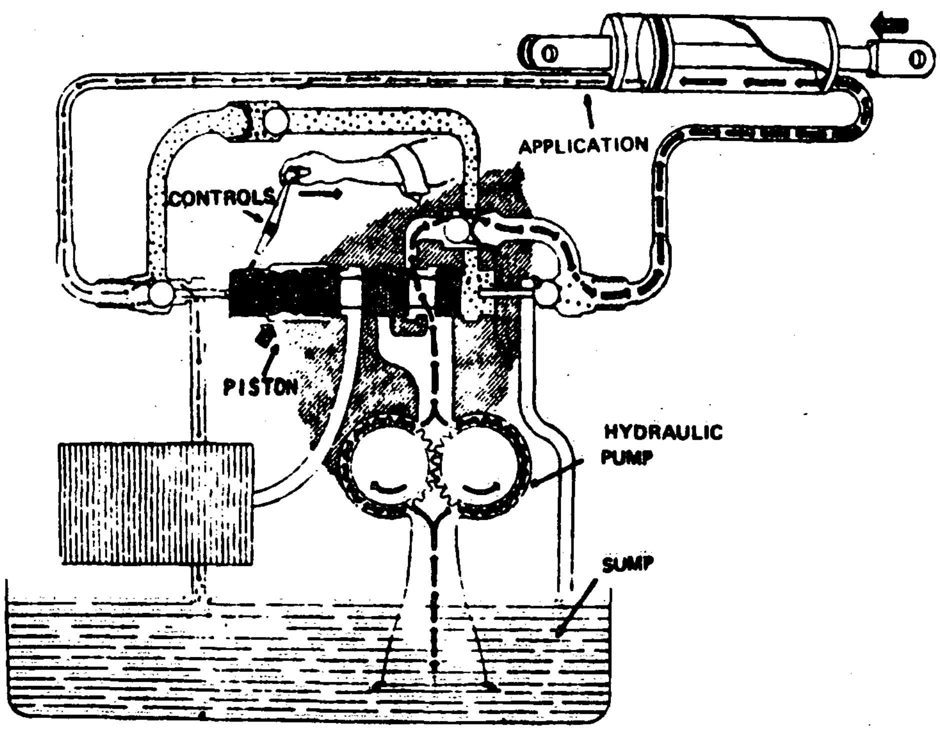


Fig. 2 - The cylinder in the diagram can be replaced with another application: clutch, brake, transmission, etc.

It is a hydraulically operated mechanical arrangement which permits the fast and efficient coupling of integral-mounted or semi-mounted implements.

GENERAL DESCRIPTION

It is set at the rear end of the tractor. Basically, it consists of *three arms:*

- *two lower* link arms, parallel to each other, both actuated by a hydraulic cylinder which may be single or double acting.
- *one upper* arm, of variable length, which pivots while describing a vertical arc with its centre on a bolt or shaft mounted on the upper hitch point of the tractor.

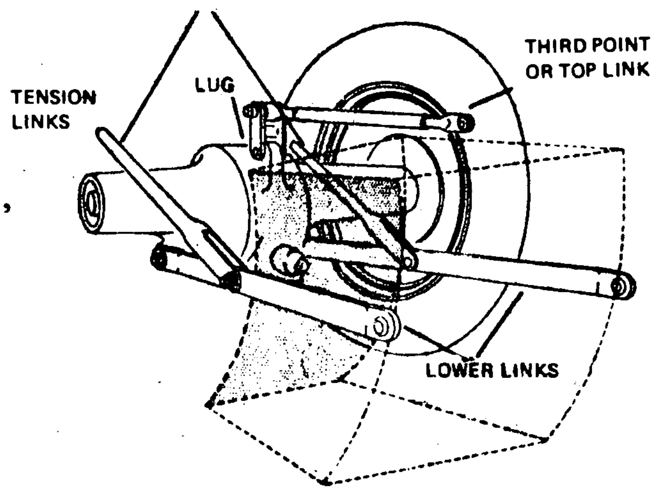
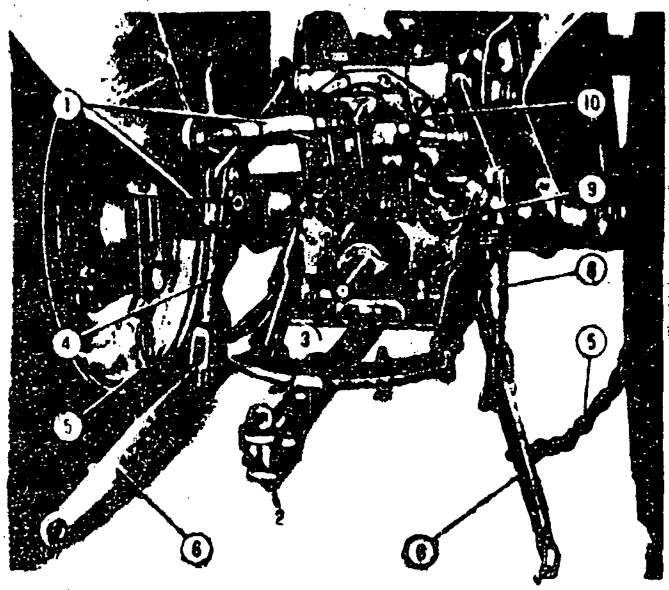


Fig. 1 - Three-point hitch.
The figure shows the arc described by the lower arms.

Figure 2 shows the position of the three-point linkage with respect to the drawbar (2) and the power take-off (3).
The lifting hydraulic mechanism (10) actuates the lower arms (6) by means of the lifting rods (4) and (8).
The implement is hitched to the lower arms and to the third point (1).
To obtain the right position of the implement with respect to the soil the adjustable link (9) is operated. This will lengthen or shorten the link. The lateral thrusts caused by the implements when working are balanced by means of the check chains (stabilizer chains) (5)



DESCRIPTION OF THE PARTS

Top link. It consists of three threaded parts. The middle section has left-hand threads on one end and right-hand threads on the other. This section allows for bringing the parts closer or extending the link and so, level the implement lengthwise (Fig. 3).

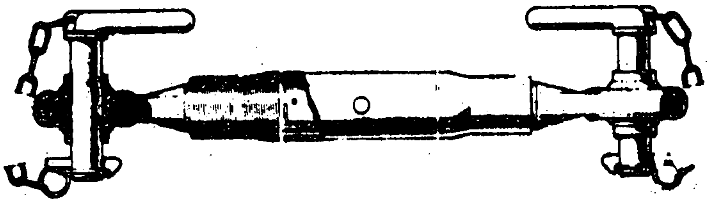


Fig. 3

Lower link arm. It has round articulations at both ends (Fig. 4).

Lifting rod. Its length can be varied (Fig. 4) in order to make the hitching of the implement easier or to level it crosswise (perpendicular to the direction of movement).

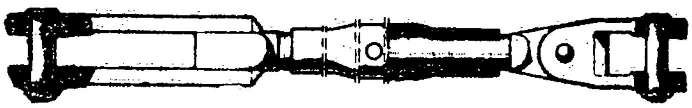


Fig. 4

Lateral butts and *check chains* (Figs. 5 and 6). These allow the control of the lateral movement of the lower link arms and therefore of the implement.

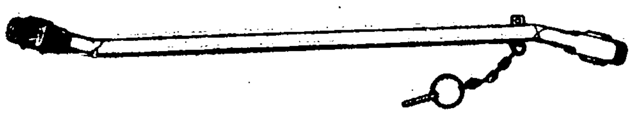


Fig. 5

Fig. 6

A pump takes the hydraulic liquid from the reservoir and sends it under pressure to the directional valve box which the tractor operator controls to start the system to lift or lower the mounted implement.

The control of the valves allows the flow from the pump to be:

- returned to the reservoir,
- directed to the cylinder; moving the piston which operates the hydraulic lifting arms.

The simplified diagram below shows both possibilities. A relief valve has been added. This avoids an excess of pressure in the system.

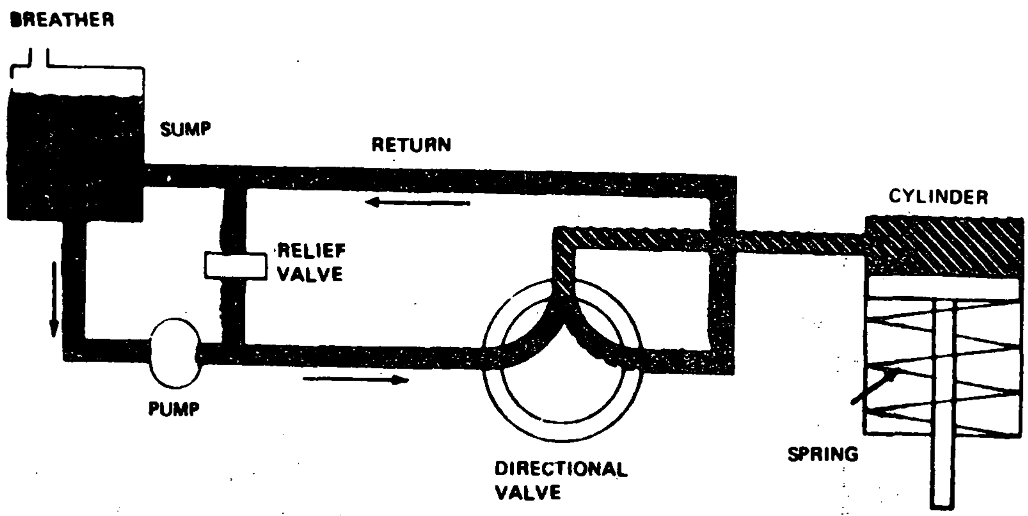


Fig. 1 Schematic drawing

The piston, when moved by the liquid, pulls the connecting rod and the rod turns an elbow shaft which actuates the lifting rods. Joined to the rods are the lower link arms, where the implements are hitched.

Figure 2 shows the lifting arms of an integral coupling operated by twin cylinders.

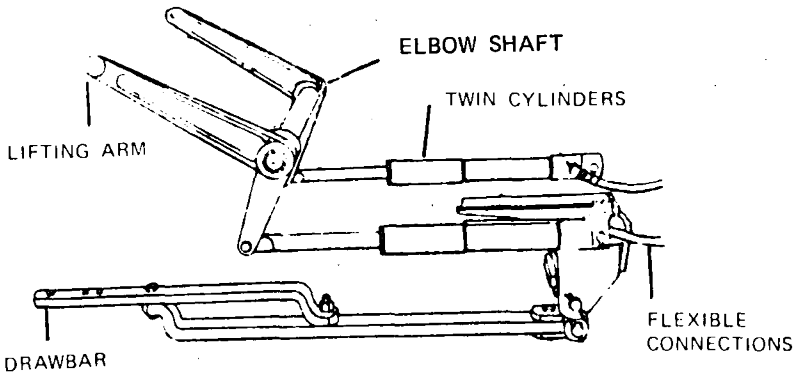


Fig. 2 - Lifting arms of an integral coupling operated by twin cylinders.

Hydraulic cylinders can be

- *single acting;* in this case they move hydraulically in one direction and the return is effected by the weight. (e.g. hydraulic jacks).
- *double acting;* the movement is done hydraulically in both directions.

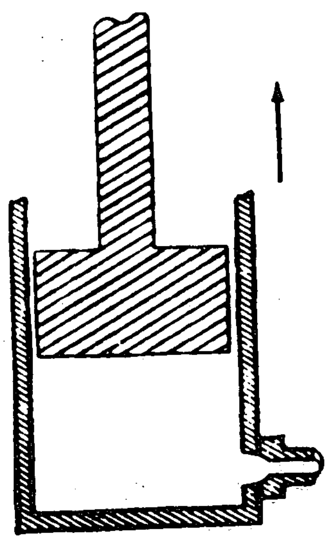


Fig. 3 - Single acting cylinder

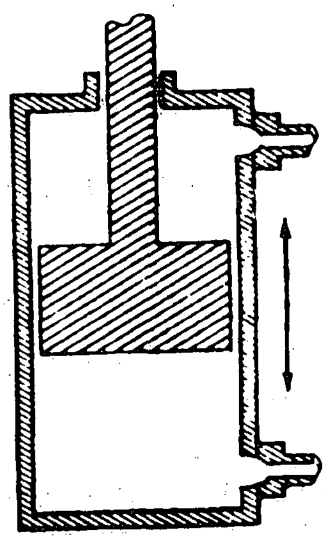


Fig. 4 - Double acting cylinder

If double acting cylinders are used, the diagram in figure 1 should be modified in the manner shown by the illustration on the following page.

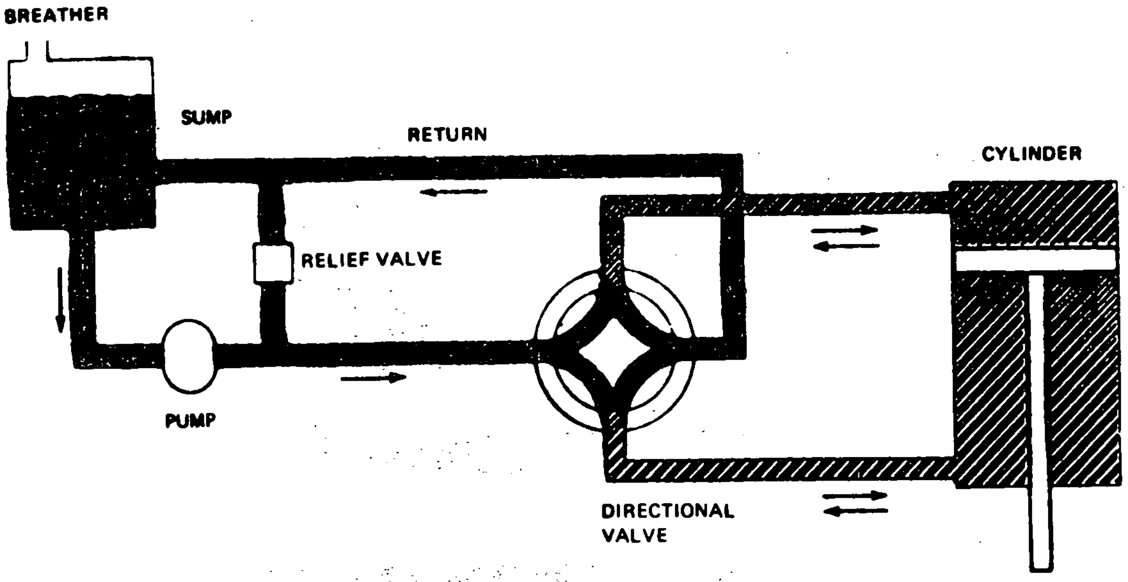


Fig. 5 - Diagram of hydraulic system with double acting cylinder.

There are two basic types:

- When single acting cylinders are used in the three-point linkage, the implement is hydraulically lifted and it descends by its own weight. In this case the implements should have depth-limiting devices. These are generally regulating wheels which keep them from going below a given level.
- When using double acting cylinders, lifting and lowering of the equipment is done hydraulically and the level to which they descend can be controlled. In this case the implement could do without depth-limiting devices.

Belonging to this type are the hydraulic systems with load and depth control. On these, the top link is fixed to a tower which is sensitive to the forces transmitted by the tensor which operates a hydraulic circuit valve.

This valve adjusts automatically taking the implement to the pre-set position.

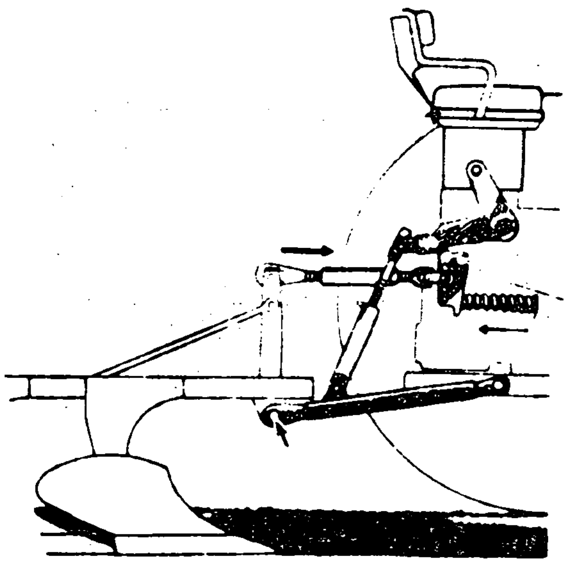


Fig. 6 - This system has automatic control for load and depth.

This is an accessory used to give movement to stationary machines. The pulley on the tractor transmits the rotation by means of a flat belt, to the corresponding pulley on the machine.

TYPES

The position of the pulley with respect to the tractor can be lateral (Fig. 1) or rear (Fig. 2). In the latter case it is usually mounted on the power take-off shaft.

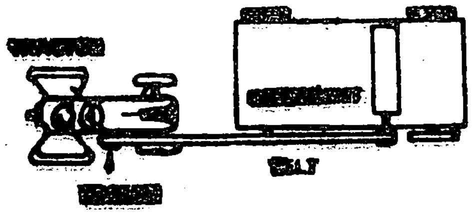


Fig. 1 - Laterally mounted pulley.

OBSERVATION

When the pulley is mounted on the power take-off shaft, it has a gearbox with lubricant:

- control the level of lubricant.
- change the lubricant according to the instructions in the manual.

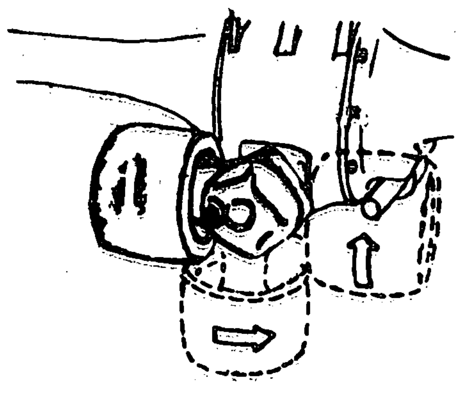


Fig. 2

CALCULATIONS FOR PULLEYS

The machines designed to be operated by pulleys and belt are often equipped in such a manner that by operating the engine of the tractor at normal speed the necessary revolutions for the implement can be obtained.

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However, many machines are not sold with their pulleys (water pumps, for example) or they work at different speeds to perform different tasks. (grain mills, threshing machines). In these cases it is necessary to make calculations.

To solve the problems we should know:

- the diameter of the pulleys, which is determined by measuring as shown in Fig. 3.
- the number of revolutions per minute at which the shafts rotate, for which we use a mechanical tachometer or, as in Fig. 4, a chronometer and an odometer.

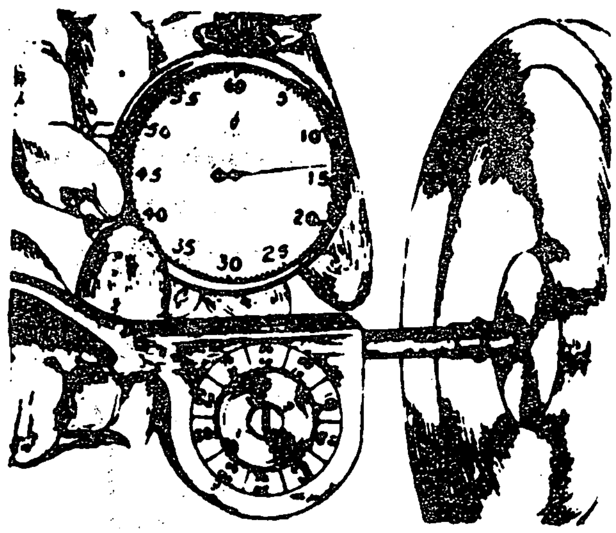

Fig. 4

Fig. 3 - Manner of measuring a pulley to determine its diameter.

All calculations for pulleys are based on the following:

- the product of multiplying the diameter of the tractor's pulley by the number of revolutions per minute is equal to the product of the diameter of the pulley of the machine by the number of revolutions per minute at which it rotates.

That is:

Diameter of the drive pulley x rpm of the drive pulley = Diameter of driven pulley x rpm of the driven pulley

(D) x (RPM) = (d) x (rpm)

The following cases can arise:

CASE I

We know or measure: the diameter of the pulley of the tractor = D,
the rpm of the pulley of the tractor = RPM,
the rpm at which the machine should work = rpm

we do not know the diameter (d) of the pulley we should mount on the machine for it to work at the required speed. We calculate the diameter by applying:

$$d = \frac{D \times RPM}{rpm}$$

CASE II

If we know: the diameter of the pulley of the tractor = D,
the diameter of the pulley of the machine = d,
the rpm at which the machine should rotate = rpm

and we do not know the revolutions per minute (RPM) at which the drive shaft should rotate, we then apply:

$$RPM = \frac{d \times rpm}{D}$$

CASE III

We wish to know at what speed the shaft of the machine rotates, then:

$$rpm = \frac{D \times RPM}{d}$$

To calculate the diameter of the drive pulley:

$$D = \frac{d \times rpm}{RPM}$$

SUMMARY

We want to know	We know	We apply
d	D, RPM, rpm	$\frac{(D) \times (RPM)}{(rpm)}$
rpm	D, RPM, d	$\frac{(D) \times (RPM)}{d}$
D	d, rpm, RPM	$\frac{(d) \times (rpm)}{(RPM)}$
RPM	d, rpm, D	$\frac{(d) \times (rpm)}{D}$

Whereby:

d = diameter of the pulley of the machine.

rpm = revolutions per minute of the shaft of the machine.

D = diameter of the drive pulley.

RPM = revolutions per minute of the drive shaft.

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This consists of an extended shaft which protrudes from the tractor. Its external end has splines which allow the coupling of the machine drive shaft and is actuated by the transmission of the tractor. When used with the telescopic shafts having universal joints, it can transmit the movement to offset elements, or to elements of variable alignment as in the case of trailed implements.

DESCRIPTION

To transmit the movement from the power take-off shaft of the tractor to the trailed machine the following is required:

- *power take-off shaft of the tractor,*
- *telescopic shaft,*
- *universal joints,*
- *covers and guards.*

In figure 1 the different parts can be seen.

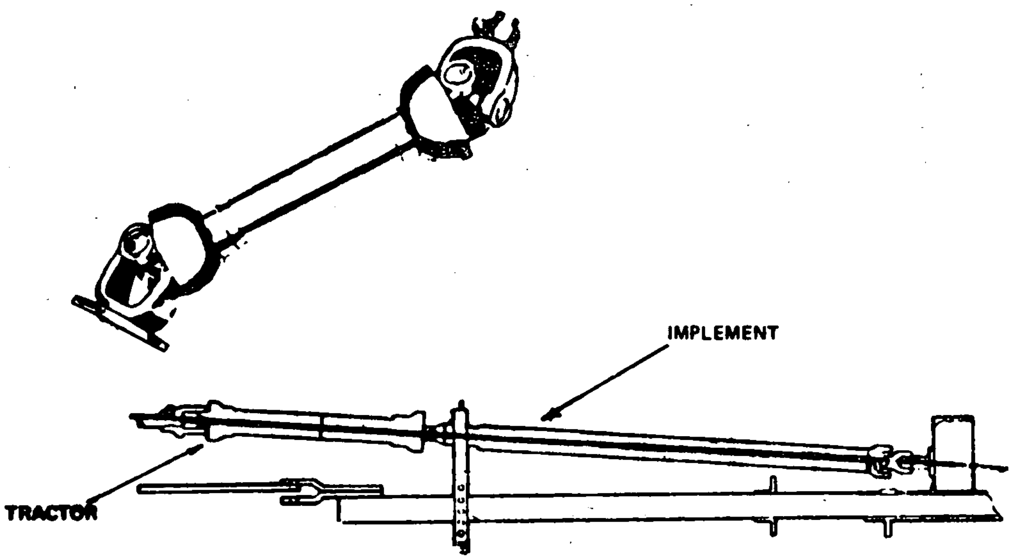


Fig. 1

POWER TAKE-OFF

The following standards have been established for tractors of different makes:

- the dimensions of the shaft and of the splines,
- the speed expressed in revolutions per minute, and
- the power that may be transmitted for each size and speed.

The following chart gives a summary of the two standardized sizes or categories.

Category	Revolutions per minute	Length of the coupling	Diameter	Number of Splines
I	540 ± 10	3"	1 3/8"	6
II	1000 ± 25	2"	1 3/8"	21

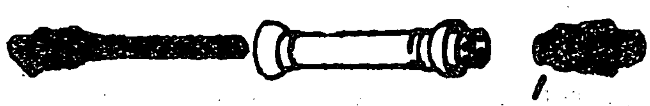
The rotation of the shaft is always clockwise.

TELESCOPIC SHAFT

It has two main characteristics:

- It allows modifying the total length of the shaft, making it shorter or longer, thus, facilitating the use of it on lands which are not level and making turns easier. This refers to cases in which the distance between the power take-off of the implement and the tractor is variable.
- It is designed for operation at different angles. This is obtained with the use of universal joints. It allows for turning, moving on irregular surfaces, and small deviations from the alignment in the coupling of the tractor and the machine.

Telescopic shafts with one section as shown in figure 2 and with two sections as shown in figure 1 are mainly used for agricultural applications.



POWER TAKE-OFF

Fig. 2

UNIVERSAL JOINTS

These are used for transmitting power between shafts which intersect and when the angle between them is variable. With the use of one universal joint (Fig. 3) uniform speed cannot be obtained in the transmission between non-parallel shafts.

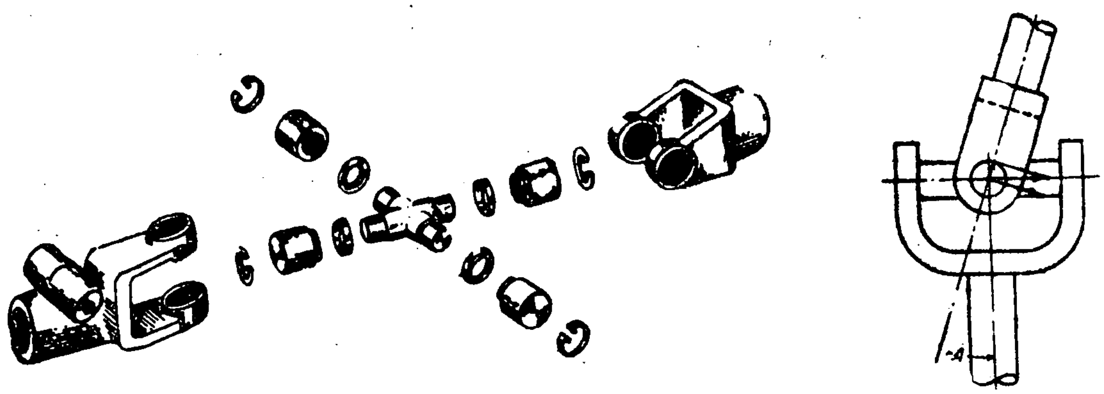


Fig. 3

Two universal joints which allow combinations as those shown in figure 4 are generally used.

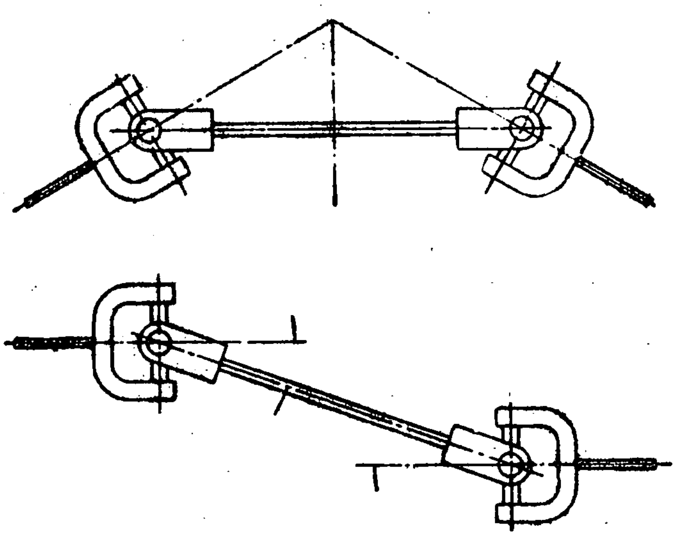


Fig. 4

COVERS AND GUARDS

There are two types of protections: the stationary (Fig. 5) and the rotary (Fig. 6).

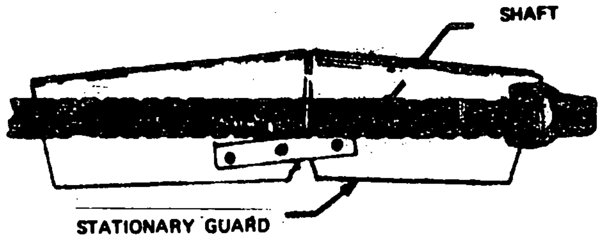


Fig. 5

The rotary guards are metal or plastic tubes which protect the operator from the rotation of the shaft. The telescopic shafts have telescopic rotary guards; this is why each section of the guard has a different diameter.

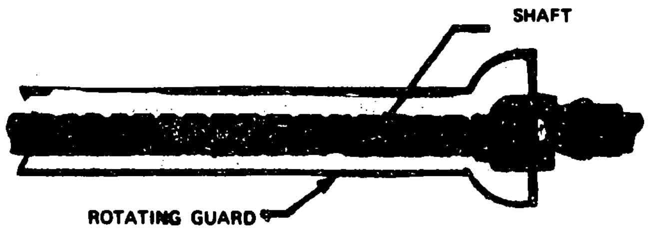


Fig. 6

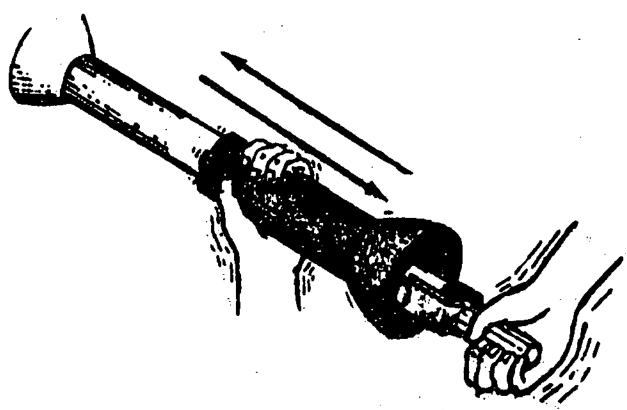


Fig. 7

CBC

TECHNOLOGICAL INFORMATION
POWER TAKE-OFF (Use and maintenance)

If properly used, adjusted and maintained, correctly selected transmission shafts will give long and economic service free from accidental damage.

Bad use and/or maintenance is costly for the owner and risky for the operator.

USE

The shafts should work with the best possible alignment during normal operation of the machine to provide a regular and smooth flow of power. Although the universal joints allow a certain degree of flexibility in the alignment, the shaft should be operated as straight as possible.

The mounting of the two parts of the telescopic shafts should be done in such a manner that the planes of the universal joints coincide, as shown in figure 1.

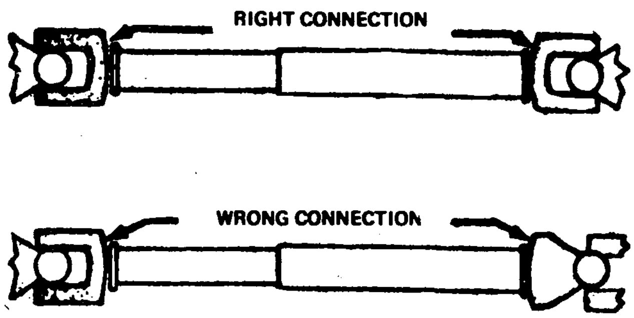


Fig. 1

SAFETY MEASURE

DO NOT OPERATE ANY POWER TAKE-OFF SHAFT WITHOUT THE PROTECTIVE GUARDS.

MAINTENANCE

Taking care of the telescopic power shafts, mainly consists of the maintenance given to their different bearings.
Proper cleaning and lubrication is the secret of the maintenance of bearings.

CAUTION

DO NOT USE GASOLINE TO CLEAN THE MACHINES. IT IS A FIRE HAZARD. IT IS ALSO POISONOUS BECAUSE OF ITS LEAD CONTENT.

The good administration of any firm demands that records be kept of each machine in its service.

In agricultural enterprises these records are kept daily, weekly and monthly. These allow an efficient organization in the aspects of trading, operation and maintenance.

COMMERCIAL MANAGEMENT

It deals with costs and yields, investments and losses or profits.
It comprises decision-making on aspects such as:

- the purchase or hiring of machinery,
- the selection of the type and size of the implements and tractors,
- the replacement of the stock,
- the purchase of new or used machinery.

Decision-making comprises factors such as:

- the speed with which the implements operate,.
- power requirements.
- purchasing, amortization and maintenance,
- costs per work hour or per acre worked,
- price for the hiring of implements, etc.

In order to know these and other factors, it is necessary to keep records which allow us to determine costs.

OPERATION MANAGEMENT

A more profitable operation can be obtained with it. It includes various aspects, such as:

- preparing daily work programmes and medium and long term ones,
- studying how to increase the efficiency of the implements, eliminating waste of time by:
- using the full capacity of the machine,
- suitably adjusting the implements, etc.

ADMINISTRATION OF MAINTENANCE

It deals with the activities necessary to adequately preserve and conserve equipment and facilities. To maintain in good condition, to recondition by performing minor repairs, to lubricate the machinery, are all aspects of maintenance.

Usually, the maintenance and operation manuals of the machine include formats related to the operations which should be done on the machine and which are to be recorded by the operator.

The layout of a record sheet is in the hands of the manager or of the owner of the machine, but, as a general rule, the following elements should be included in each type of record:

CONTROL OF THE TRACTOR

- Trade mark and model.
- Serial number and/or order number.
- Date (from - to).
- Work hours.
- Amount of fuel used.
- Amount of lubricant used.
- Class of work done.
- Repairs.
- Observations.

DAILY RECORD

- Trade mark and model.
- Serial number and/or order number.
- Date.
- Reading on the odometer.
- Amount of oil used by the engine.
- Amount of lubricant used by the transmission.
- Amount of fuel used.
- Observation.

The following is an example of a tractor maintenance sheet:

MAINTENANCE SHEET OF THE TRACTOR										
TRADE MARK AND MODEL – Hassomag R-60 NAME OF THE OPERATOR – William Tell							SERIAL NUMBER A25823 INVENTORY CONTROL 6			
		HOURS OF SERVICE								
		120 HOURS X			240 HOURS		480 HOURS			
		OR WHEN INDICATED IN THE MANUAL								
DATE	HOUR METRE	Change of engine oil	Change of oil filter element	Check oil in steer-ing box	Change fuel filter element	Change of trans-mission oil	Change of grease on front wheels	Change water in cool-ing sys-tem	Visit of mechanic for gener-al check-	REMARKS
15 April /72	4370	11 qrt	1	X	1	9 qts	XX	X	X	
10 May /72	4490	11 qts	1	X	–					
4 July /72	4610	11 qts	1	X	1			X		
8 Aug /72	4740	11 qts	1	X	1					
9 Sept /72	4860	11 qts	1	X	–	9 qts.	X	X		

Weekly and monthly reports should be a summary of the others.

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To correctly couple any agricultural implement to tractors made by different manufacturers it is necessary for it to have certain standard characteristics.

The American Society of Agricultural Engineers has approved certain standards which are followed by the manufacturers of agricultural equipment in different countries.

STANDARDS

The approved standards establish relationships between the dimensions which allow any implement having them, to be coupled to any standard tractor.

The standards establish that the location of the *power shaft* will be within the limit of 3" (75 mm) whether to the right or to the left of the centre-line of the tractor and that the speed of rotation will be of 540 to 1000 revolutions per minute and clockwise.

Other dimensions between the power shaft and the drawbar of the tractor are shown in figure 1.

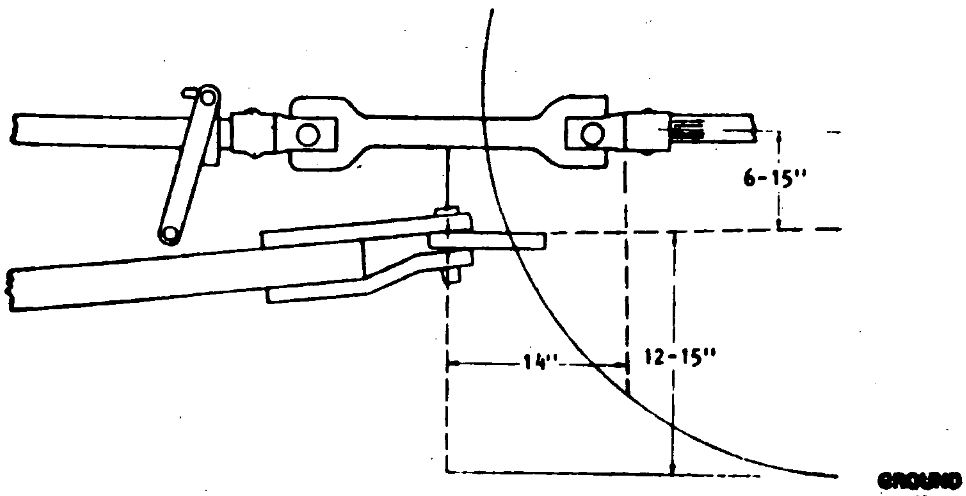


Fig. 1

Other characteristics of the power shaft have been explained in the corresponding Technological Information Sheet (Power Take-off - Description).

The standards for the pulley of the tractor establish that the peripheral speed (or belt speed) will be of 3100 feet per minute with a tolerance of 100 feet which is equivalent to 945 ± 32 metres per minute. The minimum width will be such as to allow the use of a flat belt of a 6" (150 mm) section.

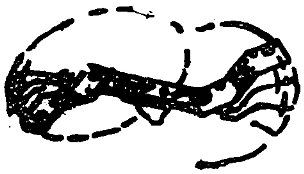


Fig. 2

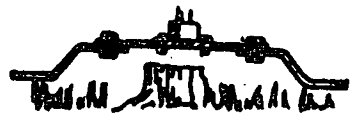


Fig. 3

FLAILS

These are made of steel and are mounted on flail rotors rigidly (Fig. 4), or oscilating freely in such a manner that when they hit obstacles they are thrown backwards to prevent them from getting damaged.

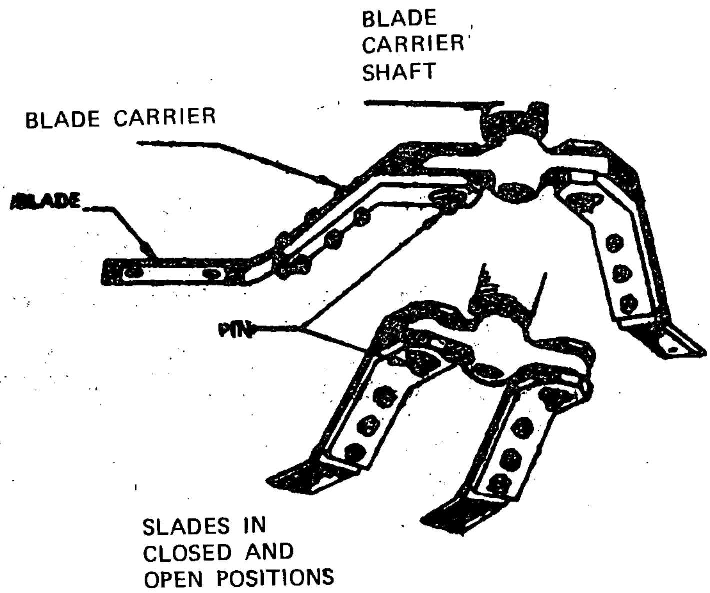


Fig. 4

Figures 5 and 6 show different types of cutting elements. These belong to rotary mowing machines with horizontal shaft. The bolt and bushing which allow the mounting of the flails can be seen in figure 6.

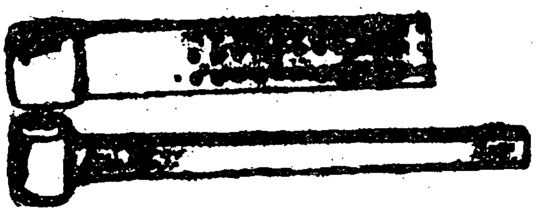


Fig. 5

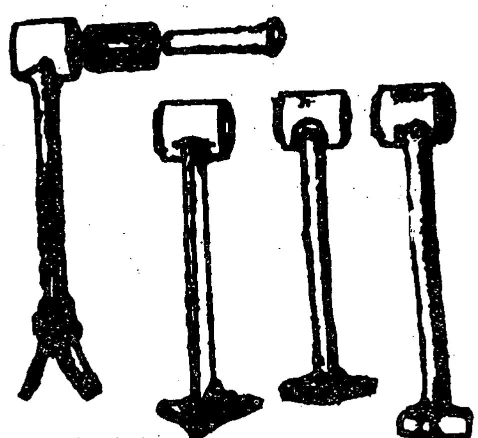


Fig. 6

Figure 7 shows a view of a norizontal shaft mowing machine. The flails which are usually called hammers, in this case can also consist of lengths of chain.

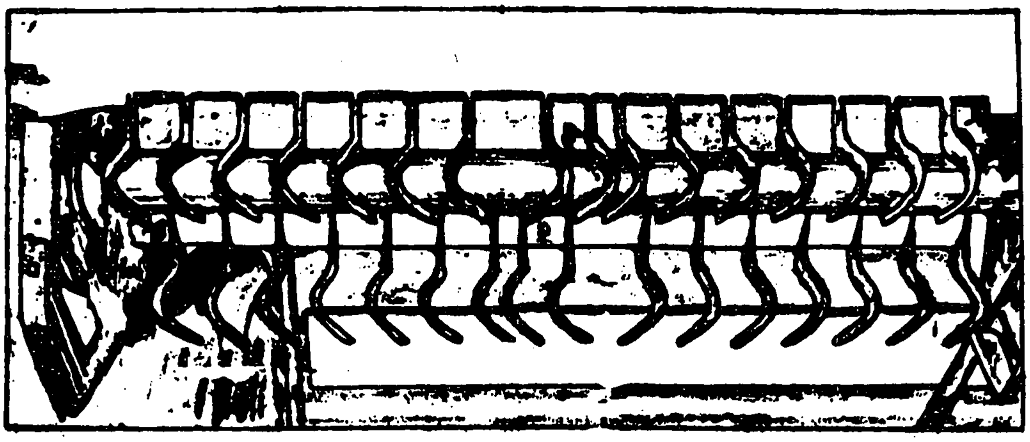


Fig. 7

Guards

Their purpose is to protect the operator by avoiding his coming into contact with parts of the machine which are moving as well as to avoid the pieces cut by the blades from being thrown with force far from the machine.

Transmission

The power take-off shaft of the tractor moves the telescopic shaft which has universal joints mounted on it and which revolves parallel to the direction of the tractor's movement. Whether the mowing machine has a rotor with a vertical or horizontal shaft a gearbox is necessary.

The gearbox usually consists of a pinion and ring gear placed in a lubricant bath and it multiplies the number of revolutions of the power shaft (540 or 1000 rpm) giving the rotor 1500 revolutions per minute.

The transmission can also consist of roller chains, belts and pulleys. Generally the assembly is protected by safety devices.

Safety Devices

In practice all mowing machines have some kind of device or mechanism which protects the weaker or more expensive parts from overloads or unexpected obstacles.
The most commonly used safety devices are shear bolts, spring loaded clutches and slip clutches. Transmission by means of "V" belts also acts as protection by slipping when overloaded.

OPERATION

The *integral-mounted* machines are directly hitched to the three-point linkage of the tractor. The trailed ones are self-contained and generally have tyres. The *semi-mounted* ones are usually lifted off the ground when being transported. When working, part of the weight rests on one or more back wheels.

CUTTING DEPTH

In the integral-mounted mowing models the adjustment is done by means of the three-point hydraulic system of the tractor.
The self-contained machines have mechanical (Fig. 1) (lift crank mechanism) or hydraulic devices (remote control cylinders) which lift or lower the cutting elements with respect to the frame which bears the wheels.
The semi-mounted mowing machines have a combination of the above-mentioned systems; the height of the arms of the hydraulic system and of the wheels are modified with respect to the flails.

LENGTHWISE LEVELLING

The machines should be levelled lengthwise, that is, in the direction of the movement, before operating them.
In the integral-mounted ones, levelling is obtained by modifying the length of the third point or upper arm of the tractor. In the semi-integral ones, in the same manner as for adjusting the cutting depth.
The trailed machines can be coupled at different heights. This levels them lengthwise.

CROSSWISE LEVELLING

Implements mounted on the arms of the hydraulic system are levelled crosswise to the direction of movement by modifying the height of the lower lift arm of the tractor.

WORKING SPEED

The rotary mowing machine has been designed to operate at the normal speed of the power take-off shaft. In order to change the forward speed, change gear. Do not change the revolutions at which the engine is running.

OPERATING

When operating the machine it should work at an adequate speed. Before beginning to mow you should reach the number of revolutions per minute recommended by the manufacturer. Figure 8 shows a conventional and convenient manner of mowing in certain cases.

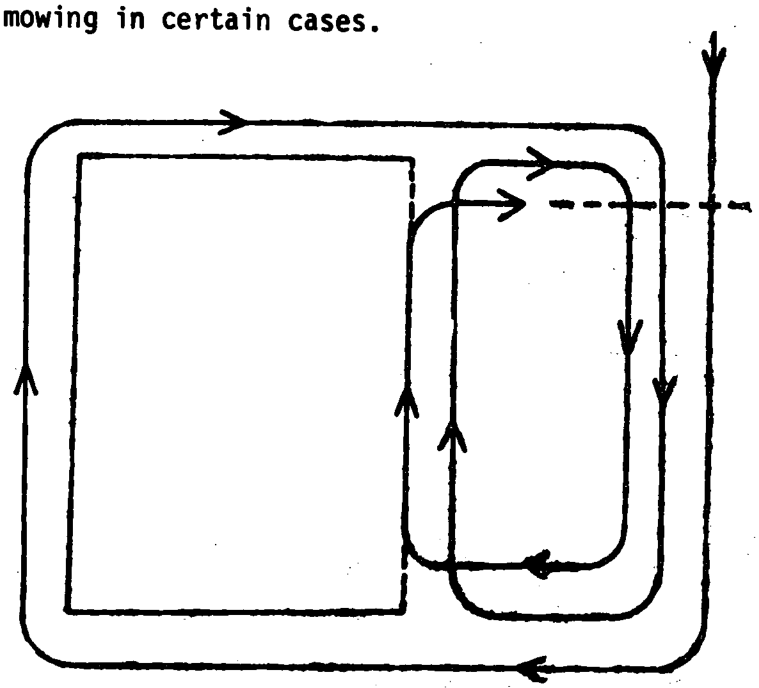


Fig. 8

Starting at one end, mow along the perimeter, thus outlining the ends which will allow the subsequent turns. The width of the ends are determined according to the width of the cuts of the machine and to whether it is directly towed behind the tractor or on one side (offset). If the mowing machine is in line once the head have been mowed, a space of 6-8 working widths is left and the mowing is done across the lot. If the mowing machine is offset, it could be convenient to continue mowing the edges.

Other forms of loaders resemble big rakes with straight teeth in varying numbers (Fig. 4). Others have upper and lower arms (Fig. 5) which interlock to hold the objects to be lifted (tree trunks, barrels). They may also consist of a simple eye in a jib and in this case objects are tied using ropes and slings.

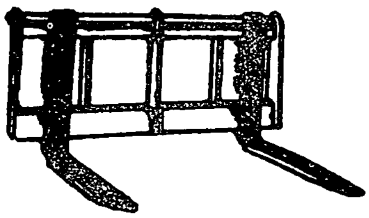


Fig. 4

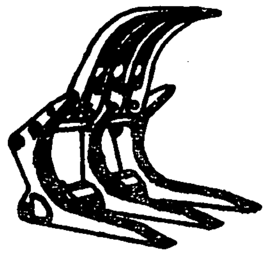


Fig. 5

OPERATION

The earlier models used slings, pulleys and towing winches to lift the loads. The present ones consist of hydraulic mechanisms. The hydraulic systems used may have their own reservoir, pump, cylinders and directional valve boxes or may use the fluid, pump and controls of the tractor.

The functioning of the hydraulic cylinders is the same as those used in the other agricultural implements, but are of larger diameter and displacement. Because of this, it may be necessary to use more hydraulic fluid, so, the operator's manuals for implement and tractor should be consulted.

The cylinders used may be of the single or double acting type in which case, when lifting as well as lowering the bucket, there is hydraulic pressure. This is useful in different tasks, such as compressing the hay loaded on trailers for transportation.

FRAME

The frame is made of steel of different forms, such as bars, pipes, channels, etc., which in general are reinforced and end in a straight or curved jib.

MOUNTING

They are constructed to be adapted to any type of agricultural tractor with wheels or track. They may be front or rear mounted.

The front mounting of the tractor makes easy the operation of the loader and allows carrying out towing tasks without removing it. The inconvenience is the overloading of the front axle and steering system.

ACCESSORIES

This implement makes many tasks easy. It is economical, saves time and labour, and allows the use of different accessories, such as forks, rakes, claws, shovels, excavators, etc.

SIZES

The size of the loaders depends on the volume of the bucket, the weight to be lifted, the total height of the jib and the time it takes to reach the maximum height with a full load.
The capacity of a tractor to operate a loader depends on its hydraulic system and the total weight of the fully loaded implement.

OPERATION

The operation of the implement requires the use of ballasts to balance the tractor and loader and keep the wheels in firm contact with the ground.

CAUTION
PLACE THE SHOVEL AT THE HEIGHT OF THE TRACTOR WHEN YOU TRANSPORT IT. DO NOT OPERATE ON STEEP GRADES. DO NOT LOAD WHEN GOING UP GRADES.
AVOID FAST TURNS. DRIVE AT MODERATE SPEED. ADJUST THE TRACT WIDTH OF THE TRACTOR TO OBTAIN MAXIMUM STABILITY.

MAINTENANCE

Lubricate, clean and check the implement for loose parts or probable fractures.
Check for hydraulic fluid leaks.
When parking the tractor, pull in the rams to keep the shafts from rusting.
Rust damages the seals and rings of the piston.

OBSERVATION
Check the tractor and loader operator's manual.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION:
Plant: -
Level: 2
Subject: 1.5-82

This item of equipment is used for transporting different materials during agricultural work.

TYPES

With two axles (Fig. 1) and one axle (Fig. 2).

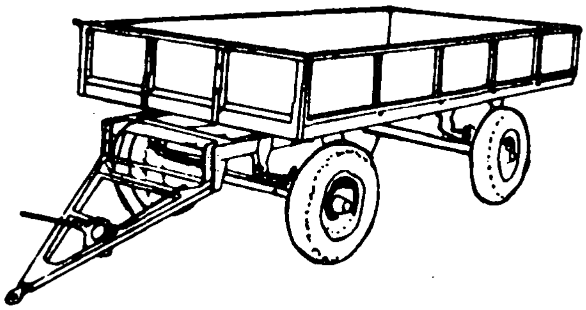


Fig. 1

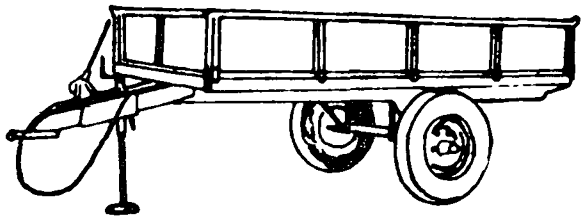


Fig. 2

Two-axle type. The rear axle is fixed; the front one allows the change of direction. It is easily hooked to the tractor and the weight of the load is distributed over the wheels. In the sugar-cane crop, trailers of the type shown in Fig. 3 are used. They are a variation of the previous type. They have coupling devices which allow part of the load to be shifted to the rear axle of the tractor. This ensures more grip to the ground.

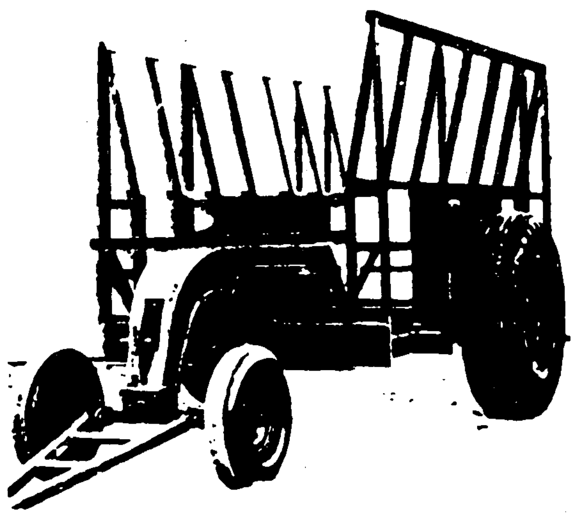


Fig. 3

Single-axle type. These transfer part of the weight to the tractor. This increases traction thus reducing wheel slip.

CAUTION

THE USE OF TRAILERS WHICH TRANSFER WEIGHT TO THE TRACTOR DEMANDS THE USE OF FRONT BALLAST. CHECK THE OPERATOR'S MANUAL.

These trailers may have leaf springs, shock absorbers, spiral springs or other suspension elements. They may also be rigid. This depends on the type of work they are required to perform.

UNLOADING

Some trailers are provided with mechanisms which make easy the unloading of bulk materials. There are different methods:

Tilting the platform backwards or sideways (Fig. 4) by the effect of the weight of the load. This is also done by simple action remote controlled hydraulic cylinders

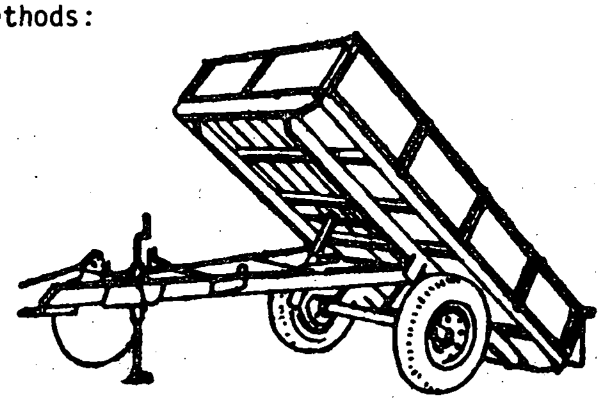


Fig. 4

Gravity is also used for unloading through a gate or trap-door situated in the floor of the wagon. This system is generalized in the crop of minor cereals.

Conveyors, belt type or screw type.

Displacement of a floorboard made up by chains and bars or wooden slats. This arrangement is similar to that of manure spreaders.

ACCESSORIES

There are different accessories. The most important are the prescribed lighting system and the railings which allow the transportation of bulk material (forage).

OPERATION

The operation of the trailer depends on the type and work for which it was designed. For safety reasons, the transportation speed, the weight of the loads for which it was constructed and the height of the load (height of the centre of gravity) should be respected. Obey the road regulations.

OBSERVATION

All trailers should be coupled to the drawbar of the tractor.

CAUTION

DO NOT EXCEED THE RECOMMENDED SPEEDS.

DO NOT MAKE SHARP TURNS.

WHEN DRIVING ALONG ROADS, OPERATE THE BRAKE PEDALS TOGETHER BY USING THE LOCKING DEVICE.

OBEY THE TRAFFIC LAWS WITH RESPECT TO LIGHTS, SIGNALING, HEIGHT OF THE LOAD, ETC.

KEEP THE TRACTOR IN GEAR WHEN GOING DOWNHILL.

OBSERVATION

Do not lock the differential or use low range gear on firm roads or at high speeds.

MAINTENANCE

This is to lubricate, clean and carry out periodic inspection for loose, broken or missing parts and care of the tyres. Check the operator's manual for:

- types of lubricant,
- greasing intervals,
- tyre pressure.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 1.5-54

This machine is used for the distribution of granular or powder fertilizers in uniform and determined amounts (pounds/acre or kilos/hectare).

It may be an independent unit or part of more complex machines which carry out various combined operations, such as seed-bed preparation, sowing, fertilizing, rolling, application of herbicides or insecticides, etc. simultaneously.

TYPES

The fertilizing machine can distribute the materials on the tilled soil and;

- they are then covered by other equipment coupled to the first one, or
- covered later in a different operation, or
- left on the surface.

The application may also be done on dense cultivations (wheat) or on natural pasture. In this case it is called: top dressing. In the previous examples the product is uniformly distributed on the soil and is covered by the same machine which is often called broadcaster. Figure 1 shows the parts of one of the machines.

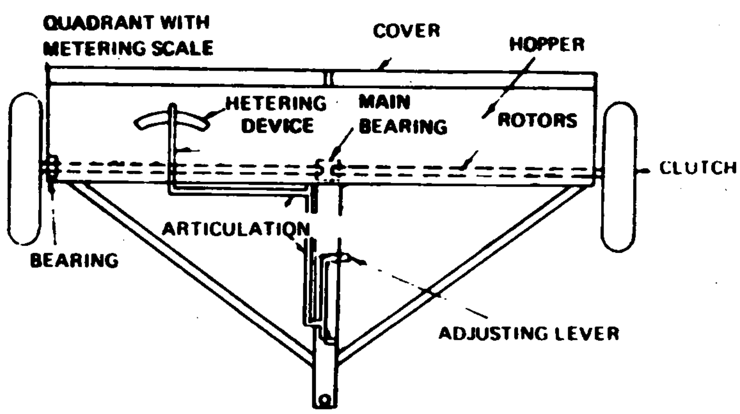


Fig. 1

Other types of machines which broadcast the fertilizer are those called *spinning-disc distributor*. They are generally integral-mounted and driven by the power take-off. They may also be trailed machines driven by their own wheels. Figure 2 shows the distribution mechanism of a power take-off operated integral-mounted *spinning-disc distributor*.

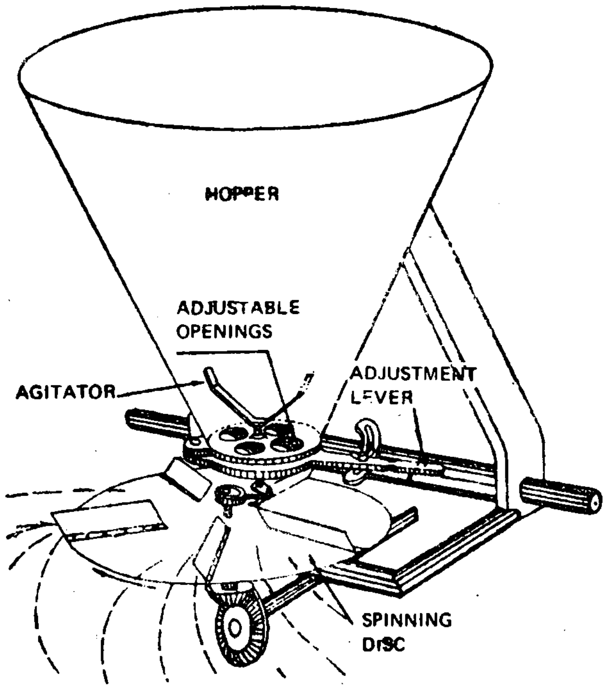


Fig. 2

OBSERVATION
The spinning-disc distributors are sometimes used for certain types of crops (rice, pastures on natural soil, seeds in pallets) or for the application of chemical products (white lime).

Among the distributors are the pendulum-spout distributors. These have a spout which discharges the jet of products following a fan or semicircular pattern (Fig. 3).

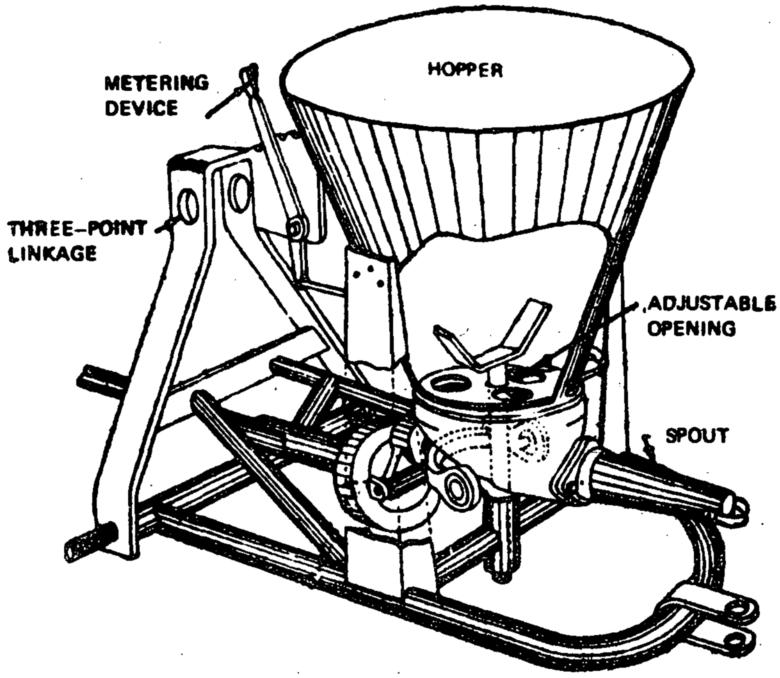


Fig. 3

Some fertilizer distributors which distribute the material at the full width of the machine are equipped to carry out the distribution in bands or belts and are used for sowing in rows. They are used in combination with accessories which bury and cover the products. These are called *placement or band distribution fertilizer distributors.*

DESCRIPTION

All the machines have *hopper, agitator, feed and metering systems.* some have placement attachments for band application.

Hopper. These are generally made of metal sheets. More recently, synthetic materials are used (fibreglass). Those on the centrifugal machines are cone shaped (like a funnel). On other machines, the hopper may be as wide as the machine itself. A section of this type is shown in figure 4.

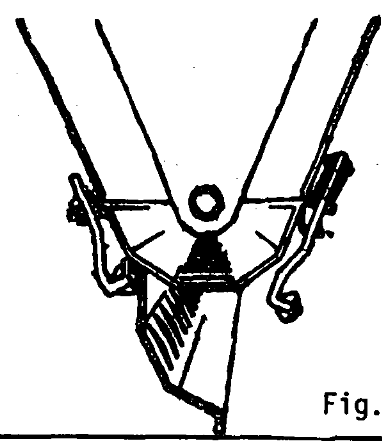


Fig. 4

Generally, all fertilizers are corrosive. For this reason it is very important that the metal parts of the machine which come into contact with the product should be easily accessable for cleaning. Figure 4 shows a section of a hopper with removable bottom for cleaning.

Agitators. These are also called mixers. Their function is to avoid the formation of lumps and compaction in the product. The agitators also ensure the continuous and uniform feeding of the distribution system.

The agitators are generally made up by two semi-axles which are driven by the wheels. Mounted on the semi-axles are sheet metal stars or pieces of rods in the form of fingers.

Figure 5 shows one of the most common type of agitator. Figures 2 and 3 show the agitator which is common to centrifugal machines.

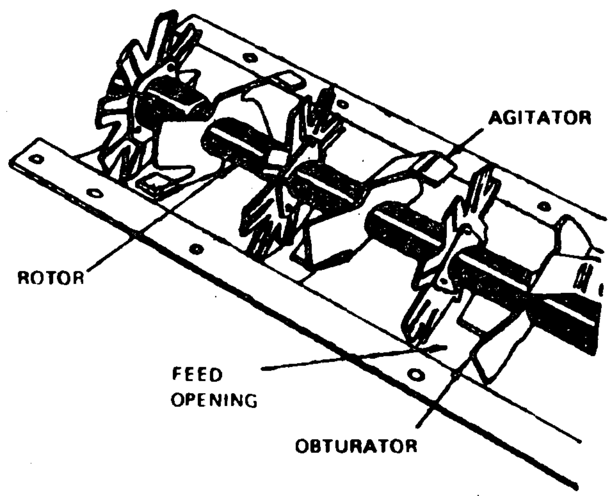


Fig. 5

Metering devices. Different metering devices are used for the purpose of obtaining a uniform distribution of a given product under different conditions and also with different fertilizer distributors.

The most common ones are constructed based on transporting plates or discs which rotate by the action of the wheels of the machine. They are also provided with adjustable parts which meter the quantity of product coming from the machine.

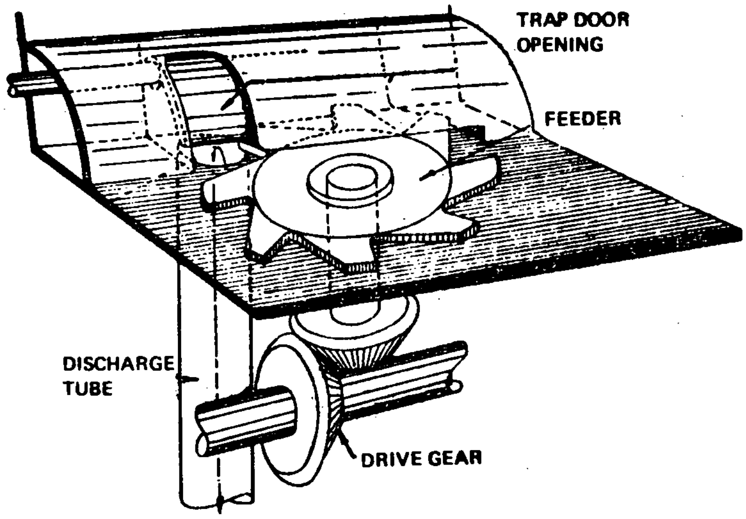


Fig. 6

Controls. The ports are controlled by one or two levers which move along graduated scales (Figs. 7 and 8). In the case of Figure 8, the same lever also cut off the flow of the product at the headlands.

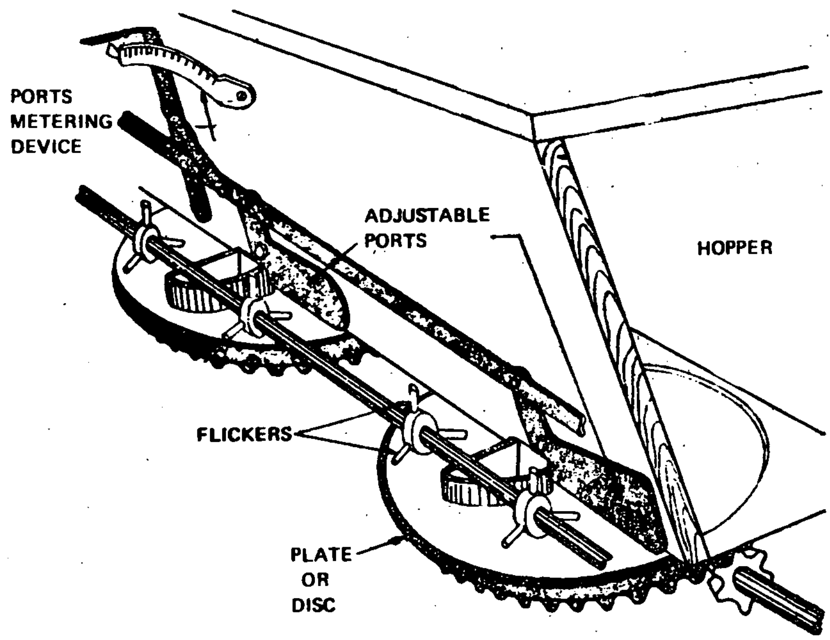


Fig. 7

The flow of fertilizer may also be cut off by using a clutching device on the wheels. These disconnect the feeding elements. This device is controlled by the operator from his seat by pulling a rope.

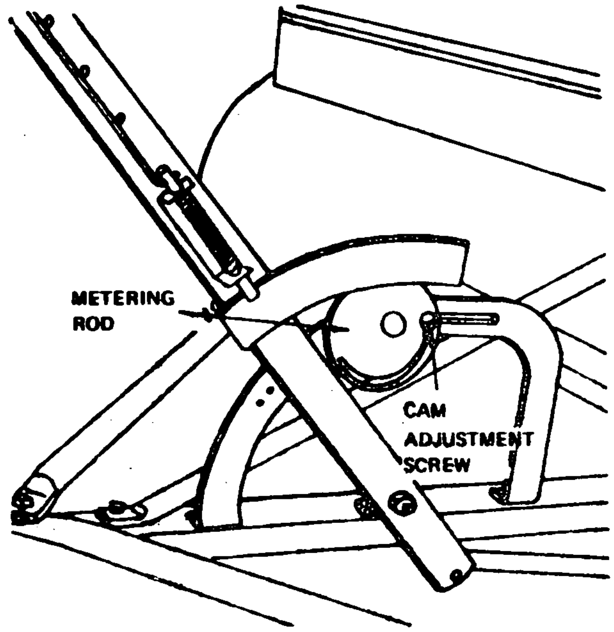


Fig. 8

Frame. Most of these machines have a frame which supports the weight of the loaded hopper. When the machine is equipped with coulters, the frame is stronger and is made of steel sections.

The frame is projected frontwards forming a drawbar terminating in a hitch which allows different hitching heights for the purpose of lengthwise levelling.

The back of the frame may have a hooking device to make easy the hooking up of light implements which are used for covering the material (chain or tine harrows). The mounting of the semi-axles, agitators and plates is carried in cast iron or bronze bearings.

SIZE

The useful or working width of the fertilizer distributors is given by the width of the hopper except in the case of the centrifugal machines.

The hoppers vary from 2 to 4 metres in width. Their capacity also varies from 120 to 150 kilograms of fertilizer per lineal metre of work. Depending on the type of fertilizer, the centrifugal machines cover between 6 and 16 metres in width.

MAINTENANCE

Because of the corrosive action of fertilizers, cleaning the machine after work is very important. Cleaning begins by operating the machine until the hopper and the distribution system are completely empty. With the machine stopped, use a broom and wire brush to loosen the rest of the material. Compressed air may also be used.

After this is done, wash with pressurized water. Scrape the rust from the rusted parts. Allow to dry. Protect the exposed or rusted parts with an antirust product or a mixture of oil and kerosene in equal proportions.

Lubricate the machine following the operator's manual. Tighten loose bolts to complete the maintenance.

Some models are provided with rubber tubes. For the conservation of these tubes, remove and store them in a dry place out of the sun.

When storing after work season, clean all the tyres. Jack up the machine and place it on blocks, this keeps the weight from damaging the tyres.

SMALL SPRAYERS

These are equipment which are used for spraying plants with a thin layer of liquid pesticides (insecticides, fungicides) and herbicides.
They are effective elements for the control of insects, weeds and plant diseases.

Other functions which they share with the dusters are:

Application of herbicides for the complete or selective destruction of weeds.

Application of defoliating products before harvesting with the purpose of making mechanical harvesting easy and stimulating the ripening process of fruits in certain crops.

Application of hormonal products with different purposes, such as growth, to increase the yield of fruits or to keep them from falling before time.

Application of products which reduce the number of flower buds which become fruits.

Application of nutrients on plant foliage (foliar fertilization).

TYPES OF SPRAYERS

There is a large variety of types and sizes of sprayers which go from small ones which are carried by a man on his back or shoulder, through cart-type spraying machines and finally, to sprayers which are mounted on or towed by tractors. These sprayers have booms capable of covering or treating swaths of 20 or more metres in width.

Manual sprayers

Among the small sprayers the following are noticeable for their functioning:

- intermittent machines.
- continuous pressure and flow machines.

Intermittent sprayers. They deliver the product with each stroke of the piston (see Figure 1).

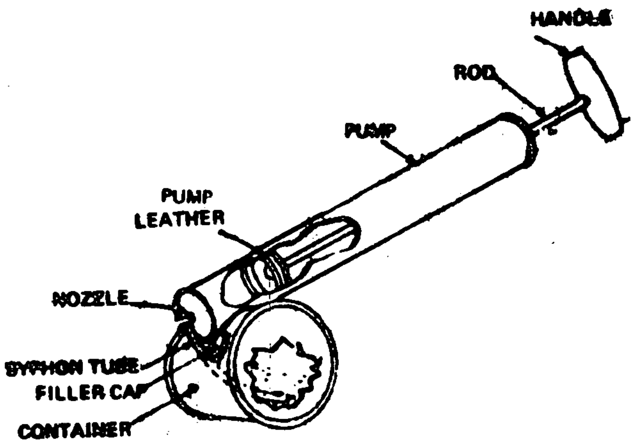


Fig. 1

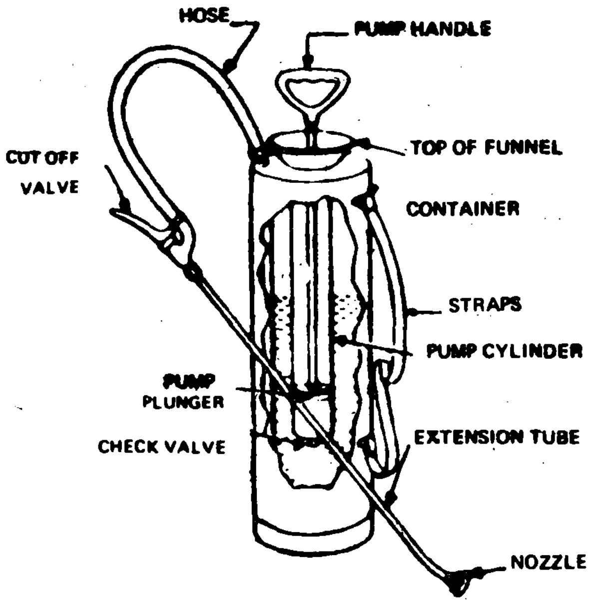
INTERMITTENT-TYPE HOUSEHOLDER SPRAYER

The nozzle in this type of machine is not usually replaceable or adjustable. Therefore, the delivery is constant as also is the size of the droplets.

Continuous flow sprayers. By maintaining a constant pressure, the delivery of the pressurized product is also constant. They generally have adjustable nozzles or sets of different valves which can modify the delivery as well as the size of the droplets.

Figure 2 shows a sprayer which consists of tank or container, piston pump, control valve or tap, tube and nozzle.

The spraying pressure is maintained by occasional pumping which demands interrupting the spraying.



CONTINUOUS FLOW SPRAYER

Fig. 2

Figure 3 shows a knapsack sprayer. The main difference with the above-mentioned is that it has a diaphragm pump which the operator works constantly in order to keep the working pressure constant.

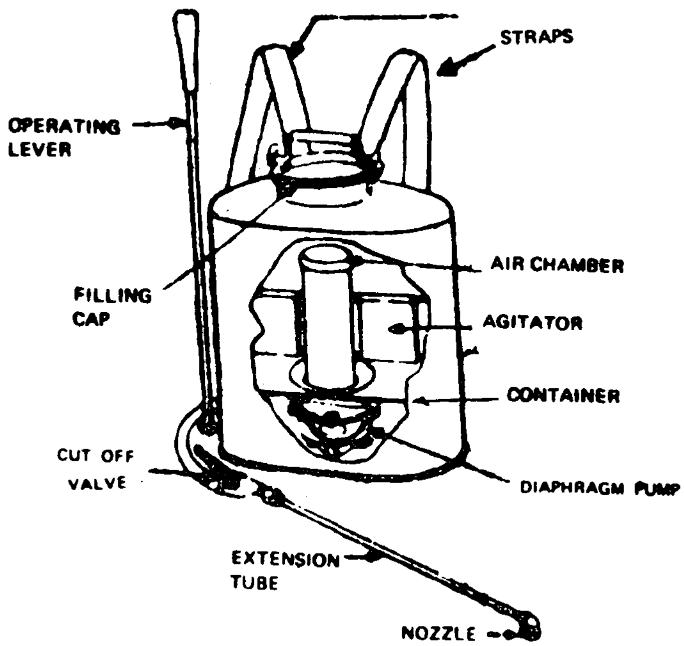


Fig. 3

MAINTENANCE

After using any sprayer, the containers should be drained and rinsed with clean water.

Plunger pumps usually require lubrication. Consult the manufacturer's manual.

OBSERVATION

When a chemical product dissolved in a liquid is carried by a current of air, the operation is called misting.

This is a machine used for spreading manure over the surface of the field saving time and labour.
Raw or decomposed (compost) manure is later added to the soil with the plough or disc harrow, or left on the surface as in the case of permanent pastures.

This machine is often used to spread other products of large volume as are the materials for correcting the acidity of the soils (limestone) and for adding humus.

DESCRIPTION
It is a *trailed machine* which has mechanisms for spreading the material and consists of *conveyor*, *shredder*, and *spreader*. Figure 1 shows a spreader in detail.

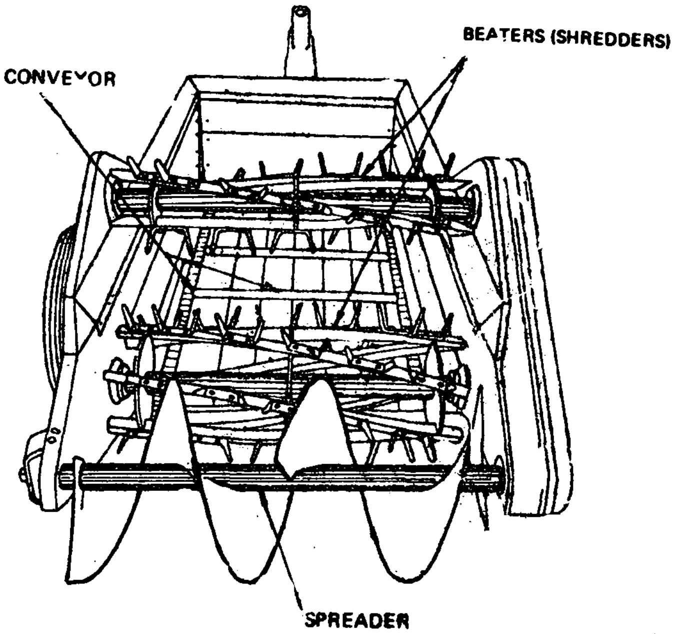


Fig. 1

The propeller shaft coupled to the power take-off of the tractor and/or the wheels of the implement move the spreading mechanism.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 1.5-56

Conveyor. It is a removable endless chain which consists of links, slats and sprockets which, when turned take the load to the rear of the implement.

Shredder. It consists of two beaters, of different diameters, one above and the other below, which turn at different speeds shredding the material (Fig. 2).

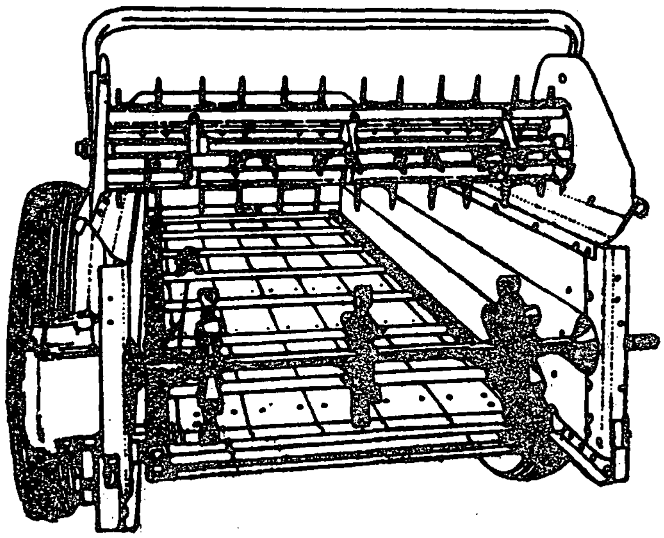


Fig. 2

Spreader. It is also called distributor and it consists of helical blades, or two axles with blades.

Hopper. Usually wood and steel sheets are used in the construction of the hopper. The dimensions in all spreader models are similar.

OPERATION

The endless chains of the conveyor run on the bottom of the hopper moved by sprockets mounted on shafts at both ends. The front sprockets of the conveyor are moved by the chain and the rear wheels are moved by a ratchet and pawl mechanism.

The feeder arm is adjusted so that it may advance 1, 2 or more teeth of the ratchet in each movement of the cam. The group is protected by one or more safety devices, such as clutch and shear bolts.

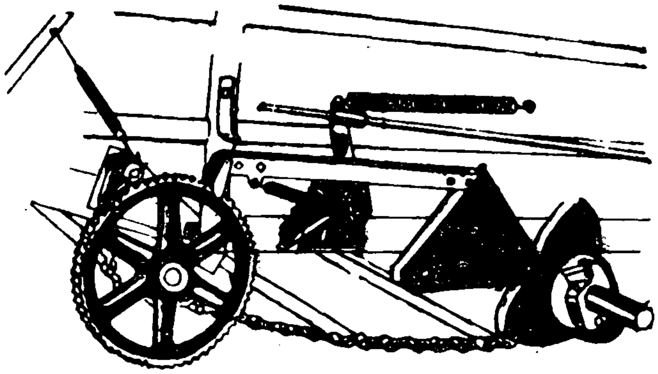


Fig. 3

SIZES

The volumes of the material to be applied are large, usually over 10 tons per hectare. The working width of the machines, that is, the width over which the material is spread varies between 2 and 2.50 metres and is wider than the width of the spreaders because of the distributors.

TYPES

Those moved by the power take-off shaft can be distinguished from the ones which receive their drive from the ground wheels.

ADJUSTMENTS

The tensions at which the chains of the transmission and the transporter should work, are very important.

OBSERVATION

Read the operator's manual for the machine in question and adjust the tension of the chains according to instructions.

USE

Avoid loads which exceed the recommended limits for each machine. Besides compacting the product, thus making distribution difficult, they overload all systems and parts (tyres).

Follow the working speed recommended by the manufacturer.

MAINTENANCE

Check and tighten nuts and bolts.

Lubricate.

Wash. This is generally done with lime solutions in order to neutralize the acias in the decomposed materials.

These are used in land preparation. They help to make the land even, break up small clods, destroy small weeds, increase aeration and infiltration, retarded crust formation and reduce the empty spaces left by the plough.

They are used to cover seeds sown by broadcasting, or mix in fertilizers superficially, also to assist germination in soils which are crusted after being sown. It is a common implement used for crop production.

DESCRIPTION

These *implements* consist of a frame with bars set crosswise to their movement and which bear rigid tines.

They are formed by a variable number of sections with widths between 1 and 1.50 metres each, with tines mounted in zigzag (see Fig. 1).

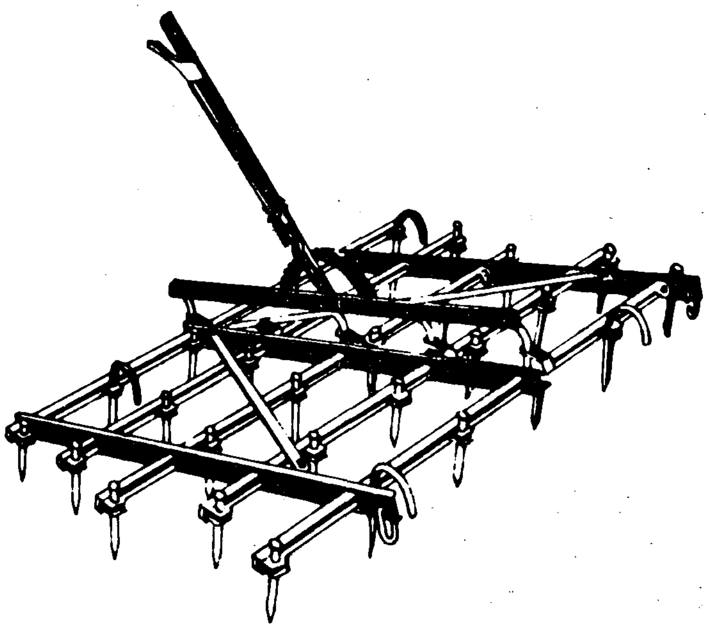


Fig. 1 - Frame of trailed tine harrow with adjustable tines

The frame which in older machines was made of wood and at present is made of iron can be rigid or articulated.

The straight tines usually, or the curved ones less frequently, with their diamond pointed end and their variable sizes (15 to 22 cm in length) are fixed to the bars by their threaded end (Fig. 2). The distance between tines on the same bar is 20 cm and alternate with those on different bars in such a manner that the final spacing is 4-5 cm.

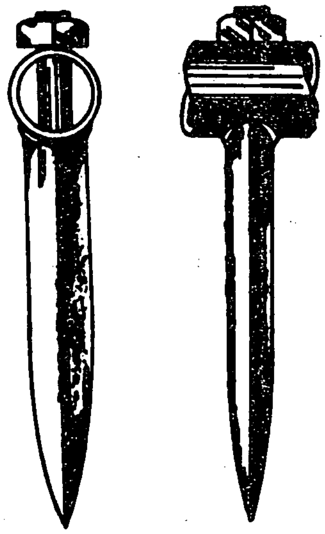


Fig. 2

The frame of the zigzag harrows is formed by lateral crosspieces with hooks which put the sections together and join them to a bar called balancer which allows the implement to be towed.

For transportation, the sections are usually folded over each other in those machines adapted to the integral mounting. The trailed implements when being transported are usually turned upside down, with the tines facing upward.

TYPES

- Trailed (Fig. 1) or integral-mounted.
- With fixed tines or of adjustable angle.
- With rigid or articulated frame.

MAINTENANCE

This consists of the periodic checking of the tightness of the tines fitted to the crossbars, sharpening the dull elements and the replacement of those excessively worn (short) or broken.

This is an implement used for the preparation of the seedbed. It evens and levels it, it uproots small weeds, breaks surface crust allowing a better aeration and absorption of water, and it mulches the soil.
It is also used in cultivation or renewal of permanent pastures. They are suitable for stony lands and consist of bars on which tines are alternately mounted.

TYPES

They are classified thus:

- integral-mounted and trailed.
- by the number of sections of which they consist, and
- by the type of elements or tools they carry.

Figure 1 shows an integral-mounted type spring harrow consisting of one section.

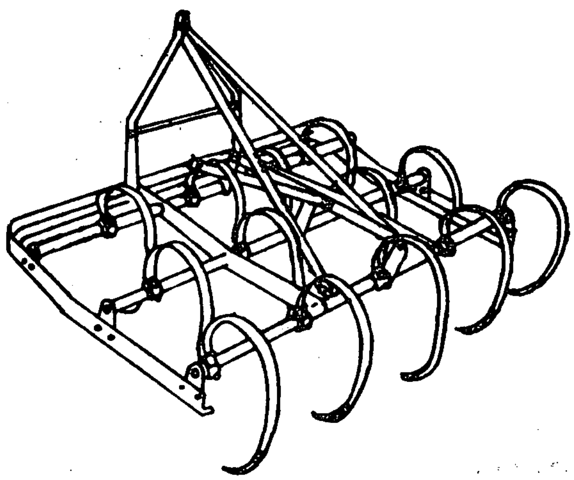


Fig. 1

DESCRIPTION

Each *section* usually has a width of 90 to 100 centimetres being able to span up to 270 cm and to have 2, 3, or 4 tool-carrier bars.

The *tines* are long and curved and are made of highly flexible steel. They are fixed by one end to the frame of the implement. The other end carries the tool which works on the soil.

Figure 2 shows a usual form of fixing on pipe-type bars.

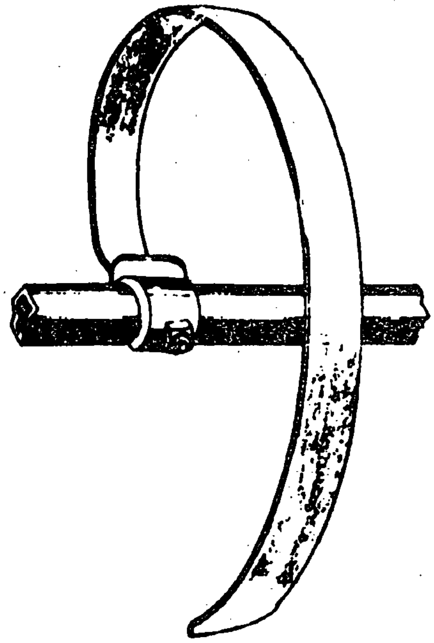


Fig. 2

Figure 3 shows different elements: removable-point tools, one-piece tools, and several other forms.

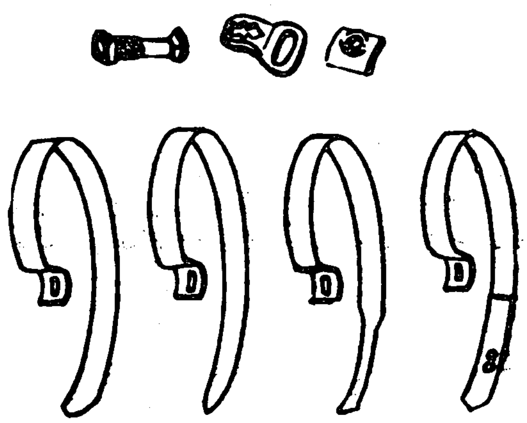


Fig. 3

Figure 4 shows removable points called weeding hoes.

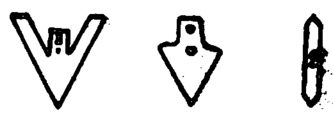


Fig. 4

The *bars* to which the tines are fixed by means of clamps are pipe-type (Fig. 2) or iron "U" sections. They are 50 or 60 cm away from each other and joined to the frame of the implement.

Skids are fixed to the *frame* (see Figure 5) which limit the working depth of the implement. When instead of skids the machines have depth wheels, the implement is called a cultivator.

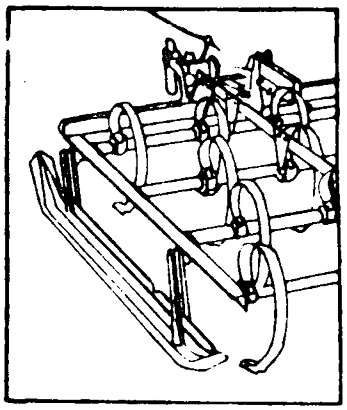


Fig. 5

ADJUSTMENT

The penetration of the implement is adjusted by changing the inclination of the tines. In some harrows the angle of each tine has to be individually changed (but ensuring that it is the same in all). In others, all the bars which form section are moved by levers, thus moving all the tines at once.

OPERATION

These machines do not permit high working speeds.

MAINTENANCE

It consists of keeping the parts tightened, replacing what is missing and repairing fractures and wear. They usually do not require lubrication.

These implements are used in seedbed preparation to break up very large clods, reduce the size of uneven spots, mulch the land and destroy weeds which grow after ploughing. When used for ploughing it is useful for breaking up the stubbles and making easy the subsequent ploughing under.

TYPES

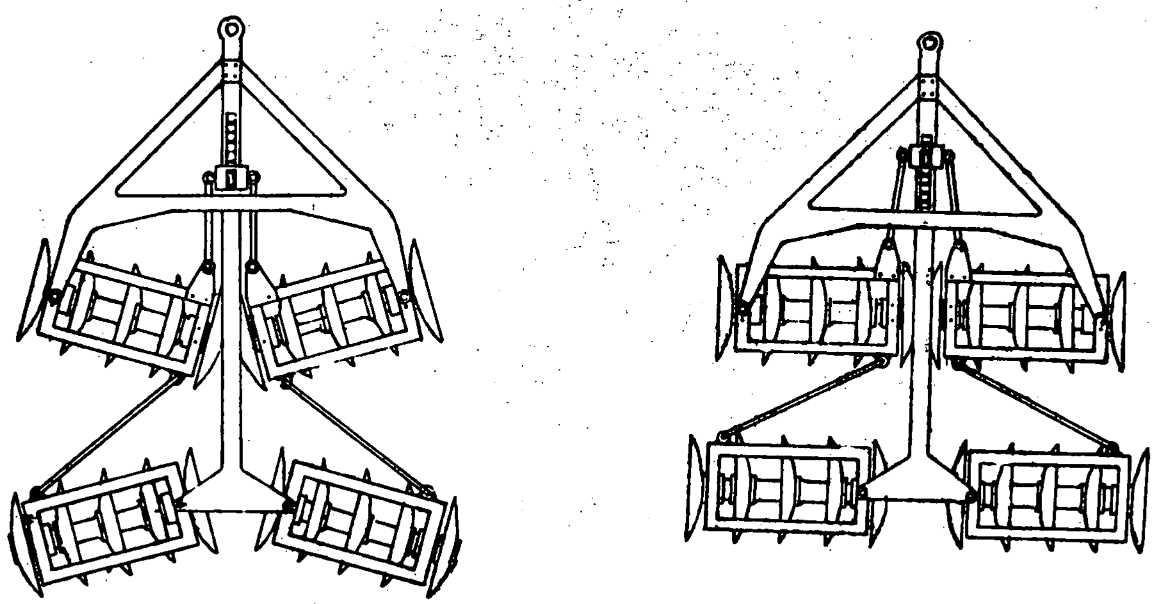
Depending on the hitching, these can be classified as integral-mounted and trailed. Among the latter there are those with and those without wheels. According to the arrangement of their elements and the work they do, they are classified as:

- *single action harrows*
- *double action harrows*
- *offset harrows*

SINGLE ACTION HARROWS

They have two gangs arranged on the same line, crosswise to its movement, each one with equal number of discs, but placed in an opposite manner. Each gang consists of a number of discs varying between 4 and 10-12. The discs turn and push the soil away from the centre thus leaving an unworked band of soil between the gangs.

Figure 1 shows a harrow in working and in transport position.



WORKING POSITION

Fig. 1

TRANSPORTING POSITION

Some harrows have a weeding hoe attached. This hoe works on the band between the two gangs as shown in Figure 2.

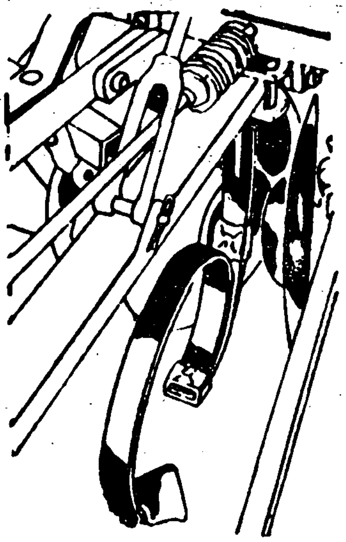


Fig. 2

DOUBLE ACTION HARROWS

They consist of 4 gangs arranged in pairs or tandem: two front and two rear. The front gangs are arranged as in the single action harrow (Fig. 1), whilst the rear ones have their discs reversed. Consequently, they move the soil towards the centre (Fig. 3). In this manner the land is left more even. These also leave an untilled middle band, but since the soil is levelled it is less noticeable.

Figure 3 shows an integral-mounted double action harrow with 32 discs in which each gang consists of 8 discs.

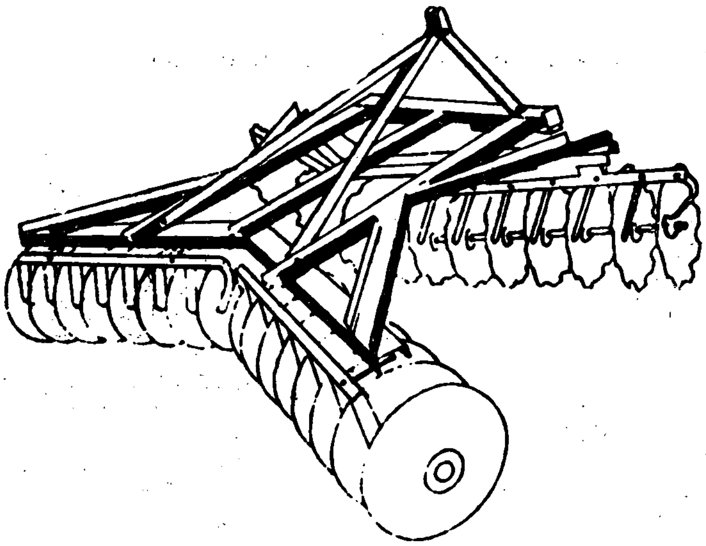


Fig. 3

OFFSET HARROW

It consists of only two gangs, but arranged in tandem. Therefore, while one throws the soil to the left the other throws it in an opposite direction. Hence, they can be counted among the double action harrows.

Its name (offset) comes from the fact that it can work outside the centre line of the track width of the tractor. This characteristic made its use widespread on fruit plantations quickly, because it allows the implement to come close to the foot of the trees.

In extensive agriculture these harrows are used, mainly the heavy-duty models in seedbed preparation. They have the advantage of leaving the land even and levelled together with being easily adjusted and operated.

Figure 4 shows an offset harrow with facilities for hitching to the three-point hydraulic system of the tractor.

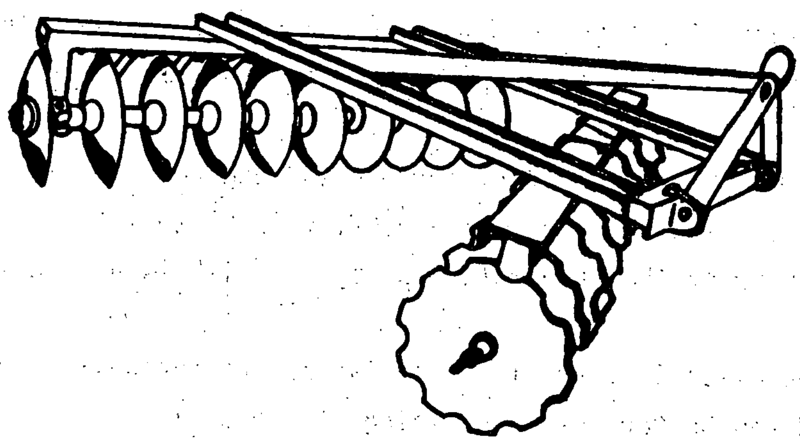


Fig. 4

DESCRIPTION

The main part is the gang which consists of discs, axle, bearings, butts, etc. The discs are mounted on a usually square axle which goes through their centre. The distance between discs is set by the spacers. The spacers have a large and concave end and another smaller and convex one. The larger end is placed on the outer face of the disc and the smaller one on the internal or concave face of the next disc. The bearings are variable in number and hold the spools joining them to the frame of the implement.

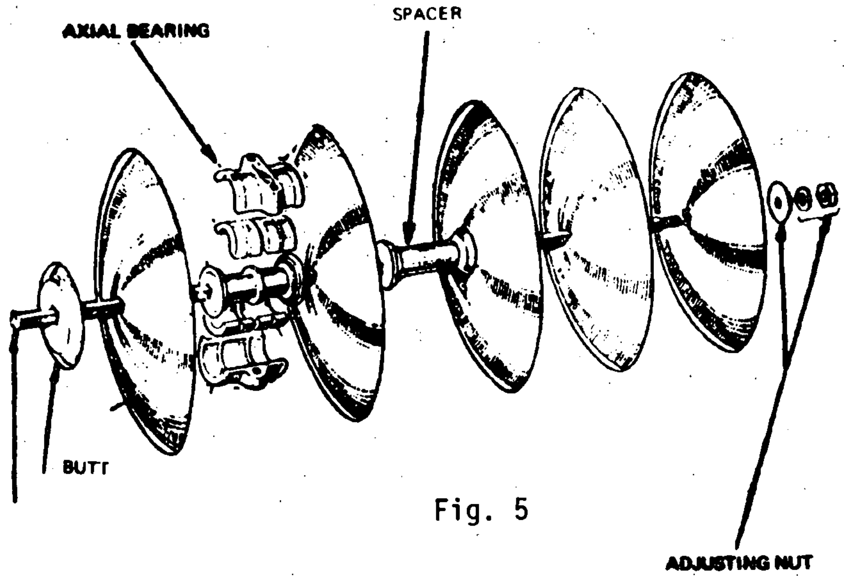


Fig. 5

Frame. It is formed by welded iron sections. It is the skeleton of each gang on which the set of an axle with its disc are fixed. Its upper part which has the form of a tray can be used to add heavy weights (ballasts) which increase the penetration of the implement allowing for deeper work.

Discs. Their diameters vary between 16" and 24". Their sizes determine the distance between discs which usually is 6" to 12".
The width of the cut or of the band worked on by the disc is a function of the diameter.
The concavity of the discs is variable. The larger the concavity, the deeper the penetration and the better the pulverizing of the soil.
The edge of the disc is sharp. It can be smooth or scalloped and so we speak of smooth and scalloped discs.

The scalloped discs cause the implement to penetrate the soil deeper. Scalloped discs are generally used on front gangs and smooth ones on rear gangs. They can also all be of the same type.

Scrapers. The harrows are usually fitted with individual disc scrapers as shown in Figure 6. Their purpose is to remove the soil from the discs. Their efficiency dependson the type of soil as well as on the moisture content of the soil.

Fig. 6

Bearings. The set of discs and the spacers mounted on the same axle and corresponding to one gang is fixed to the frame by means of bearings. These can be made of anti-friction metal, or of hard wood soaked in oil (see Fig. 5). These bearings can also have rolling elements which can be lubricated or are sealed as shown in Figure 7. The bearings can be mounted in various ways.

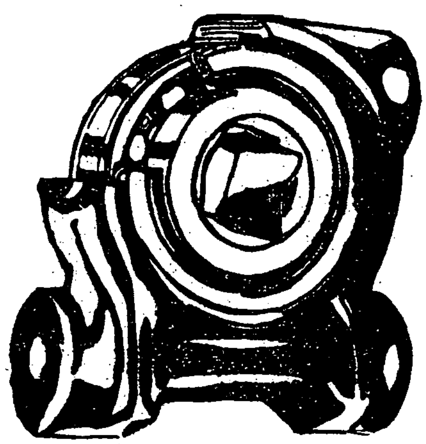


Fig. 7

SUMMARY

TYPES

- *integral-mounted*
- *trailed*
  - with wheels
  - without wheels
- *single action* (2 gangs in line)
- *double action* (4 gangs in pairs and in tandem)
- *offset* (2 gangs in different lines)

DESCRIPTION

- *Fundamental parts*
  - discs
  - spacers
  - bearings
  - frame
  - hitching device
- *Fittings*
  - scrapers
  - depth control wheels
  - transporting wheels
  - ballast carriers
  - weeding hoes

TECHNICAL VOCABULARY

Scalloped - Cut-away; Cut-out; Serrated; Notched.

The penetration of the implement is determined by the angle between the gangs and the direction of travel. The discs would not penetrate the soil if they rotate in a line parallel to the movement. The parallel setting is used when transporting trailed implements without wheels.

ADJUSTMENTS

WORKING ANGLE

The working angle is given by the conditions of the terrain, the characteristics of the soil, the size of the clods suitable for planting, etc.

There are many mechanisms for setting the angles of the gangs. Figure 1 corresponds to an integral-mounted offset harrow. By operating a lever from his seat, the operator may change the angle formed by the front and rear gangs with the direction of travel.

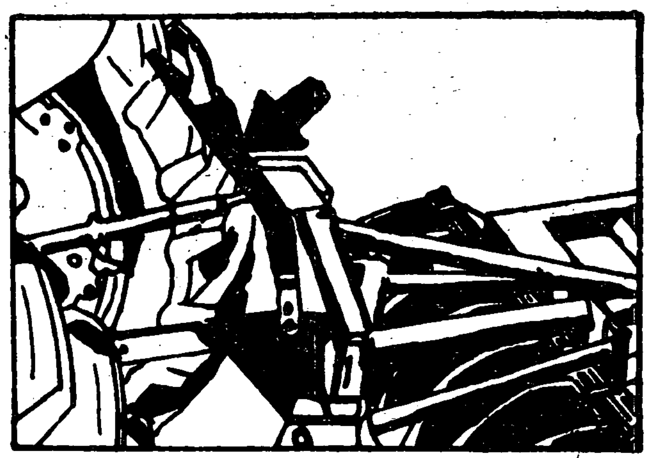


Fig. 1

In other harrows the gangsare moved manually and independently. Once the desired angle is obtained, the gangs are fixed to the frame with a bolt.

The crank system shown in Figure 2 is also used in the trailed disc harrow. The remote control hydraulic cylinder which is used in place of the crank allows for changes while in motion. It also helps in adjusting the heavy machines for different characteristics of the land.

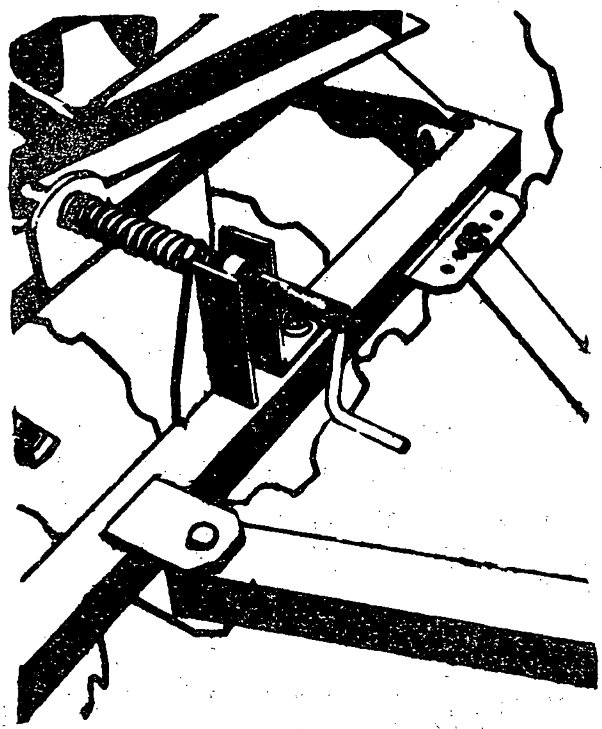


Fig. 2

LEVELLING

In trailed harrows this is done by changing the height of the drawbar with relation to the tractor's drawbar as shown in Fig. 3. In the integral-mounted harrows levelling is done through mechanisms which change the length of the arms of the hydraulic system. This levels the implement lengthwise and crosswise.

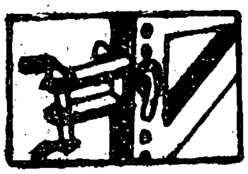


Fig. 3

WORKING DEPTH

It is determined by the weight of the harrow and the size, sharpness and angle of the gang with respect to the direction of travel. To increase penetration, weight is added to the gang and the angle is increased.

Some double action and offset harrows have wheels. These are used for transportation and for limiting the penetration of the implement. In this case the axle with wheels is moved by a remote control hydraulic cylinder. This control is independent of the one which regulates the angle of the gangs. Other harrows have depth control wheels, but these are not used for transporting the implement.

Any of the above-mentioned cases has the advantage of being able to till the soil deeply (with a wide angle) but without going deeper than necessary.

USE

The harrows are used for levelling the seedbed after ploughing. This may be done in one or more operations. When carrying out several operations, harrowing is done by successive crosswise passes.

The harrows are also used for:

- *breaking the crust* which actually forms after intense rains on clayey soils.
- *making the germination of weeds easy.* These then are destroyed with a second pass of the discs.
- *mowing or cutting stubbles* (corn, sorghum) before ploughing. This eases the burying of the stubbles.
- *keeping the land free of vegetation.* This vegetation competes with fruit trees in orchards and nurseries.

OPERATION

Because of the different models, consult the manual for each machine. When offset harrows are used, turn towards the left. This is the side where the gangs are nearer to the tractor.

To destroy the ridge left on the field by the last disc, an attachment as the one shown in Figure 4 may be used. It is sold by the manufacturers as an optional part.

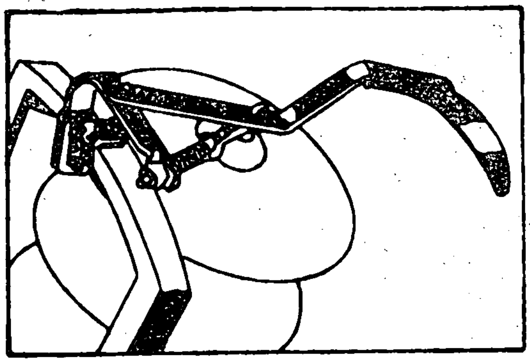


Fig. 4

SIZES

The size of the harrow depends on the number, diameter, concavity, and spacing of the discs. From these data and the working angle we obtain the working width of the implement. With single action harrows the working width does not exceed 4.50 meters.

On large expanses of flat land when powerful tractors are available, it is common to hitch up several harrows horizontally to do the work.

MAINTENANCE

The maintenance of these machines consists of the daily tightening of bolts and parts. Periodic greasing must also be carried out. At the end of the working season the complete implement should be washed and painted. Cover the discs with a coat of used oil or any other anticorrosive agent.

There are different methods or ways of harrowing. All of them produce adequate, fast and economical work with minimum physical effort required from the operator.

The operation of harrowing is repeated on the same terrain but in crosswise directions (crossed) with the same or different implements.

Proper harrowing:

- levels the land,
- gives the desired size of clods,
- eliminates weeds,
- reduces large depressions,
- should not leave furrows or ridges.

METHODS

The method of harrowing to be used depends on the:
- type and size of the implement,
- size of the field,
- crop to be planted,
- condition of the soil,
- available time.

The most common forms of harrowing are called *round and round* and *in lands*.

ROUND AND ROUND

This method saves time, the quality of work is poor and is used in large fields.

It consists of harrowing around the field beginning at the boundaries towards the centre or from the centre towards the boundaries of the field.

The direction of the spirals are clockwise or anticlockwise when using implements with rigid or flexible tines or single and double action discs. When using offset disc harrows, the turning direction is determined by the angle of the gangs.

The work is poor in sections where the course of the implement is not straight. This causes a change in the angle which the discs form with the direction of travel (Fig. 1). On the other hand, the implement is forced by lateral thrust.

To avoid the above, the implement (integral-mounted and semi-mounted) is lifted at the turns or the angle formed between the gangs is reduced when reaching the corners of the field. In this case, to complete the work, harrow the diagonals of the field which were not worked (Fig. 2).

However, in the above cases the work is not thorough and the field is never uniformly harrowed.

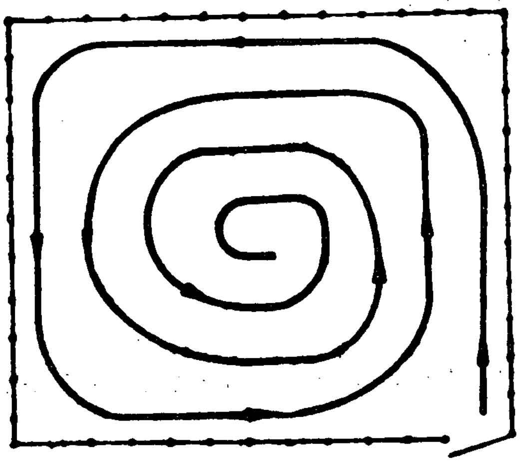


Fig. 1

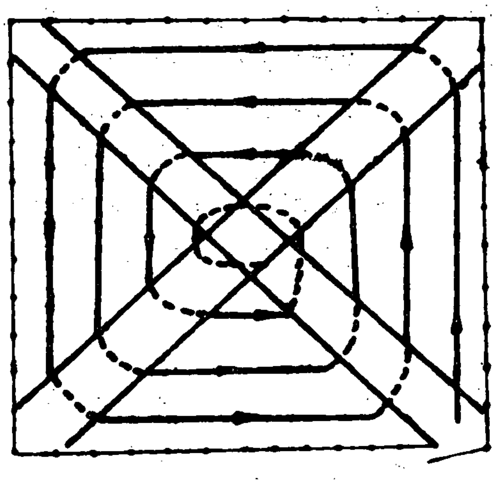


Fig. 2

IN LANDS

This system consists of subdividing the field in to regular rectangular zones called lands. The headlands are not worked. The machine describes straight lines, always turning right or left (Fig. 3).

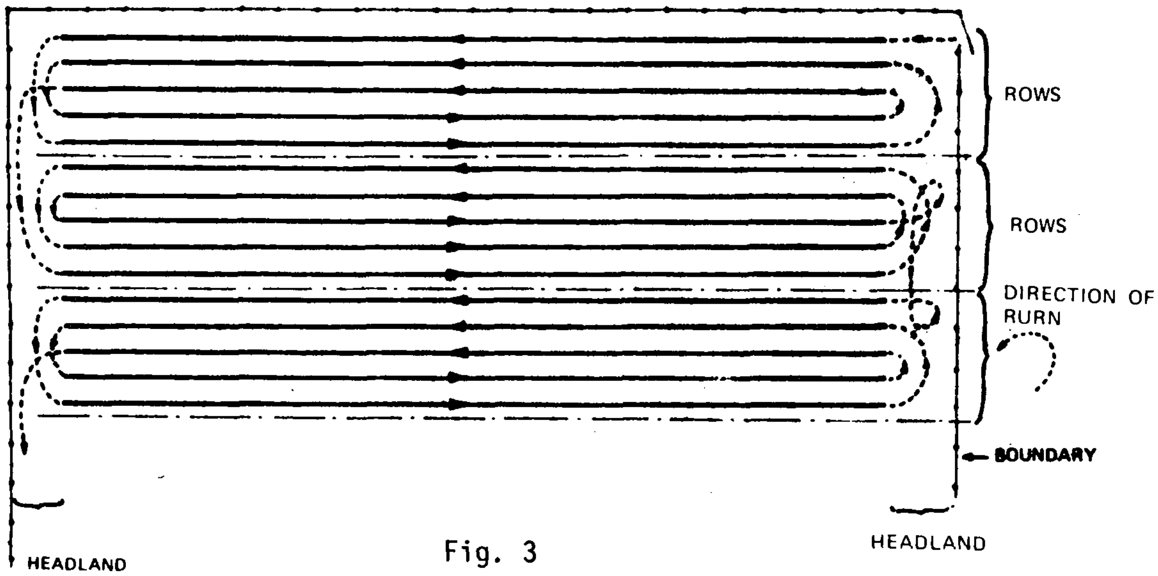


Fig. 3

The headlands are harrowed when the work on the lands is finished. A uniform and suitable job is obtained. The disadvantage is the waste of time caused by the sharp turns at the headlands. This system is good with all types of implements but the integral-mounted ones are more efficient.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 1.5-21/4

Ploughs are the most widely used implements for the initial working or tilling of the soil when the field is being prepared for crops.

They cut, separate and invert the topsiol. They also bury plants and residues making their decomposition and incorporation in the soil easy. This, at the same time increases the porosity of the soil.

TYPES

They are divided into two large groups depending on the elements used for cutting and turning over the clods of earth. They are:

- *mouldboard ploughs,*
- *disc ploughs.*

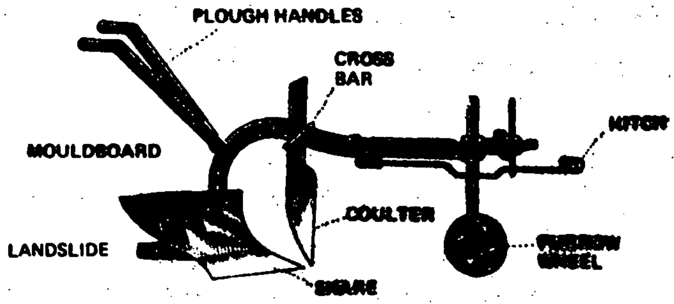


Fig. 1 - Animal drawn plough commonly called "handle plough". It is provided with ploughshare and mouldboard.

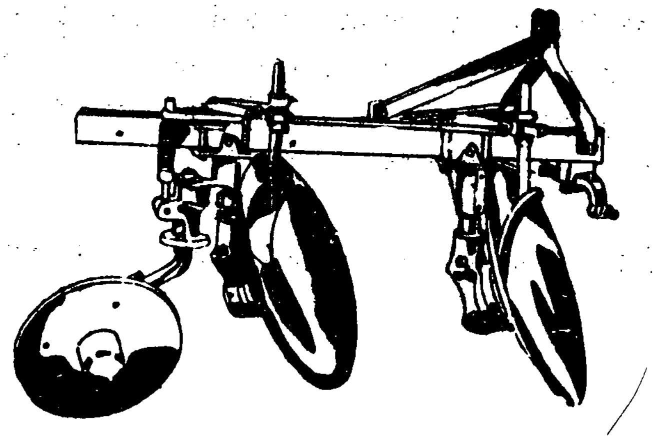


Fig. 2 - Mechanically drawn integral-mounted disc plough

Ploughs are designed in different sizes for mechanical or animal draught. The size of the plough depends on the number of elements (discs or mouldboards). There are ploughs with one, two, three and usually up to eight bottoms or discs.

Ploughs which are tractor drawn, depending on their hitching, may be:

- *integral-mounted;* at present these are hitched to the 3-point system,
- *semi-mounted;* the tractor tows the plough and at the same time supports part of its weight,
- *trailed;* these are towed by the tractor but the weight rests on the wheels of the plough.

These implements are designed for turning the furrow slices to the right of the cut and in the direction of travel. In some cases the ploughs turn the slices right or left. These types of ploughs are called *reversible ploughs*. The ones which throw to one side are called *fixed or regular* ploughs.

Reversible disc ploughs have a mechanism which allows the disc or discs to rotate in such a manner as to throw the earth to the right or left.

The reversible mouldboard plough has right hand and left hand elements mounted on a frame. The operator selects one at the beginning of each furrow.

COMPARING PLOUGHS

Each type of implement has advantages and disadvantages. Their selection depends on the particular conditions of each field: surface to be worked, type and class of soil, available time, moisture of the soil when working, stoniness, crops and other considerations.

The following table establishes some differences between mouldboard and disc ploughs.

	Mouldboard	Disc
Turning the furrow slice	Very good	Regular
Covering of residues	Very good	Regular
Penetration in hard and dry soils	Regular	Very good
Suitability for stony soils	Not much	Suitable
Cutting of canes and woody roots	Does not cut	Cuts
Need for sharpening the cutting elements	Yes	Sharpens during work
When it meets obstacles (rocks, trunks)	It sticks	Rolls over

These consist of elements or parts which make the vertical cut *(coulter)*, the horizontal cut *(share)* and the inversion *(mouldboard)*. These combined operations cause the portion of soil which has been cut to collapse.

Each set of elements is rigidly mounted on a part called the beam and they make the *body*. the beams are assembled on the *frame* which ends in an attachment which allows the implement to be hitched to the traction source (tractor or animal).

PARTS OF THE PLOUGH

The basic elements of a plough are shown in Fig. 1.

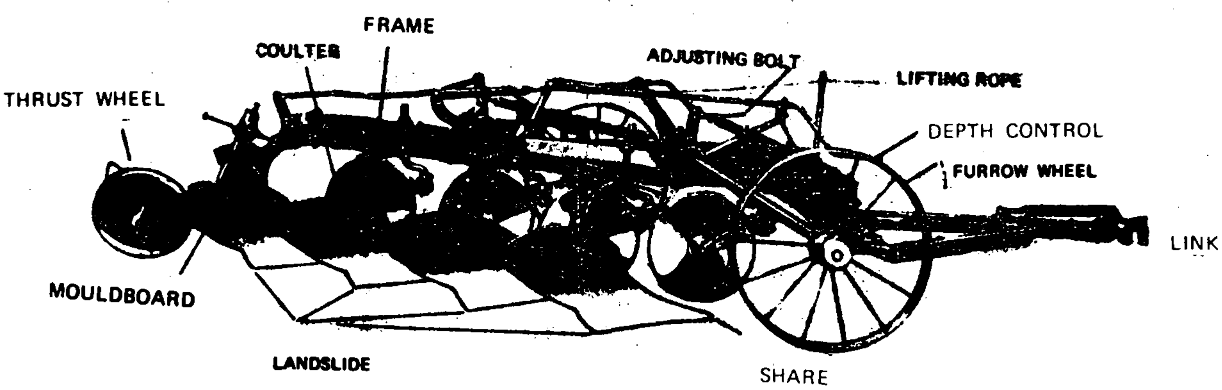


Fig. 1 - Trailed plough, for tractor operation with four bottoms

Usually the element consisting of the beam, share, mouldboard and coulter is called the bottom. Thus we speak of ploughs with 1, 2, 3 and up to 7-8 bottoms.

The *beam* serves as an attaching element for the various parts and for coupling to the frame by which the implement is towed (see Figs. 1, 2, 3).

The *coulter* which in Figure 1 is a flat disc can also be a simple flat blade. Whichever the type, its purpose is to make vertical cuts. Figures 2 and 3 show the relative position of the coulter with respect to the point of the share.

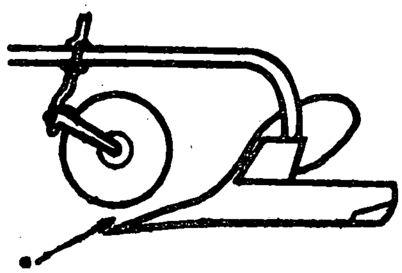


Fig. 2

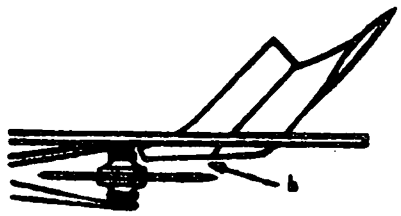


Fig. 3

There are scalloped circular coulters which make cutting easier.

The *share* cuts the portion of land horizontally and begins to separate the slice subsequently turned over by the mouldboard.

SHARE

It has a cutting edge which makes the horizontal cuts. Its form makes the penetration of the plough easier.

A dull share demands a greater tractive effort and makes penetration in the soil difficult.

The share allows for vertical and horizontal penetration or suction:

- *vertical suction;* the point of the share is turned downward.
- *horizontal suction;* the point of the share is turned towards the unploughed land.

Vertical suction allows for penetration and helps to maintain a constant working depth.

The horizontal or lateral suction makes the cutting width of the share constant and correct. Figures 4, 5 and 6 show the cutting width and the suctions of a share.

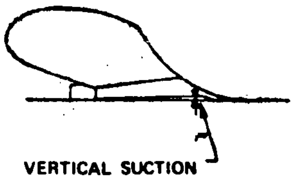


Fig. 4

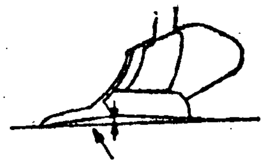


Fig. 5

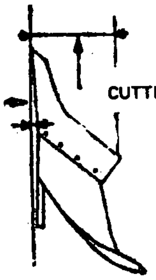


Fig. 6

Shares are made in different sizes which express in inches the width of the prism they cut. The most common sizes or widths are 10", 12", 14" and 16".

The share wears, and with it suctions are reduced. The operation of sharpening or stretching the shares has to be done by an experienced blacksmith capable of restoring their original form (sunctions) and sharpness.

There are shares with replaceable points which can be changed for new ones.

MOULDBOARD

The slice of earth once cut is turned over in order to break it up, pulverize it and turn in the surface vegetation. This is done by means of the mouldboard.

There are several types of mouldboards which are adapted to the work on different soils and conditions. Figures 7, 8, 9 and 10 show a few types.

Figure 7 shows a mouldboard which adapts to different soils. It is called a "general purpose" mouldboard.

Fig. 7

Figure 8 shows an all-purpose mouldboard for higher speeds.

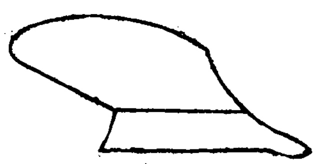


Fig. 8

Figure 9 shows a mouldboard suitable for working on very stick soils which adhere to the implement.

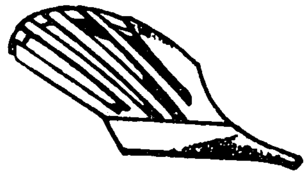


Fig. 9

Figure 10 shows a mouldboard designed for ploughing untilled ground, that is, the first ploughing of virgin land.

Fig. 10

The adjustment of the implement is necessary for the proper operation of the combination (tractor-plough) as well as for obtaining a suitable quality of tillage at the lowest possible cost.

Good tillage is obtained when plant residues are completely covered, the slices uniform, the soil well turned over and the furrows straight, parallel and of the same depth.

HITCHING ADJUSTMENT

The adjustment of the hitch consists of making the line of pull of the tractor coincide with the line of resistance of the plough both being in the furrow in a working position.

The line of pull of the tractor is determined by two points: the middle point of the rear axle (A) and the mid-point of the drawbar (B) (Fig. 1).

The line of resistance of the plough determined by two points, is that which joins the centre of resistance of the mid-section (C) with the hole of the hitching device (D) passing through the drawbar of the tractor (Fig. 2).

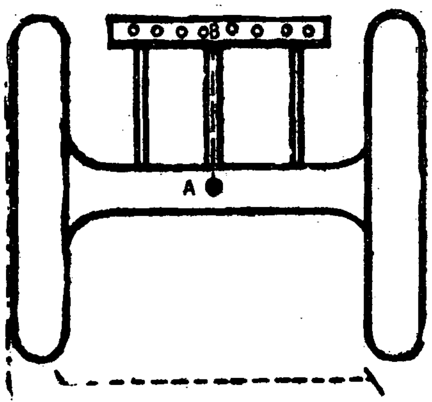


Fig. 1 - Centre line of tractor

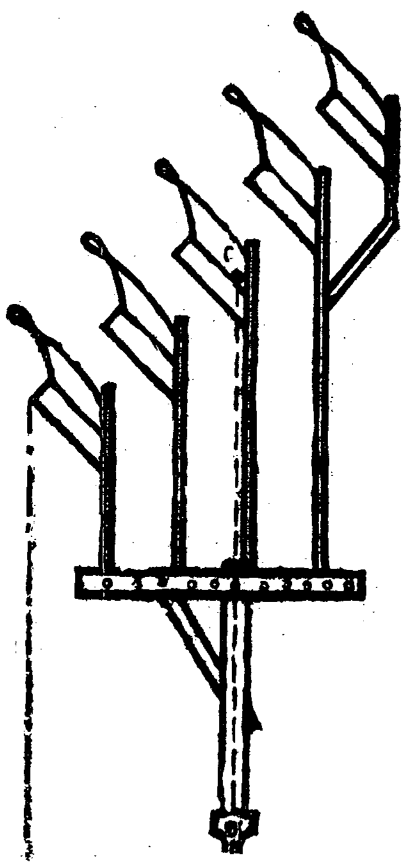


Fig. 2

If the plough has an even number of bodies, the centre of resistance is an imaginary point which is at an equal distance from the individual centres of resistance of the two middle bodies. See Figures 3, 4 and 5.

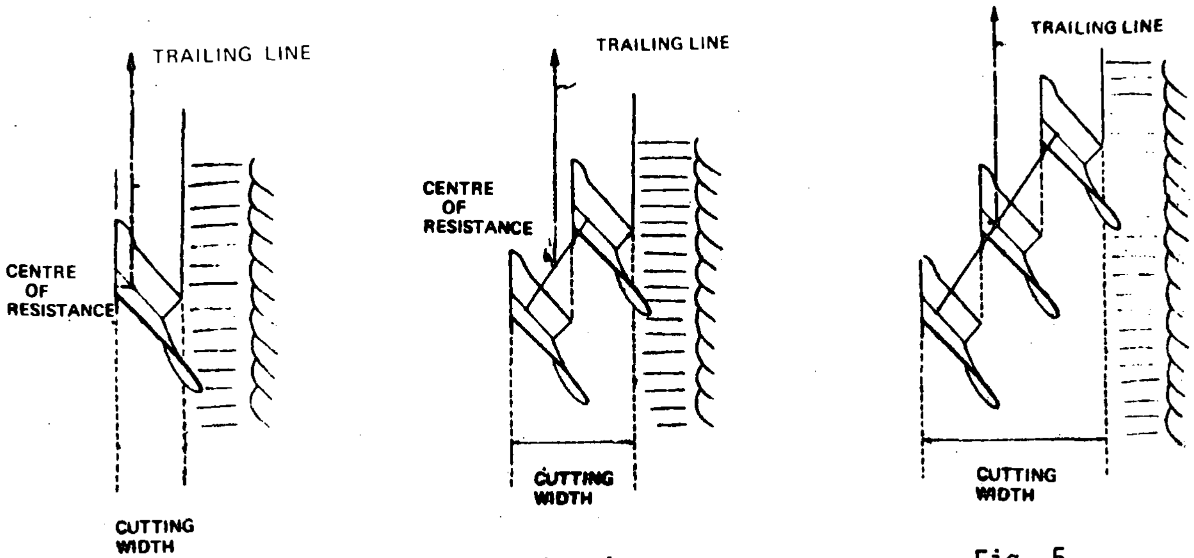


Fig. 3 Fig. 4 Fig. 5

Figure 6 shows a perfectly adjusted tractor and plough and the relation between the width of the cut and the track width of the tractor.

When the track width of the tractor is different to the cutting width of the plough the track width should be adjusted.
If the track width cannot be adjusted, the equipment should then be adjusted by means of the cross-shaft (Fig. 7) in such a manner that all points are on a straight line.

Figure 6 shows a top view of the adjustment.

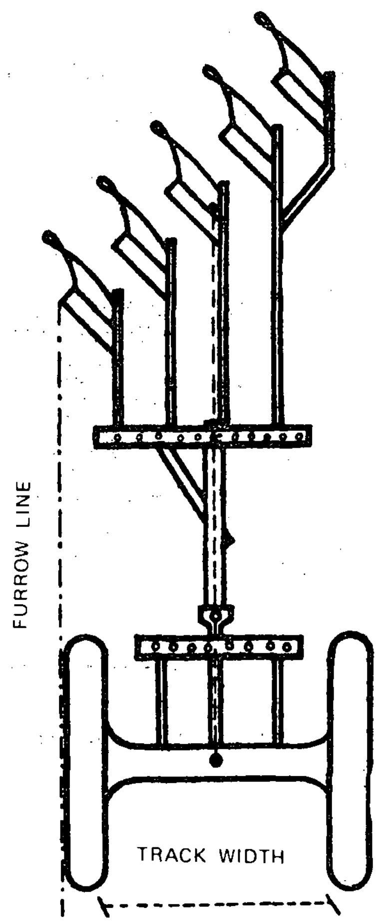


Fig. 6

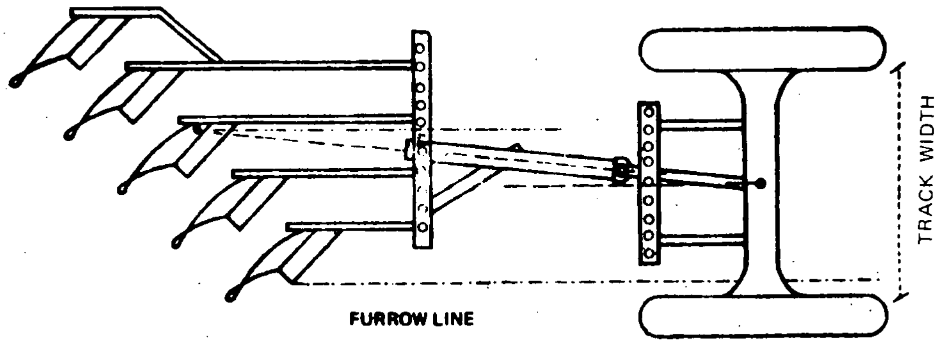


Fig. 7 - The track width is smaller than the cutting width of the plough

Figure 8 in a side view shows that all the points should be on a straight line.

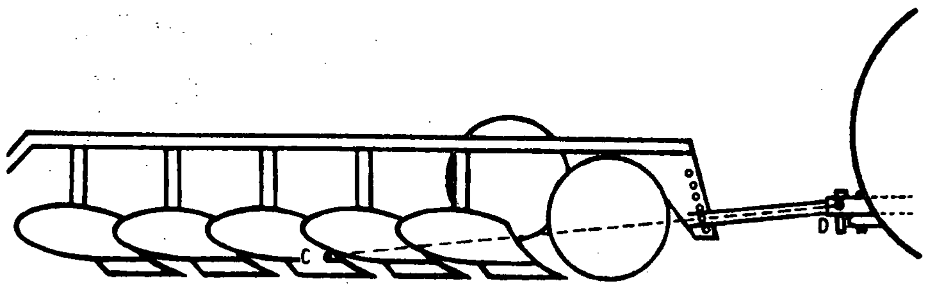


Fig. 8

LEVEL ADJUSTMENT

The frame of the plough should be level, that is, parallel to the surface of the ground. Levelling should be lengthwise and crosswise. To do this, levelling devices and depth screws are used.

Lengthwise levelling: The plough must be level seen from the side.

Crosswise levelling: The plough must be level seen from behind and looking forwards.

INTEGRAL-MOUNTED PLOUGHS: ADJUSTMENT

Track width adjustment. Consult the operator's manual and adjust the front and rear track width of the tractor as recommended.

Adjustment of cutting width. The inner face of the rear tyre of the tractor should coincide with the wing of the share on the same straight line parallel to the direction of travel.

To obtain this line, the plough is moved on the bar shown in Figure 9.

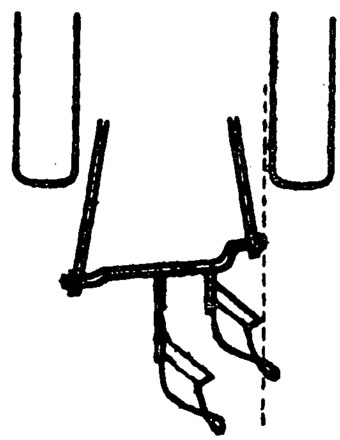


Fig. 9

Adjustment of working depth. It can be obtained by means of the adjusting wheels of the plough in the trailed and semi-mounted ones, or by the hydraulic system of the tractor in the integral-mounted or semi-mounted ones.

Levelling. Crosswise levelling is obtained by adjusting the height of the arm of the 3-point linkage of the tractor.

Lengthwise levelling is adjusted by extending or shortening the third point of the hydraulic system.

A disc plough is specially adapted to difficult conditions: stones, rocks, trunks, extreme dryness, etc.

This implement penetrates because of its own weight and of the angle which the discs form with the direction of travel.

DESCRIPTION AND PARTS

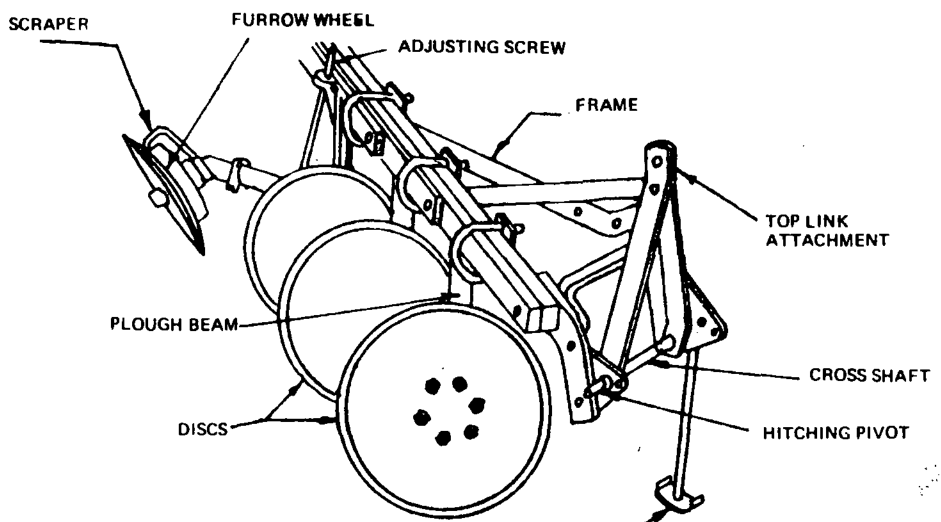


Fig. 1

DISCS

These cut and turn over the furrow slice.

FRONT FURROW WHEEL

This is not seen in Figure 1 because it shows a mounted implement. It allows for control of the working depth. See Figure 2.

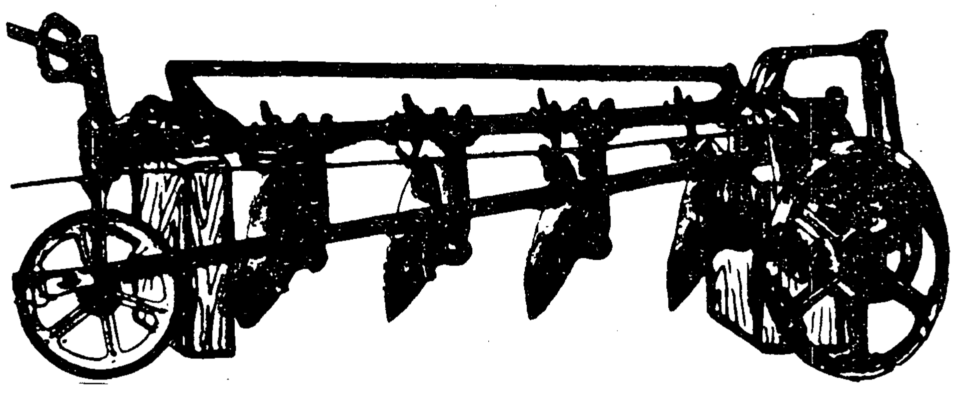


Fig. 2

DISC-CARRIER

This carries the disc and it serves to adjust the angle which the disc forms with the direction of travel as well as with the line perpendicular to the ground.

CROSS-SHAFT

This serves for levelling the plough crosswise and to change the cutting width.

REAR FLOATING FURROW WHEEL

This guides the rear part of the plough. It works at an angle to the land in order to absorb lateral thrusts.

FRONT FLOATING FURROW WHEEL

This guides the front of the plough. It absorbs lateral thrusts.

FIELD FLOATING WHEEL

This turns idle on the land. It is connected with the mechanism which lifts or lowers the plough.

LIFTING DEVICE

This is a mechanism which serves to lift the discs for transportation or to lower them for work.

MUD SCRAPERS

These help to turn over the soil that has been cut and to clean the discs in sticky soils. See Figure 3.

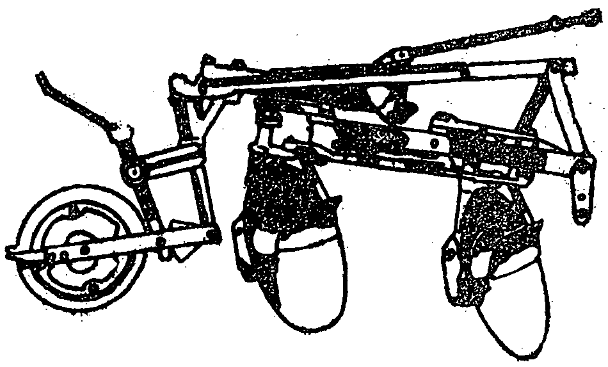


Fig. 3

ADJUSTMENT OF THE DISC PLOUGH

Figure 4 shows the centre of resistance of an individual disc.

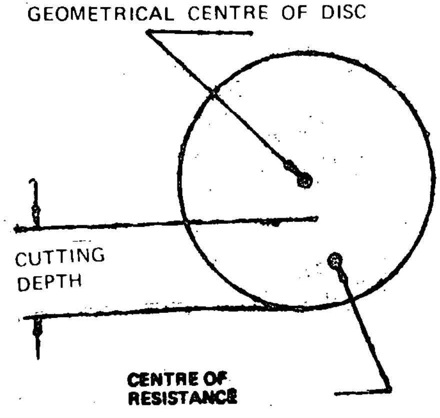


Fig. 4

Figure 5 shows the centre of resistance of a plough.
The centre of resistance is located in the centre of the line which joins the individual centre of resistance of each disc.

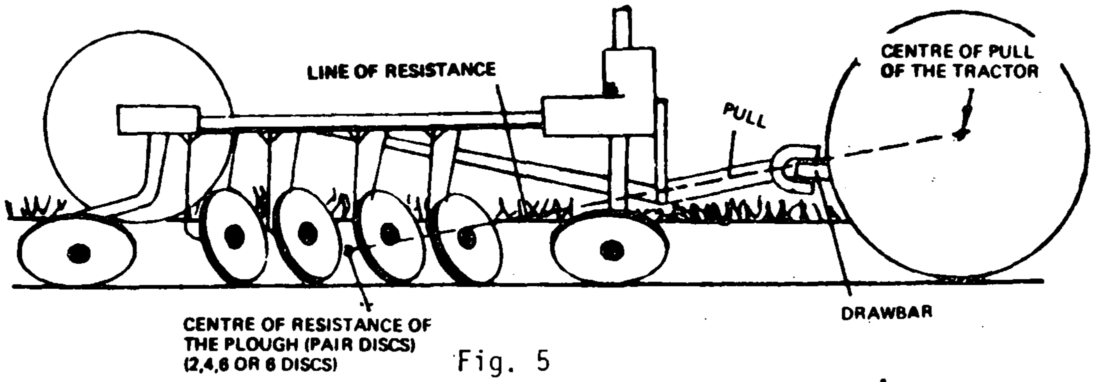


Fig. 5

The penetration and work of the plough depends on the angle which the axle of the disc forms with the direction of travel. See Figure 6.
Ploughs usually have adjustments whereby their angle may be altered.

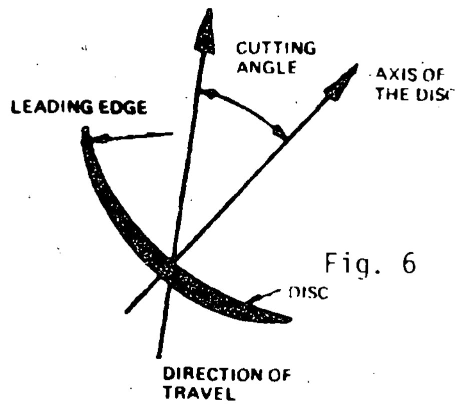


Fig. 6

The cutting angle affects the working width of each disc (Fig. 6) and of the plough (Fig. 7). For this reason, it also influences the position of the centre of resistance which varies with the depth and width of the work.

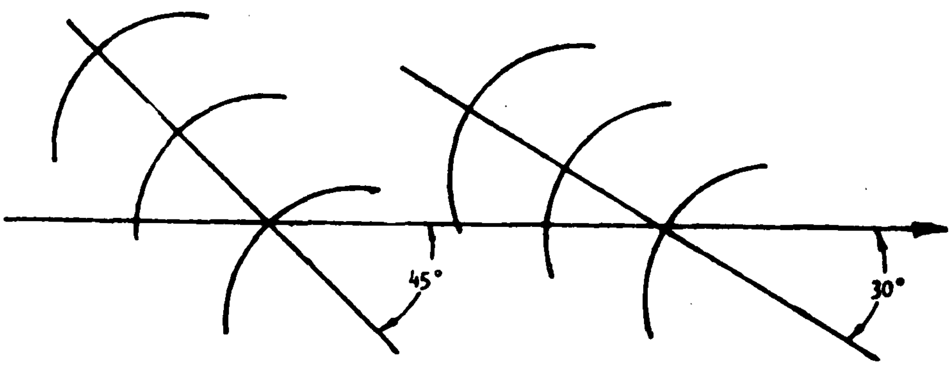


Fig. 7

HITCHING THE PLOUGH

A balance should be obtained as in the mouldboard ploughs between line of pull and resistance forces. To achieve this, the drawbar of the implement should be accurately aligned with the central axis of the tractor, both horizontally and vertically. See Figure 5.

WIDTH OF CUT

This should be equal to the distance between the inner surface of the wheels of the tractor, that is, the track width of the tractor.

DEFECTS IN THE WORK

The *lack of penetration* of the disc plough can be corrected by adding weights (ballast) and/or changing the angle of the discs.

Width of cut. It is changed in order to adapt it to the conditions of the soil or to the available power.

Inadequate covering of residues. It is corrected by adjusting the mud scrapers and changing the working speed.

MAINTENANCE

Careful and regular lubrication extends the life of the implement and lessens the tractive effort. Therefore, the consumption of fuel and possible damage and wear are reduced.

Once or twice a day check and grease the implement. Consult the maintenance manual.

CBC

TECHNOLOGICAL INFORMATION

DISCS

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 1.5-23 1.5-26

These cut and turn over the soil when ploughing. They have a concave shape and they are made of forged steel with a high carbon content. Around their centre there are holes through which bolts are fitted to attach them to the disc-carrier.

Discs are classified by their diameter, height, concavity and form.

Diameters of plough discs vary from 22 to 32 inches. Some heavy duty ploughs use discs with diameters of up to 40" (Fig. 1).

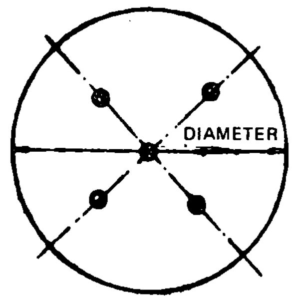


Fig. 1

The lowest working depth obtainable depends on the size of the disc and corresponds to one third of the disc diameter.

The thickness of the sheet with which the disc is made is expressed in inches. The most common thicknesses are 3/16 and 1/4 of an inch.

The concavity of the disc is also measured in inches and varies from 3 3/8 to 4 1/4 inches (Fig. 2).

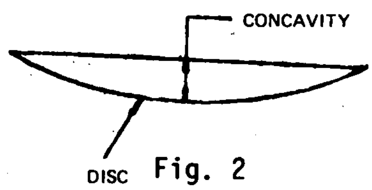
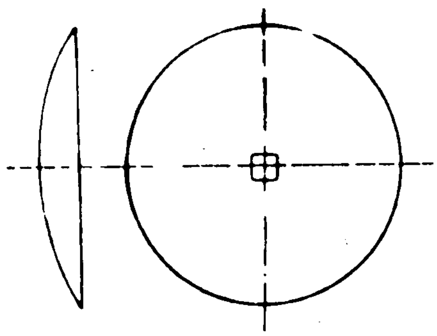


Fig. 2

The concavity gives the disc more resistance and contributes to inversion; it influences the extent of pulverization that is obtained and the capacity for penetration. With a smaller concavity a greater penetration and pulverization of the soil is obtained.

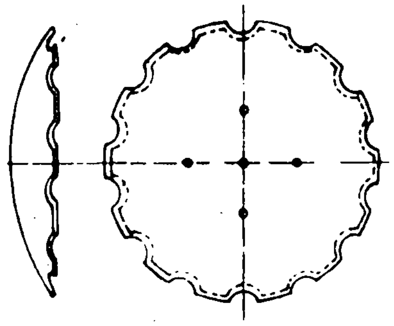
A larger concavity causes less break-up and less depth. It is advisable to use discs of smaller concavity on heavy soils, and the opposite on loose soils.

Depending on their form, discs can be smooth (Fig. 3) or scallop edged (Fig. 4).



SMOOTH EDGE DISC

Fig. 3



SCALLOPED EDGE DISC

Fig. 4

Scallop edged discs work well on soils with much underbrush, stems or roots. The scallops keep the stems or roots from slipping away from the pressure of the discs (Fig. 5), thus cutting them more easily.

Smooth discs of a large diameter cut roots and stems well (Fig. 6). Those of a smaller diameter pass over them (Fig. 7).

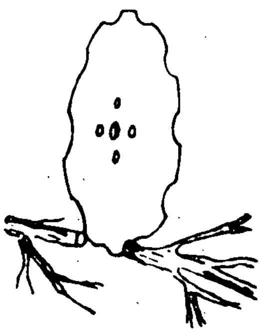


Fig. 5

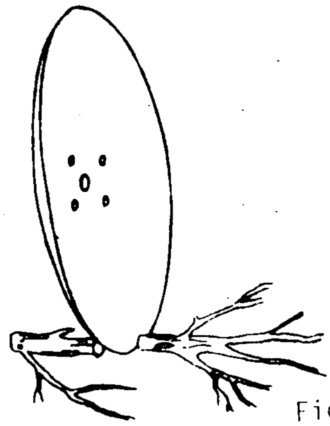


Fig. 6

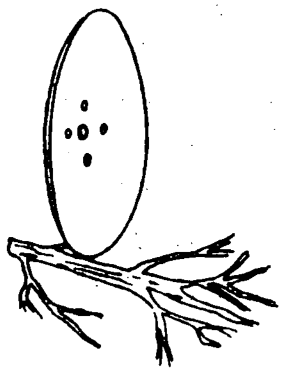


Fig. 7

There are two ways of sharpening discs: internal or concave sharpening (Fig. 8) and external or convex sharpening (Fig. 9). Internally sharpened discs cut better on hard soils, but have a shorter life. Externally sharpened ones cut less, but last longer. From externally sharpened discs better work can be obtained at high speeds.

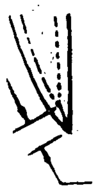


Fig. 8

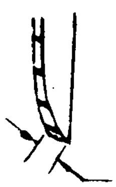


Fig. 9

This is an agricultural implement made for tilling the soil at a depth below 30 cm where the regular plough cannot reach. It breaks the hardened layer making the free circulation of water and air towards the subsoil easier and it encourages a better development of the root system of the plant. It also makes underground channels for drainage by coupling a mole expander to the rear of the share.

PARTS

- *Hitching device*
- *Frame*
- *Subsoiling tool*

The subsoiling attachment. It consists of the cutter, the front edge which cuts the soil, the share which tills the subsoil and the mole which is used to open underground channels for drainage when necessary (Fig. 1).

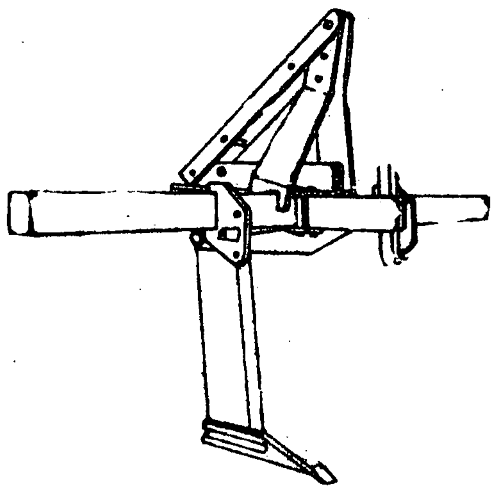


Fig. 1

CLASSIFICATION
These implements can be integral-mounted or trailed.

In the integral-mounted subsoilers the frame is a tool-carrier bar to which one or several tools can be coupled.

The structure of the tool-carrier bar is made of a high resistant and very rigid metal. It has an attachment for the three points of the hydraulic system of the tractor. It is built in different forms and sizes. It can combine with different implements, such as cultivators, sowing machines, listers and others.

In the trailed subsoiler the frame, besides being a support for the subsoiling tool, also serves as such for the transporting wheels, the clutch and the depth control mechanism.

The working depth of the integral-mounted implement is limited by the hydraulic system of the tractor or by depth wheels or skids with which the implement is fitted.

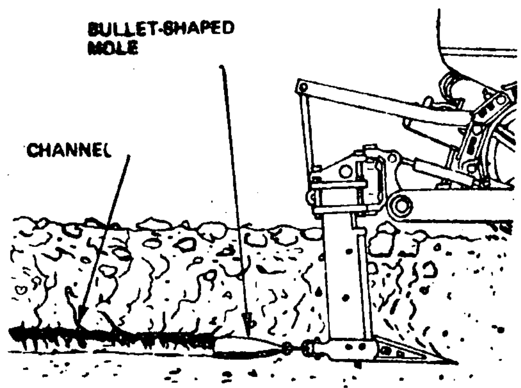


Fig. 2

MAINTENANCE

In the trailed subsoiler greasing should be done according to the operator's manual.

The maintenance of the tool consists of replacing the front edge and the share when they are excessively worn or when they are damaged. The of nuts and bolts should be checked daily.

Before parking the subsoiler it should be washed and the parts likely to rust, protected with anti-rust, or oil or grease if antirust is not available.

This is an implement which when coupled to the power take-off of the tractor, is used to bore round holes of different diameters and depths in the soil. It can be used for special sowing and for planting trees or posts (Fig. 1).

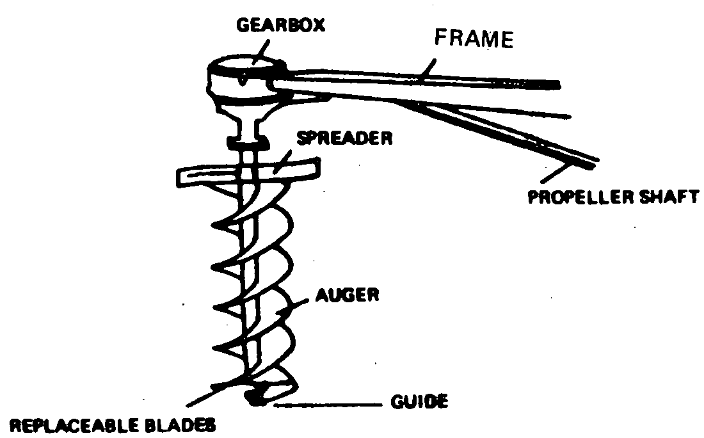


Fig. 1

BEVEL GEARBOX

This is the gearbox which is turned by the propeller shaft. It transmits the power from the power take-off of the tractor to the auger.

AUGER

This is the tapered section which bores into the soil. It is coupled to the shaft which is joined to the bevel gearbox.

GUIDE

This is the pointed end of the auger. It is used as a guide when digging.

REPLACEABLE BLADES

These are placed after the guide and on the lower part of the auger. They are fastened with screws. They are made of steel and are sharp in order to cut the soil.

FRAME

This is used as the skeleton of the machine. It serves as a base for the supports and for all the other parts which make up the unit.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 1.5-14

OPERATION

The digger is turned by the power take-off shaft of the tractor which is coupled to the propeller shaft of the machine. It is supported by the tractor's hydraulic system which serves to lower and lift it while digging.

ACCESSORIES

There are different augers which can be adapted (Fig. 2) to the same drive. Figure 2 shows different types.

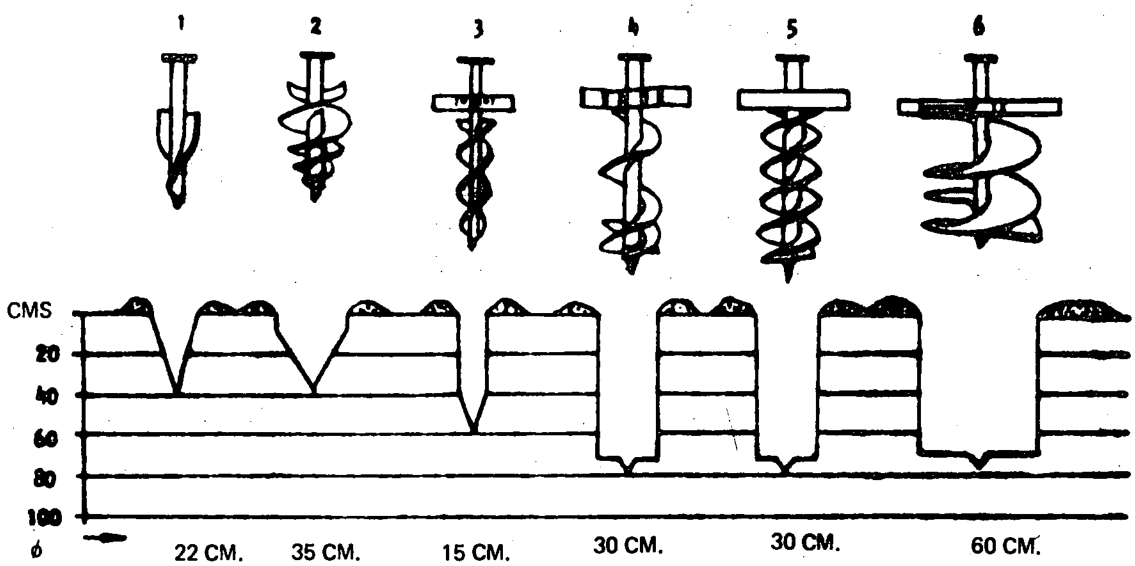


Fig. 2

∅ means diameter

Augers 1 and 2 are used when transplanting trees and other plants. Auger 3 for fence posts. Augers 4 and 5 for posts which require more depth. Auger 6 for special cases.

USE AND CONDITIONS

The auger operates on the same principle as a carpenter's auger. The pointed end guides it to avoid the blades from straying when the cutting starts. At the upper part it has a helix or screw which spreads the extracted material.

Some post hole diggers are mounted on trailed frames. However, most of them are integral-mounted. The depth of the hole is determined by the length of the auger. When the auger is long, the depth can be controlled by the hydraulic system (Fig. 3).

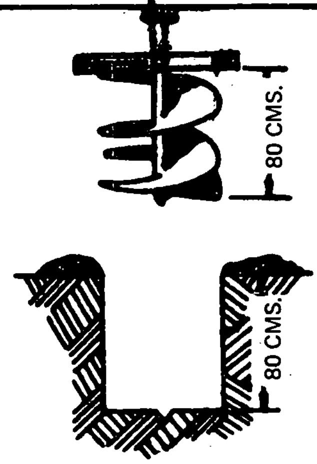


Fig. 3

Having the auger coupled and on the spot to be bored, it should be slowly lowered until the guide is on the exact point for digging. It should then be started slowly and gradually advanced to a depth of about 10 or 20 centimetres, depending on the hardness of the soil. Having reached that depth, it should be taken out by lifting it with the hydraulic system. The aim of this operation is to clear the soil gathered around it. After it is clean the operation is repeated several times if necessary, until the required depth is reached.

The guide as well as the blades should be kept tight. The blades should also be kept sharp.

MAINTENANCE

Check that there are no loose, broken or dull parts. To change oil, lubricate and grease, consult the manufacturer's manual.

CAUTION

WHEN MAINTENANCE IS DONE TO THE MACHINE IT SHOULD NOT BE MOVING.

THE SAME APPLIES WHEN CHANGING THE AUGER.

LOWER IT SLOWLY TO AVOID FRACTURES.

DO NOT LET PERSONS COME NEAR WHEN IT IS WORKING.

WHEN TRANSPORTING THE AUGER BE SURE IT DOES NOT TOUCH THE GROUND.

Graders are machines used for the correction of superficial and minor irregularities of the land. This is done for the establishment of irrigated crops, roads on the farm or water retaining terraces. The working element of the grader is a blade. They may be coupled to the three-point linkage, trailed or mounted on the front of the tractor.

TYPES

There are many types of graders. They may be classified as:

- *Integral-mounted (or rear mounted)*
- *Front mounted*
- *Trailed*

CHARACTERISTICS

The integral-mounted grader is coupled to the three points of the hydraulic system. The lifting and placing in working position of the grader is done with the hydraulic control lever (Fig. 1).

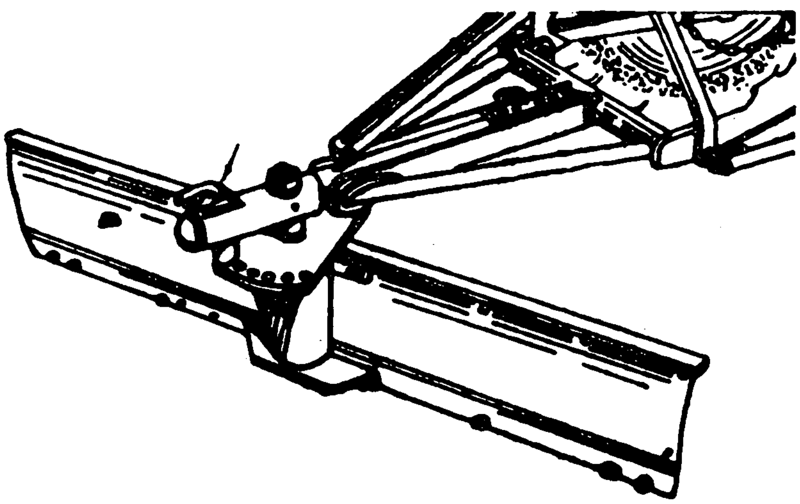


Fig. 1

The regulating system of the grader allows the blade of the scraper to form an angle to the right or to the left of 0^{o}, 15^{o}, 30^{o} or 45^{o} with the perpendicular to the direction of travel. This is done by placing the pin in the position which corresponds to the desired angle.

The scraper may also be tilted with reference to the land as shown in Figure 2.

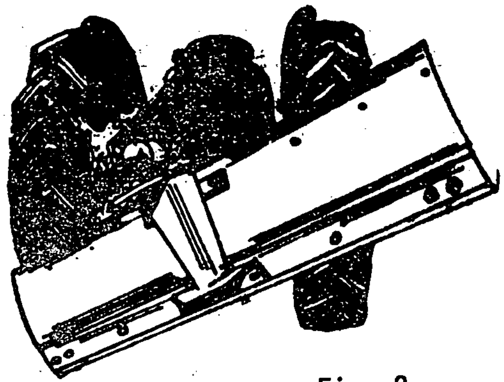
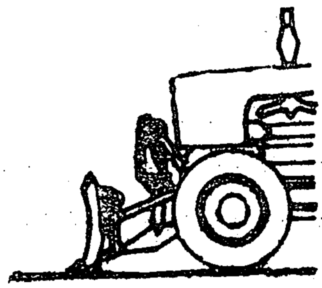


Fig. 2

Generally, the greater the angle, the greater the penetration of the blade.

Greater or less penetration may be obtained by adjusting the upper link. This changes the angle formed by the base of the blade and the vertical line. The conditions of the land and the work to be done determine the working angle.

Front mounted grader. It is not used too often with agricultural tractors because of its limitations - narrow angle (up to 30°) and a maximum of 0.15m penetration in the soil in each pass (Fig. 3).



This grader is operated by one or more remote control cylinders. Its hitching is different from other implements. To mount it on the tractor consult the operator's manual.

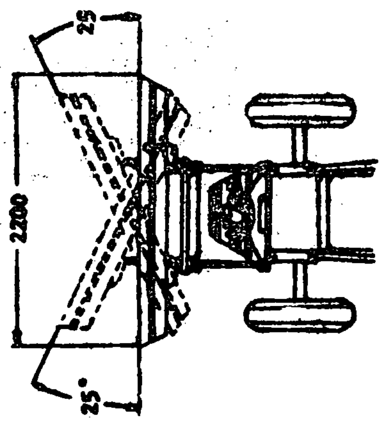


Fig. 3

Trailed graders. In general, they consist of the following elements:

Hitching device. The grader is hitched by this element to the tractor.

Frame. This is the support on which all the parts which make up the implement are mounted.

Main control bar. One of the ends of the bar is connected to the hydraulic cylinder of the remote control. The other end is connected to the depth control mechanism. The blade is lifted and lowered according to the needs of the operator.

Lateral supports. These counteract the lateral forces which act on the blade.

Blade. This is the part used for moving the soil.

Blade limiter. This prevents the removed soil from spilling over the sides of the blade. This is an optional accessory.

Transporting wheels. These are used for lifting the blade when it is transported.

Rear wheels. These are used for controlling the height or cutting depth. They also support part of the weight of the implement.

Tilt adjustment bolts. The crosswise tilt of the blade is adjusted with these bolts. In recent models these adjustments may be made with the hydraulic cylinders.

Depth control mechanism. With this mechanism the position of the rear wheels with reference to the frame is controlled.

USE

When levelling lands, work is done in all directions, filling the blade when cutting down hill and emptying the dirt in the lower parts and holes. If levelling is to be precise and over a more or less large area, the operator should strictly follow the instructions of the technician who carried out the topographical measurements.

When the land is very uneven, the contours should be followed. This ensures hauling smaller volumes of dirt over shorter distances.

MAINTENANCE

Check the nuts and bolts daily, tightening them, especially those on the pivot and on the supports. Grease the nipples daily. Before greasing clean them to keep out dust and other foreign matter.

Before storing the grader, wash, inspect, change damaged parts, lubricate and paint rusted parts with antirust or used mineral oil.

The fundamental element of the rotovator is a horizontal rotor provided with blades. The unit formed by the rotor and blades turn faster than the forward travel of the tractor. The movement is received from the power take-off through a telescopic shaft with universal joints.

The position of the rotor is perpendicular to the direction of travel while the position of the blades is parallel.

Each blade digs up, removes and throws clods of soil and vegetation against the cover of the machine. In this manner, a better break-up of the soil is obtained. The degree of pulverization depends on the mellowness of the soil and the relation between the travelling speed of the machine and the speed of rotation of the rotor and blades.

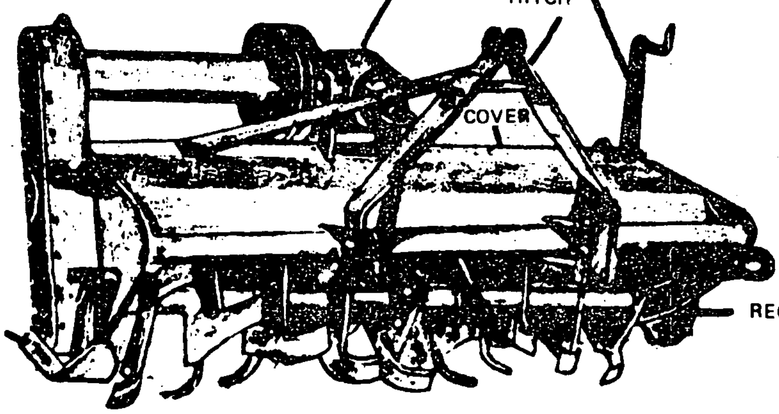


Fig. 1

HITCH. The point where the arms of the hydraulic system of the tractor is connected. It is also a drawbar and lifting mechanism.

DEPTH CONTROL. A crank which moves the mechanism. This allows for lifting or lowering the working depth control elements (wheel and skid).

WHEEL. This is found on the left side of the implement. It controls the working depth. If the implement is of the trailed type, it has wheels on both sides which also serve for transportation purposes.

BLADES. Parts used for pulverizing the soil.

GEARBOX. This contains elements (pinion and ring gear) which change the working speed and the direction of the transmission shaft.

COVER. Made of thick, hinged metal sheets. It prevents the flying of sticks or stones during work and serves as a protective covering. It also breaks up the clods which are thrown against it by the blades.

SKID. This support is placed on the right side of the implement and is used for controlling the working depth.

This machine may be integral-mounted, semi-mounted or trailed depending on its hitching to the three points of the hydraulic system or the drawbar of the tractor. It is always operated by the tractor power take-off.

LEVELLING. When the implement is integral-mounted, the crosswise and lengthwise levelling is done with the arms of the three-point hitch. On trailed implements, the lengthwise levelling is obtained by the hitching with the drawbar. The crosswise levelling is obtained with the wheels. The semi-mounted implements have the systems of both the trailed and integral-mounted ones.

The working depth is controlled by lifting or lowering the skids or wheels of the implement.

In some cases it is possible to change the position of a pair of gears to modify the speed of the rotor with respect to the forward speed.

OPERATION

The power take-off shaft is coupled to the propeller shaft of the machine. The rotation reaches the gearbox which in turn transmits it to the mechanisms which move the central rotor on which the blades are mounted.

When the machine is in operation the rotor and blades which are fixed to it, spin digging up the soil. This rotor works at high speeds and mulches the earth while the plant residues are chopped and incorporated into the soil.

The position of the blades on the rotor makes the digging uniform and continuous.

Sometimes this machine may be worked off-centre, placed to the right or left of the centre-line of the tractor.
When it is integral-mounted it is only necessary to change the lower hitching points to obtain the off-centre position (Figs. 2 and 3).

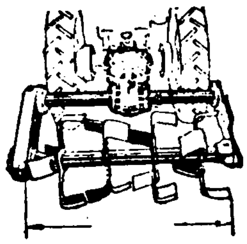


Fig. 2

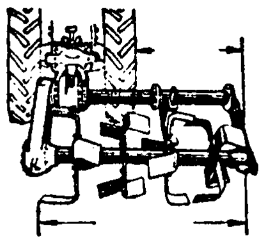


Fig. 3

The off-centre hitching facilitates working the soil under trees close to their trunks and is very useful when working in groves.

MAINTENANCE

- Check the level of lubricant in the gearbox.
- The bolts of the blades must be kept tight.
- The blades must be sharp.
- Grease or oil the indicated points.

OBSERVATION
Consult the operator's manual.

CAUTION
WHEN ADJUSTING OR LUBRICATING, THE MACHINE MUST BE STOPPED.
WHEN WORKING, AVOID HAVING ANYONE BEHIND THE MACHINE.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 1.5-15 1.5-29

These are implements usually fixed to trailed or integral-mounted tool bars. They are used for opening furrows for sowing or irrigation, or trenches for drainage. They are also used to build ridges, to sow in soils with difficult drainage or to build dams for flood irrigation.

The ploughing section consists of a plough which has a double mouldboard, one left, one right. Other implements consist of discs.

DESCRIPTION

Figure 1 shows the parts of a lister body with mouldboard.

1. Replaceable point
2. Share Wings
3. Frog
4. Mouldboards
5. Safety Friction Release

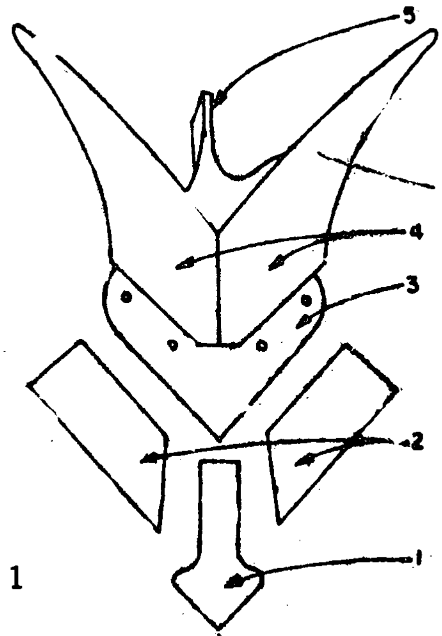


Fig. 1

Figure 2 shows a trailed trenching machine and the parts of which it consists.

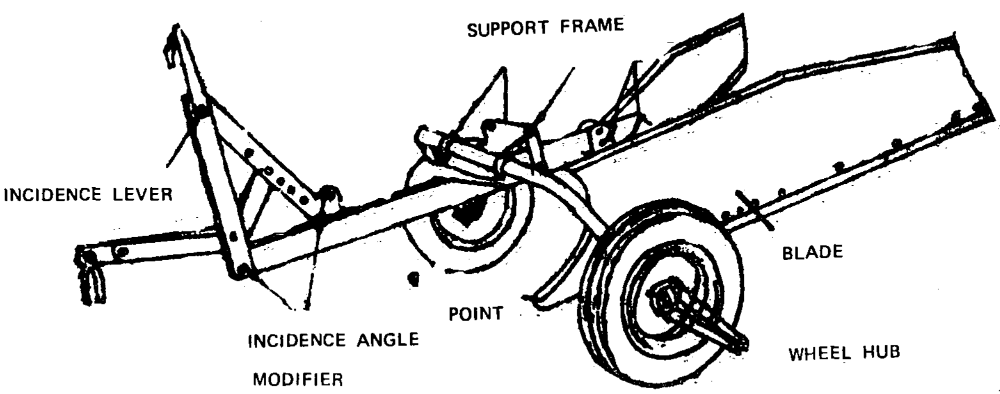


Fig. 2

- The wheels support-axle. This allows for transportation and for depth limiting.
- The hubs of the wheels. These are important points to be lubricated.
- The system by which the angle of incidence of the share or its point can be changed without altering the towing height.
- Parts of the frame.
- Angle of blade control lever.

SHARE OR BLADE. This tool is made of mild steel. It makes penetration easier and it cuts, ploughs or breaks up the soil. The shares can be replaced by new ones and they are usually stretched or sharpened by experienced blacksmiths.

MOULDBOARDS. These elements separate and push the soil broken up by the share to the sides. There are double mouldboards of different sizes for furrows, with different measurements. In the case of two mouldboards the separation between them can be adjusted by means of a device which is at the rear and is used for changing the size of the furrow or trench.

HITCHING. These can be trailed, semi-mounted or integral-mounted.

The trailed and semi-mounted ones consist of a frame on which the body of the trenching machine is mounted. They have wheels for transportation and for controlling the working depth. The wheels may be hydraulically controlled from the tractor, or they may have a mechanical lifting system.

Figure 3 shows a tool bar for a 3-point hydraulic system hitch which allows for different implements to be mounted on it, such as trenching machines, listers, cultivators, etc.

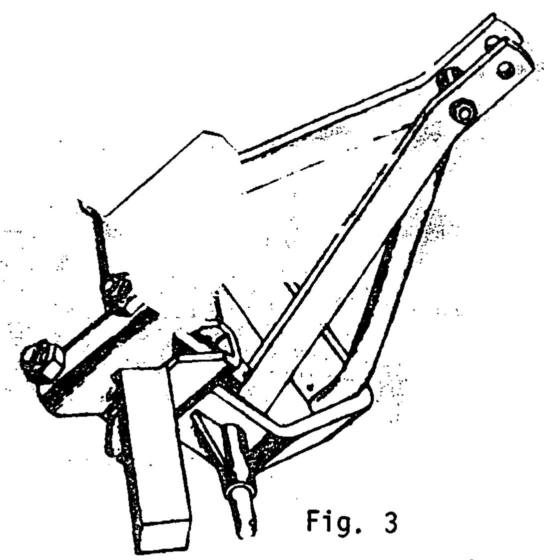


Fig. 3

Figure 4 shows an integral-mounted tool bar with three listers. It shows the device which adjusts the angle formed by the mouldboards with each other, thus adjusting the width of the furrow. The same figure shows the working depth adjusting wheels and screw used for changing the depth. It also shows at the left end of the bar a small share-like marker which marks the path on which the tractor wheels should run for the next pass.

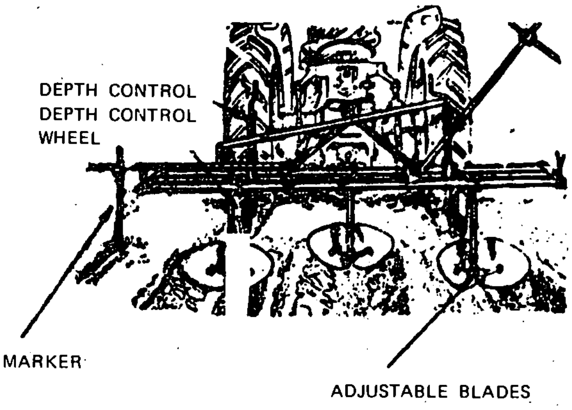


Fig. 4

USE

These implements, because they open furrows and form ridges, are suitable for handling water supply in semi-arid places (lister, tillage system). They are also used in flood lands for sowing on the ridge, thus providing a relatively dry seedbed.

The implement is generally used on soils which have previously been conventionally tilled (ploughing, harrowing, etc.) Some trenching machines designed for heavy-duty work can operate on untilled soils.

In certain cases, in order not to exceed the capacity of the implement or tractor, two or more successive runs are done. Each successive run is done deeper and/or widens the furrow or ridge.

These implements are used for crops, such as sugar-cane, cotton, potato tobacco, etc., which are usually irrigated. They are also used in areas prone to erosion.

SIZES

The models used in agriculture consist of 1, 2, 3 or more listers. Each one cuts a width between 25 and 100 cm.

The section of the implement depends on the needs of the crop itself and the power of the tractor to be used.

Figure 5 shows the relation between the height of the ridges, the depth of the furrows, the distance between these and the depth of the previous conventional tilling.

All those particulars should be borne in mind when considering the preparation of the seedbed.

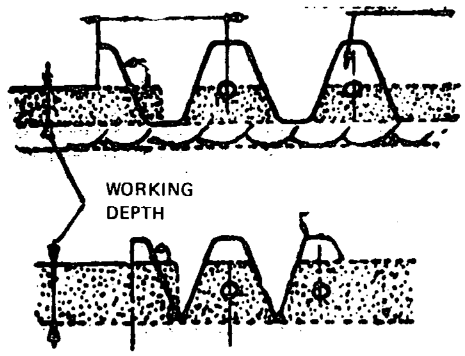


Fig. 5

DISC IMPLEMENTS

These listers and ridgers consist of a minimum of two discs similar to those used on ploughs, arranged in an opposing manner with respect to each other. See Figure 6.

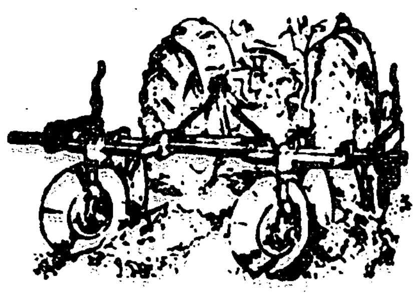


Fig. 6

The discs are capable of turning 360° in order to change the angle formed by their axis with the direction of travel. They can be separated or brought closer by moving them on the tool bar in order to form ridges of different widths.

MAINTENANCE

The lubrication of agricultural implements done as recommended by the manufacturer should be supplemented with the tightening of parts, sharpening or replacement of shares, and the necessary attention, such as cleaning and applying antirust paint. Do this before storage.

This implement is used to make retaining ridges or to dig water channels. They consist of a tool bar and sets of ridging discs.

The operating parts of the ridger may consist of smooth or scalloped discs.

CLASSIFICATION

The different types of ridgers are used according to the needs of the crop to be grown and can be grouped as follows:

Depending on the hitching	*Trailed* *Integral-mounted*
Depending on the number of bodies	*Two bodies* *Four bodies*
Depending on its working features	*Simple* *Complex*

Simple. These consist only of sets of discs.

Complex. These are so called when besides the discs they have devices for heaping and compacting the earth. The ridges are made in one single pass.

OPERATION

The work of the ridger depends on the angle of the discs. A small angle causes low ridges; a larger angle, higher ridges.

The working speed depends on the power of the tractor and the number of discs and bodies of the ridger.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 1.5-13

ADJUSTMENT

To obtain good work it is necessary to adjust the angle of the discs between opposing sections with respect to the vertical line and to the direction of travel.

The discs can be adjusted perpendicularly to the line of pull of the tractor and to the soil (Fig. 1). They can be separated from each other by shifting them on the tool bar.

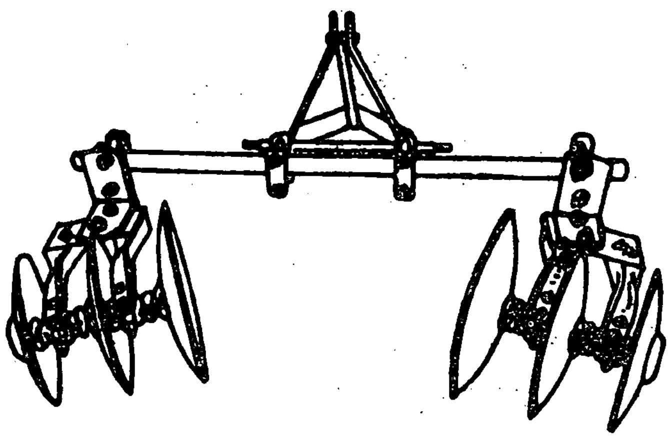


Fig. 1

MAINTENANCE

Lubricate the grease nipples daily if the discs rotate on wood or metal bearings, and the ball bearings, if these are not pre-packed. Carry out a general check on all parts of the implement. Tighten loose nuts or change damaged parts.

This machine is used for spreading over the surface of the soil seeds (grass, rice, etc.), fertilizers, and other soil dressings (limes, etc.).

It consists of a rotary plate or disc which is turned by the power take-off of the tractor. The previously metered product comes from a hopper and falls on the disc. The material is uniformly distributed by centrifugal force.

STRUCTURE

The disc distributor consists of a hopper with adjustable openings or ports on its bottom (Fig. 1). An agitator forces the fertilizer or seeds through the adjustable ports. The fertilizer or seeds then fall on a horizontal rotary disc with fins which throws off the product over a swath (band) of a width between 5 and 12 m.

The evenness of distribution which covers the whole width of the swath (band) is affected by the wind—its intensity (kilometers/hour) and direction.

Some models have a guard at the rear which is called a curtain and it partially avoids the action of the wind.

These distributors can be integral-mounted or trailed. The trailed ones are hitched to the drawbar of the tractor. In both cases the rotary disc moves by means of the power take-off shaft. Some trailed machines are ground wheel driven.

METERING

The distributor has a scale with which the application rate can be adjusted. To do this, adjust the position of the lever which opens the ports to get the desired quantity per hectare as a function of the speed of the tractor and the type of product to be distributed - type of seed, lime or granular fertilizer.

The capacity of the hopper varies. Some integral-mounted ones hold up to 400 kg of fertilizer. in trailed machines, used by contractors, the capacity usually is of several tons.

The outlet flow can be adjusted backwards, to the left or to the right, by adjusting the position of an adjustable collar. This device is useful in the case of orchards.

USE

Once the distributor is adjusted, it does not offer major problems in its operation. The working speed can be changed (7 to 15 Km/Hr) depending on the irregularities of the land.

Once a speed has been selected it should not be changed because the distribution will not be as recommended, nor uniform. By changing the speed the the amount of product applied per unit area changes.

It is recommended that the runs on the land be done lengthwise continuing with parallel runs. In this manner the effect of the wind is partially modified after successive runs.

At the boundaries of the field, make adjustments so that the outlet flow is directed inside the field. At the headlands, make open turns. In integral-mounted machines, it is not necessary to disconnect the power take-off shaft.

MAINTENANCE

Before starting to distribute, grease the machine and change the lubricant in the gearbox. Follow the instructions in the operator's manual.

If it is used for distributing chemical fertilizers, wash the hopper thoroughly and apply an antirust product.

In trailed distributors with tyres check pressure daily and adjust when necessary.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: ( )
Level: 2
Subject: 1.5-42 1.5-53

This machine is used for sowing of small grain seeds (oat, wheat, corn, flax, rice). When sowing, it does so in the proper amounts, to the right depth and in small furrows which it later covers. It is capable of forming small channels in order to protect the seed and prevent the erosion of the soil. It also distributes different classes of chemical fertilizers in granular and powder form, in variable quantities depending on the needs of the crop and the characteristics of the soil.

CHARACTERISTICS

This sowing machine carries out four operations at once. It opens a small furrow in the soil, sows the seed, distributes the fertilizer and covers both. The grain-fertilizer drills have two independent distributing units; one for the seed and another for the fertilizer.

SIZES

The size of the drill is expressed by its width in metres, the number of coulters and the space between them.

The seed tube is the opening through which the seed passes to the coulter. The separation is the distance between two consecutive coulter tubes and it is measured in centimeters. For example, the number 17 x 18 means that there are 17 coulters spaced at 18 centimetres. By multiplying both figures the total sowing width is obtained, which is 306cm. Another method of calculating the sowing width is to measure the space between the end coulters and increase it by a space equal to the distance between consecutive coulters.

Common distances between coulter tubes are 15, 18, 20, 25 and 50 cm. The most common distance is 18 cm. The number of coulter tubes varies.

The drill may have coulters with one or two discs. In those having one disc, half the coulters push the soil to the right and the other half push it to the left. Drills with hoe coulters are also used.

MAIN PARTS OF THE DRILL

HOPPERS. These are containers for seed and fertilizers. They are made of wood or steel sheet.

FEEDING MECHANISMS

Double-run feeding mechanism. It can be used for sowing large seeds like bean or corn, and small ones like alfalfa or clover. The bottom of the hopper has cups; one for each coulter The cups are divided into two parts forming two channels for seeds (Fig. 1).

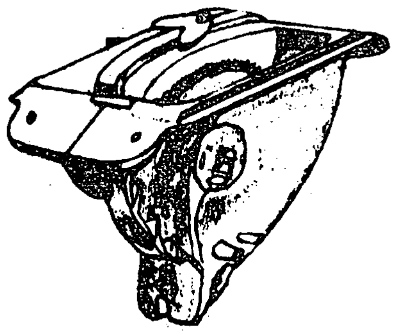


Fig. 1

The feed disc. One side is coarser than the other one. The coarser side has thick ribs on the inner surface of the rim. The shallower side has smaller ribs. The ribs help to get the seeds out of the hopper and to carry them to the outlet tubes.

The side of the main feeding wheel which has thick ribs is used for bean, corn, and other large seeds. With the aid of a special reducer which can be adapted, it may be used for medium size seeds. The side having small ribs is used for oats, wheat and barley. By using reducers made of cast iron this size can be used to plant alfalfa and pasture seeds.

DISCHARGE CONTROL. With the double-feed system there are four ways in which the seeding rate can be altered:

- By choosing the side of the feed wheel recommended in the instruction plate on the sowing machine for a given sowing rate and seed.

- By changing the speed at which the feeder rotates (Fig. 2).

- By selecting the position of the feed gate.

- By using reducers.

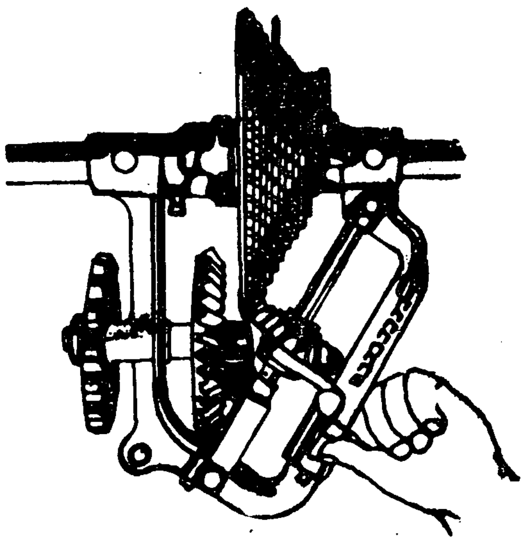


Fig. 2

To change the speed of the feed wheels a special multiple gear is used. It consists, essentially, of a disc or cone with rings or concentrical teeth arranged (Fig. 2) on a circular surface. Note that the outer ring has more teeth than the preceding one.

The teeth of a small pinion meshed in different positions of the bevel gear will make the pinion turn faster or slower. In turn, the small pinion is geared to the square shaft which controls the different feed discs.

Fluted roller feeder.

It is also called external force feed. The seeds are carried from the cup by a fluted roller (Fig. 3). This feeder is very common.

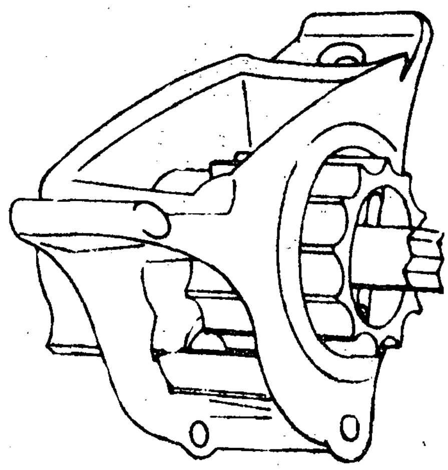


Fig. 3

There is a cup for each seed chamber, a coulter tube and a coulter.

The fluted roller is turned by a long square shaft which in turn, is rotated by the driving mechanism. The rollers move lengthwise on the shaft when the adjusting lever moves over a dial (Fig. 4). Adjoining each fluted roller there is a cut-off. It moves lengthwise with the fluted roller shutting off the flow of seeds. If the roller moves lengthwise and away from the cup, the plate closes the coulter tube in the same proportion, and partially or totally interrupts the flow of seeds depending on the distance reached.

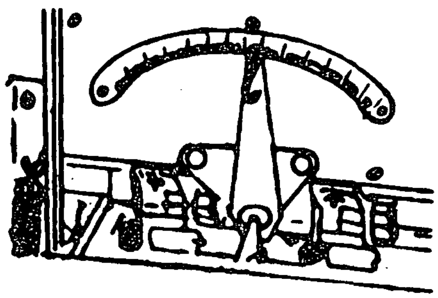


Fig. 4

When the roller is fully inserted in the housing full sowing capacity is obtained because the entire surface will be exposed to the effect of the flutes.

In this manner the flow of seeds can be controlled by changing the length of the exposed surface of the roller and therefore of the blanking plate. Most of the machines with fluted feeders have adjustable feed gates (Fig. 5) at the lower part of the cup. This is a means of adjusting the size of the outlet.

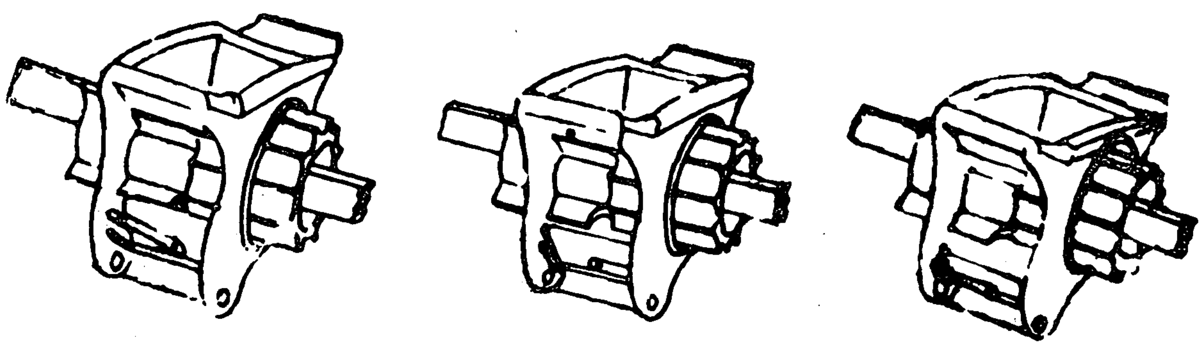


Fig. 5

OUTLET ADJUSTMENT OF FORCED FEED MECHANISM

The outlet is almost completely controlled by the lengthwise movement of the roller inside the housing. This movement is controlled by levers. If the sowing machine has more than 8 coulters, it may have two levers.

One controls the left half of the coulters and the other one controls the right half. The adjusting levers move along dials which have notches or teeth.

OBSERVATION
When changing the feeding rate move the lever to the notch which is next to the indicated one and then return to the correct one. In this manner a better adjustment is obtained.

- By moving the fluted rollers lengthwise. With this action a larger or smaller amount of seeds is exposed to the flutes and it causes a change in the sowing density or kilograms per hectare of distributed seed.

- By adjusting the feed gates to one of the three positions (Fig. 5).

- By changing the speed of the feeder shaft (only in some models).

COULTER TUBES. These carry the seed from the feeding devices to the coulters. They may be flexible, of rubber, plastic or steel sheet spiral. They may also be of rigid material and of telescopic structure (Fig. 6).

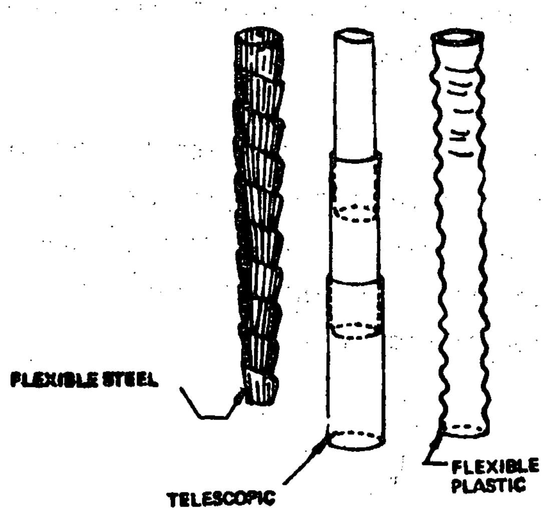


Fig. 6

COULTERS. These furrow openers may be of the fixed or rotary type. The fixed type include the hoe coulter, the mouldboard and the suffolk (Fig. 7).

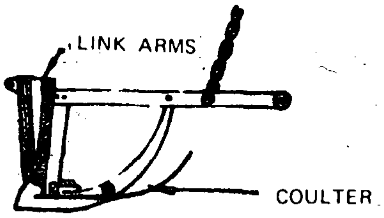


Fig. 7

Double disc and single disc coulters are rotary type (Fig. 8).

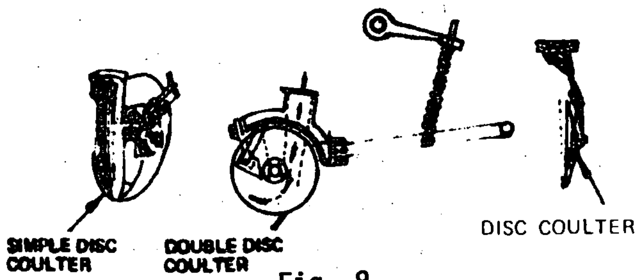


Fig. 8

The hoe coulters are generally used in European-made machines. They are not very suitable for stony lands or soils with many roots. They are capable of placing the seed at a greater depth than other types.

The suffolk works well at medium depths. They are rarely used.

The double disc coulters are specially suited for surface or medium depth drilling. The penetration is usually less than can be obtained with single disc coulters.

Single disc coulters are excellent for deep penetration and also for cutting stubbles. They are suitable for a large variety of conditions and are very much used in American-made seed drills.

The disc coulters are mounted on two "V" arms which in turn are joined to a heavy bar situated at the front of the frame of the machine. The connection of these arms to the bar is such that it allows them to move vertically and thus follow the contour of the land. Springs, conveniently placed, contribute to make easier the penetration of each disc.

DEPTH CONTROL

Coulters may be equipped with additional weights or spring-loaded arms to increase weight and to keep them from coming out of the soil when meeting with irregularities.

BOOTS

In some models the boot supports the bearing, and the arms are directly fixed to the boot. The boots can be made of mild steel.

SEED COVERERS

There are machines which have no parts with which to cover the seeds; they depend on gravity to return to the furrow part of the removed soil.

Other machines have covering elements called furrow coverers. The most common one is the chain coverer (Fig. 9). It consists of different size links which when dragged behind the coulter, spread a little soil over the seed. The surface remains loose which may be convenient when planting in moist land.

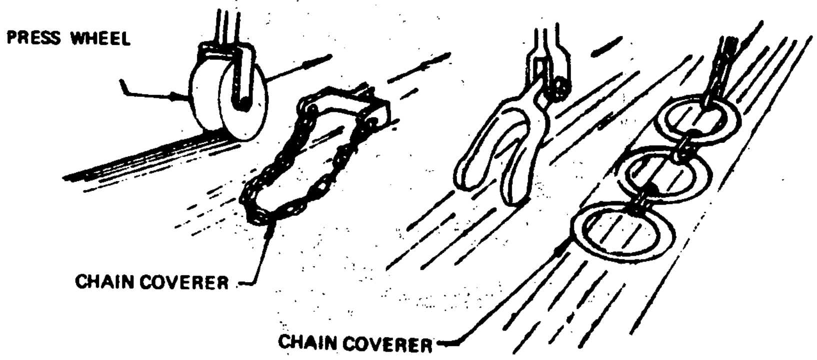


Fig. 9

PRESS WHEELS

The hoe coulter, suffolk and single disc coulters are sometimes equipped with press wheels. Each grooved-rim wheel is joined to a coulter and compacts the soil on the seed thus obtaining a good contact between the seed and the soil. They are not suitable for soils which tend to form crusts or are too moist.

WHEELS

Two types are used: press wheels and end wheels. Both type move and support the mechanism of the machine.

Fertilizing device

This has a hopper which is separated from the seed, with a capacity of 70 to 100 Kg per linear metre, that is, per each metre of hopper width.

Star wheel

This is the fertilizer distributor's main part. It is an iron disc or plate with fingers which can easily be removed. It has a rather long bushing on its underside. This plate is moved by two bevel gears, one directly connected to the feed wheel. The other gear is in a vertical position and it moves by means of a square shaft which is turned by the ground wheel.

This feed star-wheel turns on the bottom of the hopper carrying the fertilizer to a single outlet at the front of the hopper.

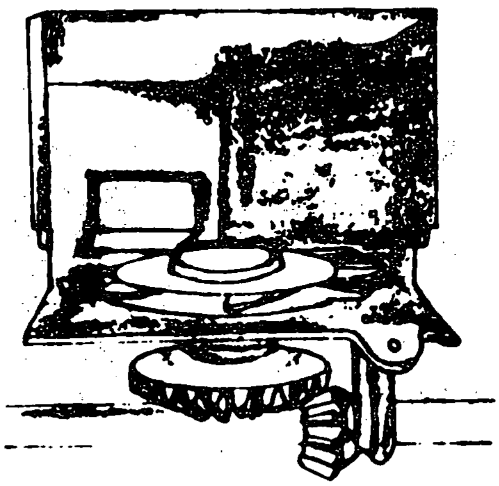


Fig. 10

To regulate the amount of fertilizer distributed, a vertical adjustable slide is installed behind each outlet or port. This slide is directly above the disc fingers. If the slide is lifted, more fertilizer reaches the feed opening. By lowering the slide the amount is reduced.

All the slides are lifted at once by means of two end levers on large machines and by one lever in the small ones. If the feed...

wheel is turned faster with respect to the forward travel of the sowing machine, more fertilizer is discharged. In some machines, gears or sprockets are used to change speeds and by so doing the feed rate also changes.

Feed wheels can also be obtained in various sizes.

NORMS

See Technological Information on the row crop planters.

CALIBRATION

Follow the instructions given in the Technological Information sheet for row crop planters.

MAINTENANCE

The main cause for the deterioration of grain drills is the moisture caused by seeds left in the hopper. This moisture is the cause of rust which affects the parts of the feeding system. Fertilizers usually absorb moisture. Take out all the fertilizer, wash the machine and cover all the parts with protective products. When drilling is completed wash, grease and keep the machine duly protected from rust.

TECHNICAL VOCABULARY

COULTER = Furrow opener
CUT-OFF = Blanking plate

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: ( )
Level: 2
Subject: 1.5-41 1.5-53

The furrow markers leave guidelines on the land during the operation. These guidelines allow the operator to drive the tractor in the next run, parallel to the previous furrows. In this manner a constant distance between consecutive runs is maintained.

The markers are adjusted in such a manner that by following the guideline which they leave, the tractor can be driven taking as a reference the front or rear wheels or the centre of the tractor.

STRUCTURE

Markers consist of the following parts: (Fig. 1).

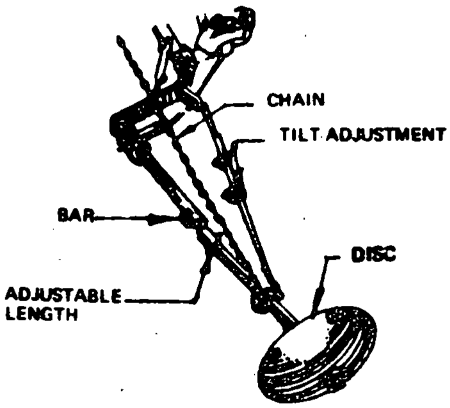


Fig. 1

POSITION OF THE MARKERS DURING OPERATION

During transportation (Fig. 2) (the drill is not working) the markers are lifted. This is done by means of hinges. Different methods are used to keep them in that position.

In a working position (Fig. 3) the marker begins its operation once the coulter touches the land.

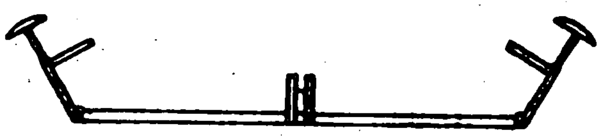


Fig. 2

Fig. 3

CHARACTERISTICS

The markers are of adjustable length. The purpose of this is to change the distances between furrows.

ADJUSTMENT OF THE MARKERS IN TWO-FURROW DRILLS

After placing the units of the drill on the toolbar at an equal distance from the centre of the tractor, the marker coulters should be placed in such a manner as to obtain accurate marking.

When returning, that is, in the next run, a wheel or the centre of the tractor will be placed on the furrow which has been marked by the marker coulter. Bear in mind that the distance from the centre of the tool-bar to the disc will be:

- Twice the distance between furrows if the centre of the tractor is used as reference (Fig. 4).

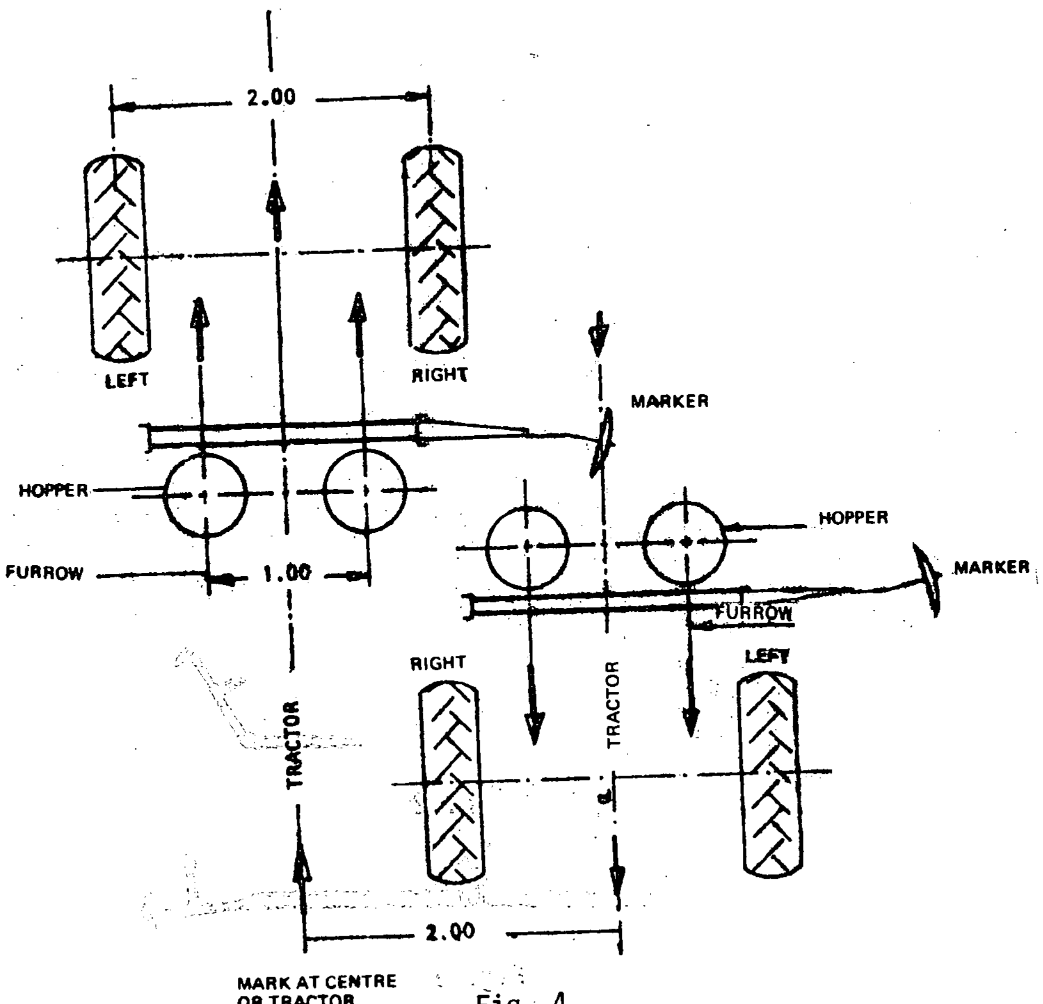


Fig. 4

- Three times the distance between furrows if one of the wheels is used as reference (Fig. 5).

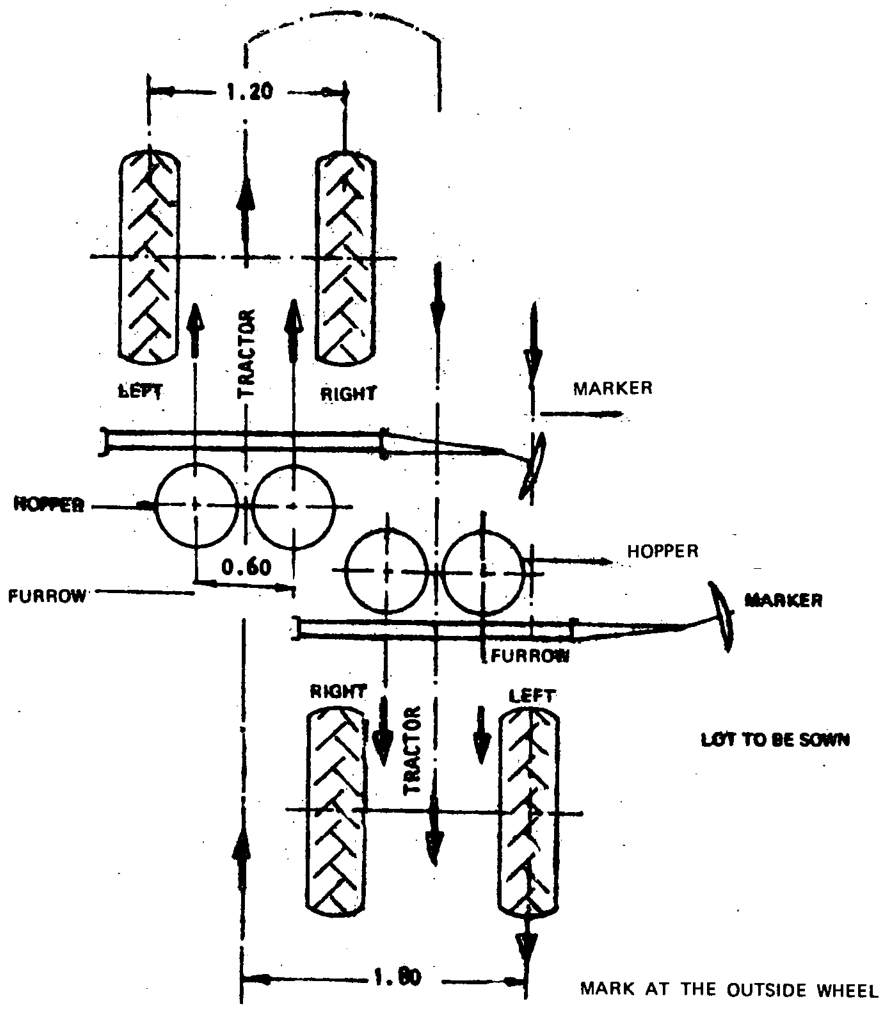


Fig. 5

MARKER ADJUSTMENT IN FOUR-UNIT DRILLS

The marker on these drills can be adjusted by the outer wheel, the inner wheel or the centre of the tractor according to the width of the furrow, bearing in mind the same conditions as for the two-unit machines.

Distance from the centre of the toolbar to the marker-coulter.

- For marking, the inner wheel should be at a distance equal to three times the distance between furrows (Fig. 6).

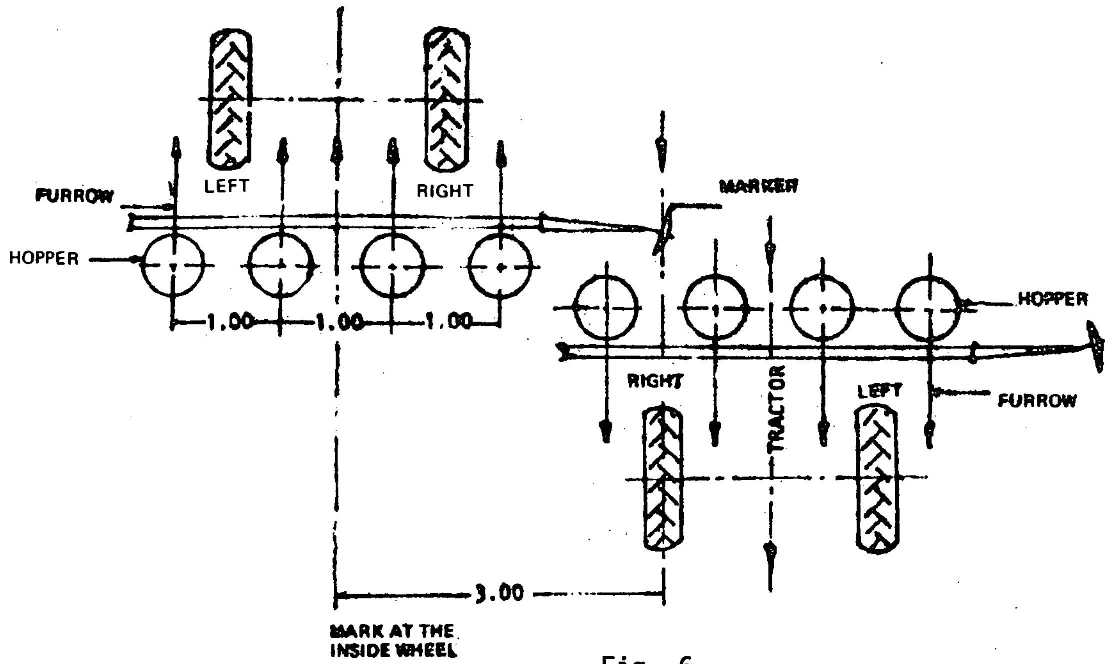


Fig. 6

- For marking, the centre of the tractor should be at a distance equal to four times the distance between furrows (Fig. 7).

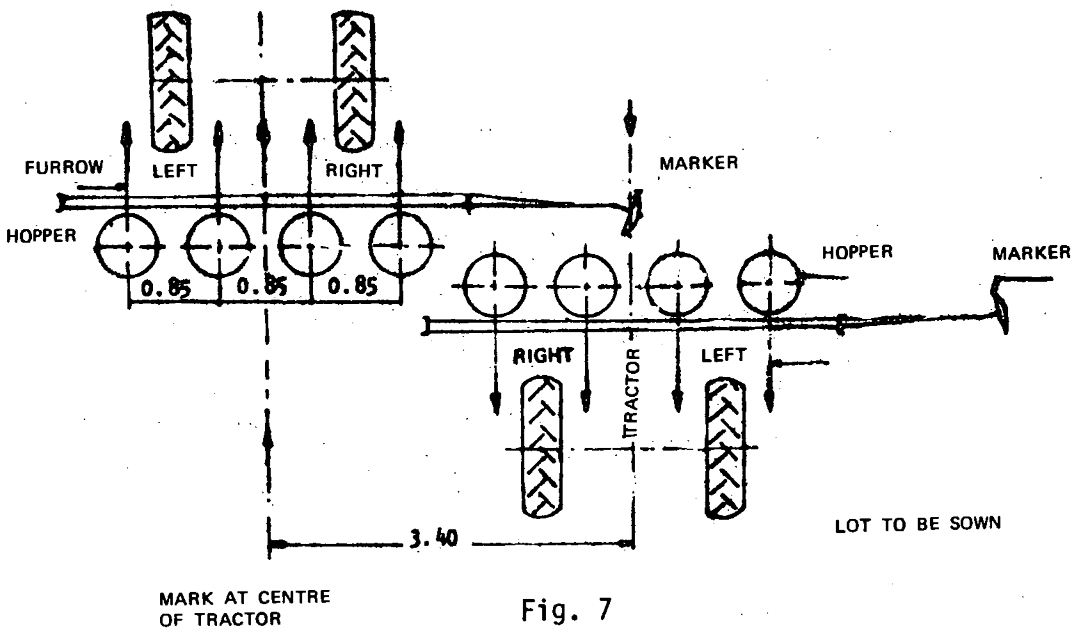


Fig. 7

- For marking, the outer wheel should be at a distance equal to five times the distance between furrows (Fig. 8).

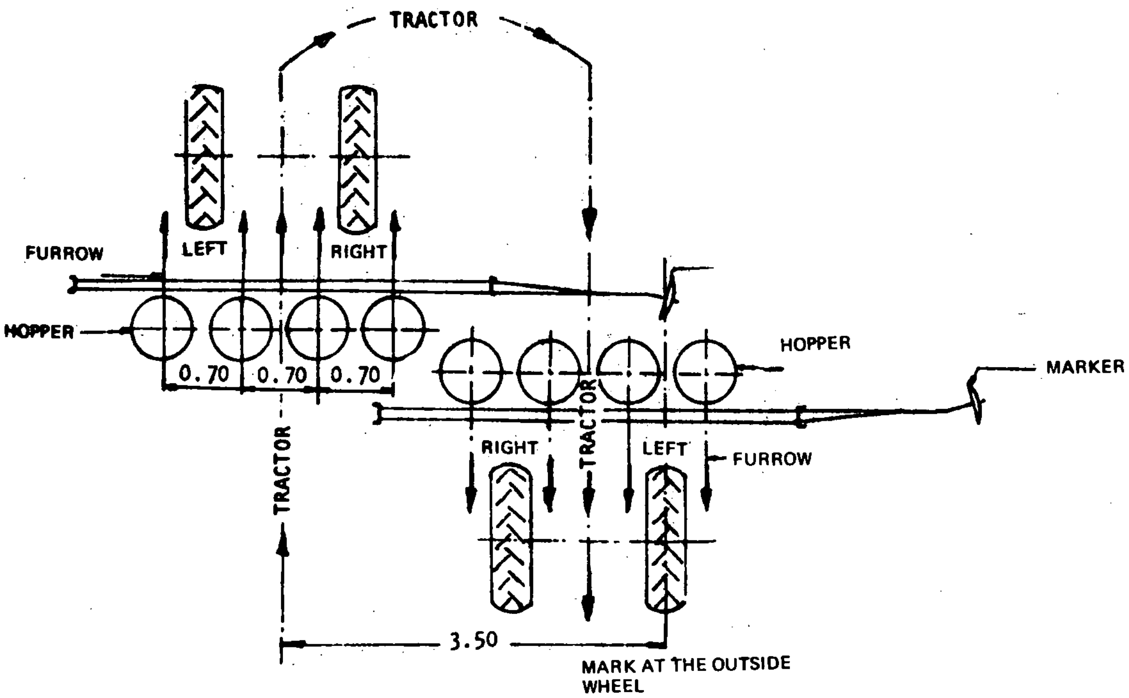


Fig. 8

These implements are used for sowing row crops with a uniform distance between rows. They differ from other in-line sowing machines in that, while placing the seed in uniformly separated furrows, they also distribute the seed in them at regular intervals whether individually or in small groups.

Sowing at uniform distances between seeds is called "placement" as against "broadcasting". The regular spacing in all directions between plants enables them to make a better use of sun energy and makes cultivation works easier.

DESCRIPTION

Row crop planters consist of a toolbar or frame on which one, two or more sowing units are mounted.

Each sowing unit consists of the following parts: (Fig. 1).

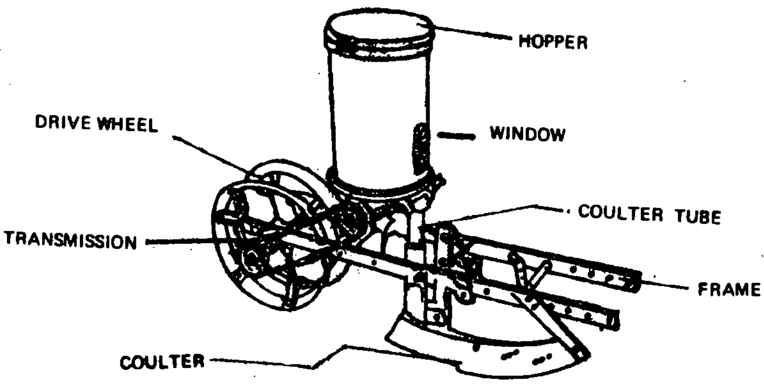


Fig. 1

FRAME. This is the main structural part. It is supported by wheels.

HOPPER. It is made of steel sheet or plastic material. It can be mounted on the coulters or on the frame. It has a window which allows the operator to see the seed level inside the container.

FEEDING. (Fig. 2) It consists of a moving part with cells the size of which are such as to take individual seeds or groups of the same number.

The horizontal seed plate is a very common device. Its cells may be on the periphery with an open outer rim, or have inside round or oval holes which are used for different size seeds (corn, sunflower, etc.) or varieties.

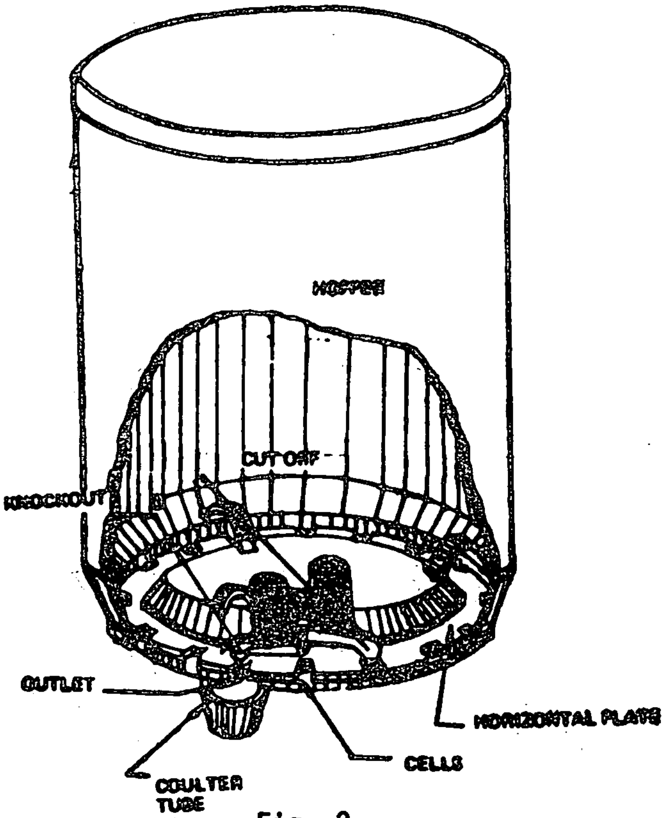


Fig. 2

A large assortment of seed plates is supplied with each machine to satisfy the requirements of many types of seeds.

These machines usually have a plate without cells which is called a blind plate. The holes can be bored when different spacings or special sizes are desired. The knock-out, the cut-off, the spring and the outlet complete the number of parts which make up this device.

DISCHARGE TUBES. These depend on the position of the container. When they are on the coulter the tubes are short and have the advantage of reducing friction and bouncing of seeds inside them. If the container is situated on the frame, flexible or telescopic discharge tubes are used to connect the hopper to the coulter.

COULTERS. These are usually share or suffolk-type and their purpose is to open the furrow in which the seed falls.

SEED COVERERS. These usually consist of concave press wheels. Sometimes these wheels control the depth and supply movement to all the distribution system by means of a chain transmission. When used for covering they can work together with covering discs.

OPERATION

The propelling and press wheel turns when in contact with the soil and the machine is towed by the tractor, producing the movement required by the planter. This movement is transmitted to the ring of the lower plate by means of a set of sprockets and chains. When this plate turns it carries the seed plate with it.

The seed which is in the hopper or container gets into the holes or cells of the plate. When the wheel turns, it takes them to the outlet where they are ejected to the soil after passing through the discharge tube.

OBSERVATION

Most of these planters have fertilizing equipment which work simultaneously with the planter but are totally independent (Fig. 3). They usually spread fertilizer in a continuous band.

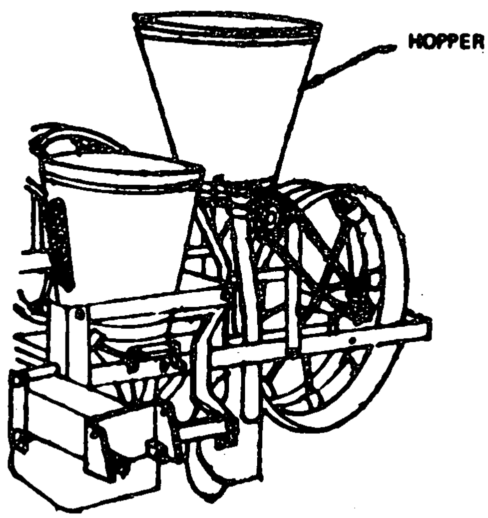


Fig. 3

ADJUSTMENT

Spacing of the seeds in a row.

This spacing is determined thus: the ratio of the speed of the seed plate to the speed at which the planter moves and to the distance between cells. The following relations have been established between these factors:

$$E = D.Rv \quad \text{and} \quad E = C/N.Rr;$$

E = Distance between seeds in a row in centimetres.
D = Distance between cells in centimetres.
Rv = Relation between the speed of the machine and the speed of the cell wheels in metres per second.
C = Circumference of the drive wheel in centimetres.
N = Circumference of the drive wheel in centimetres.
Rr = Relation between the revolutions of the drive wheel and the revolutions of the seed plate.

To obtain the proper distance between seeds the seed plate can be changed for another of a different number of cells.

The relationship between the speed of the drive wheel and the seed plate can also be changed. It can be done by using different pinions on the wheel axle and on the axle which moves the seed plate.

OBSERVATION

Because of the diversity of designs and trade marks, consult the operator's manual with respect to metering and adjustments.

TECHNICAL VOCABULARY

COULTER = Furrow Opener

This is a machine which is built with special characteristics for planting tubers. It performs different operations, such as opening furrows, dropping or placing seeds at regular intervals at the required depth, and uniformly covering the tubers with soil.

There are machines which work on one or several furrows simultaneously.

TYPES

Automatic. These are equipped with devices which take the seed and place it in the furrow.

Semi-automatic. These are also called assisted feed. They require an operator to place a seed in each segment of the dispenser wheel. In this case the speed of operation of the machine is limited by the capacity of the helper to feed the dispenser wheel of the planter. It also depends on the distance between plants in the same row.

A good planter should plant accurately and uniformly with respect to the distance between plants and depth.

It is necessary to keep the mechanism of the machine from damaging the seed. Blows, cuts or bruises will cause poor shoots or favour the transmission of disease (Fig. 1).

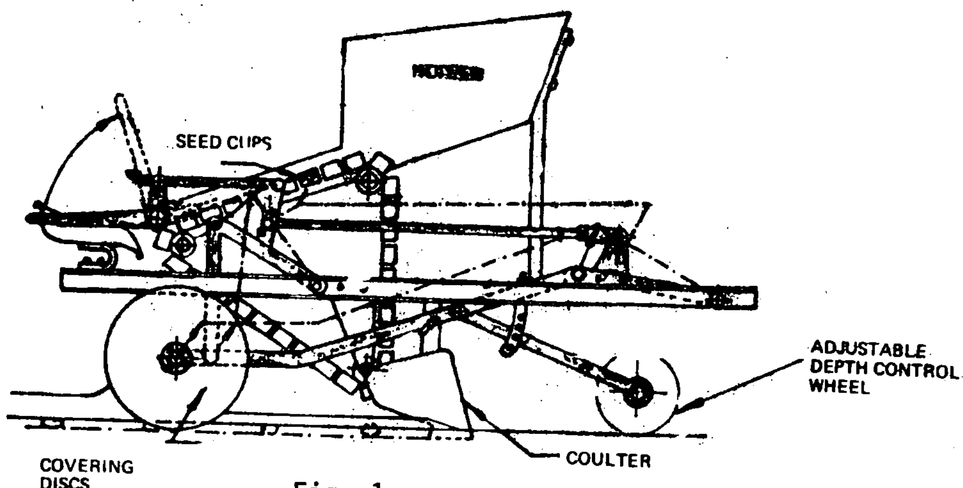


Fig. 1

DESCRIPTION AND PARTS

Furrow markers. This traces a guide line for the following furrows.

Furrow opener. This opens a small furrow in which seeds are placed.

Hopper and seed distribution mechanism. A large quantity of seed per hectare (1 to 3 tons) is usually planted. Therefore, the hopper should be of sufficient size to hold a large quantity of seeds.

Accuracy in obtaining uniform distance in the row depends on the seed-dropping mechanism.

With horizontal dispenser wheel (Fig. 2).

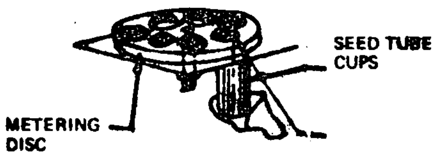


Fig. 2

System with chain elevator and containers or pockets for the seed (See Fig. 1).

System with vertical dispenser wheel (Fig. 3).

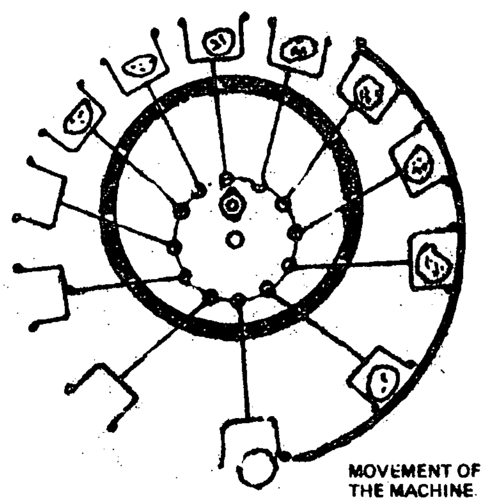


Fig. 3

Device for covering the seed. This covers the seed once it has been placed in the furrow. It usually consists of two discs which form an angle with the direction of travel.

Frame. All the main parts of the machine, including the control and movement of the transmission system, are mounted on it.

ACCESSORIES

The added device for the distribution of fertilizers is usually supplied as an accessory. It consists of a hopper, metering mechanism, and distributors independent of those for planting the product.

OBSERVATION
The fertilizer products should not get in contact with the tubers unless it is expressly stated that they are safe for the shoot.

ADJUSTMENT

Potato planters have different systems for metering the amount of seed per hectare. In some cases it is metered by increasing the relative speed of the feeder with respect to the speed at which the machine moves. This is obtained by changing gears.

In other machines, outlet tubes are opened or closed, or cups (or pockets) are removed.

Read the operator's manual pertaining to your machine.

The planting depth is controlled by means of regulating skids or wheels.

Lengthwise levelling in trailed machines, which are the most common, is done by lifting or lowering the coupling of the drawbar of the machine with respect to the drawbar of the tractor.

The angle of the covering discs can be changed in order to make their work suitable to each type of seedbed.

Once the crop germinates it is necessary to carry out operations, such as moving the soil around the plant, loosening and weeding it. These operations also conserve moisture and make the penetration of air into the root area easier, even when they do not go deep. By increasing gaseous exchange microbial life processes are stimulated.

TYPES

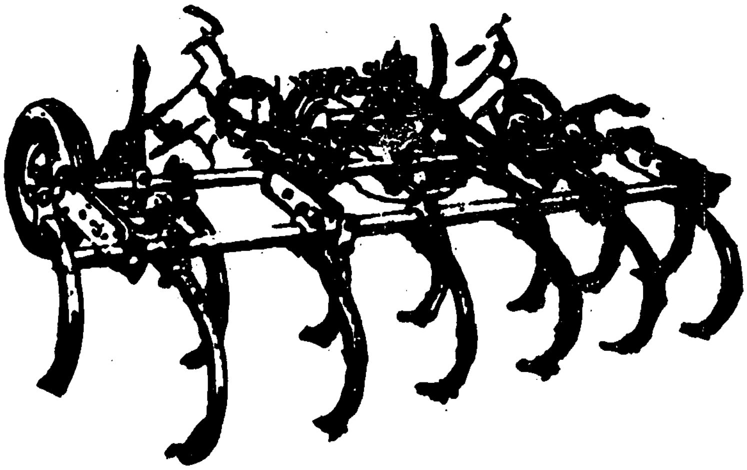
The types of cultivators on the market vary greatly. In some cases they are only local because they are adaptations of the farmer to suit the type of soil and crop of the region.

According to the form of hitching they are classified as:

Integral-mounted cultivators. These are coupled to the front or rear of the tractor.

Trailed cultivators. These are coupled to the drawbar of the tractor and run on their own wheels.

Some types are used for row cultivation as well as for tilling and mulching the soil before sowing. Thus, they are classified as cultivators and tine harrows (Fig. 1).



CULTIVATOR MOUNTED ON TOOL BAR

Fig. 1

DESCRIPTION AND PARTS

Figure 2 shows the elements of a front-mounted cultivator.

Frame. The frame is fixed to the body and supports the oscillating arms which lift the weeding elements, shares or discs. There are three types of frames depending on whether the implement is:

- front-mounted,
- rear-mounted,
- trailed.

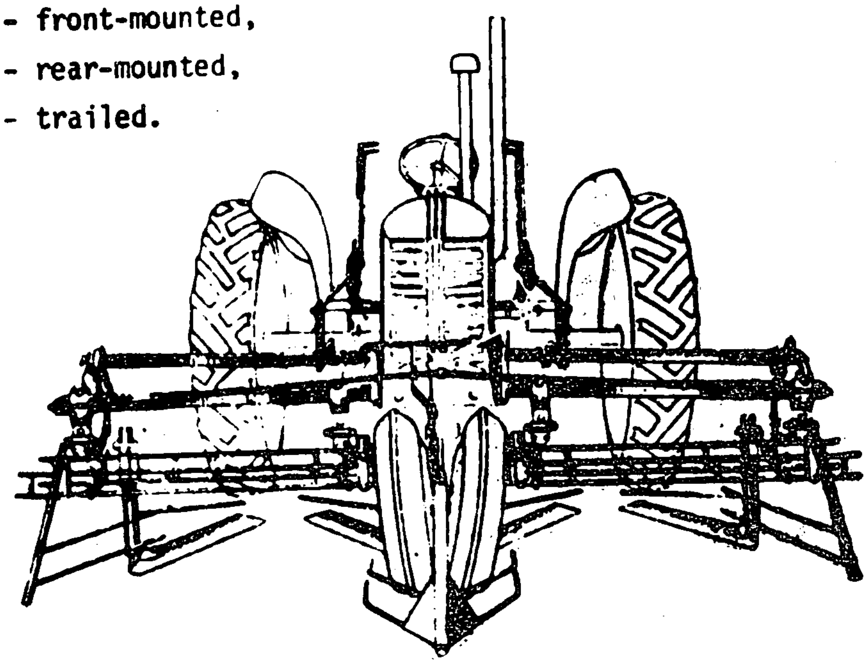


Fig. 2

Front framework. This is the support for the gangs and for the implement in general.

Depth control wheel. This allows the adjustment of the working depth.

Tubular supports. These are of different sizes and they support the standards which carry the weeding hoes.

CLASSIFICATION OF CULTIVATOR TOOLS

Depending on their form and function, cultivator tools (or simply weeding hoes) are classified as:

Weeding hoes. These work under a surface layer of earth, cutting the weed which hinders the free development of the crop. Their position can be adjusted with respect to each row of plants. Each weeding hoe has a spring and a mechanism which is worked by the spring. These make the weeding hoe trip when it meets an obstacle, thus keeping it from breaking.

Weeding hoes have a standard, rings, point and wings and a safety trip mechanism (Fig. 3).

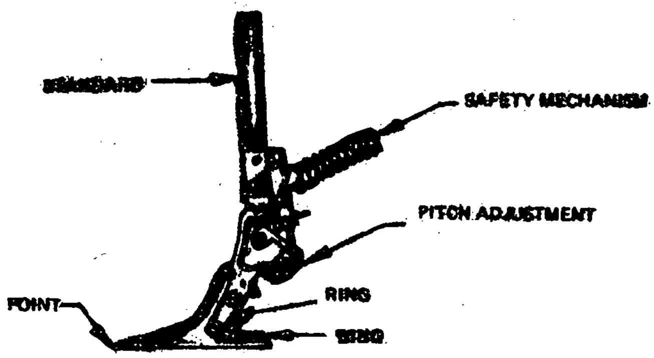


Fig. 3

Depending on their shape and the work they do, weeding hoes are classified as:

Shovels. These have no wings and they are called:

- *Harpoon point.* These are for working on seedbeds and flat lands. The soil runs over the point without piling up (Fig. 4).
- *Irrigating.* These are wide and have wings as mouldboards (Fig. 5).

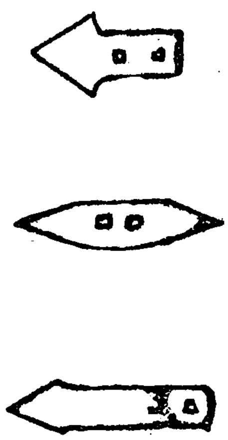


Fig. 4

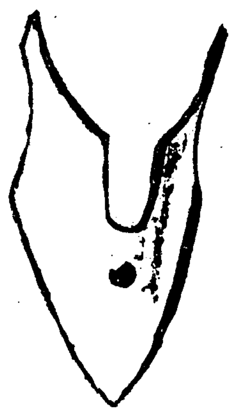


Fig. 5

- *Spear point.* This is like the harpoon point, but it is adapted for use on the spring loaded supports.
- *Chisel point.* This is used for working on closer and deeper crops. Because of its narrow and wingless form it does not throw earth on the plants.

There are cultivators which have discs instead of weeding hoes. They remove soil from the sides of plants. They are also used for hilling (Fig. 6).

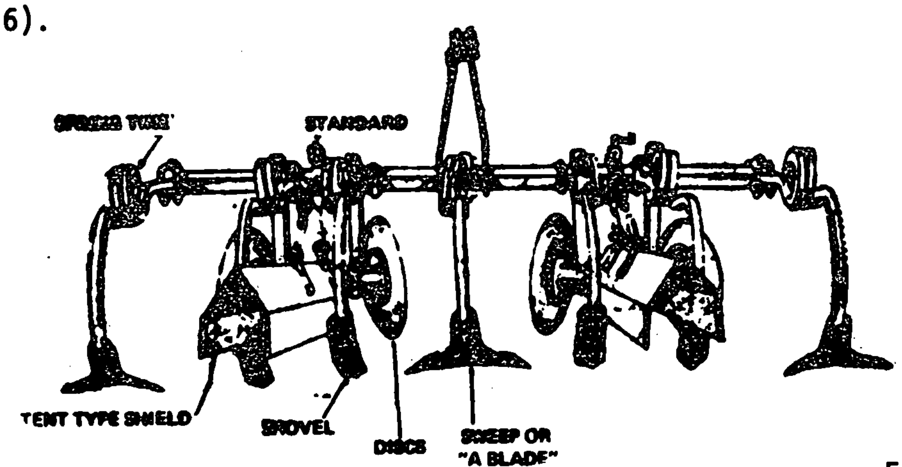


Fig. 6

They work better on heavy lands and on soils which stick to the implement because the discs have mud scrapers.

Standards. These connect the weeding hoes to the supports. They can be long, medium or short.

A toolbar is generally used, to which different implements are hitched (cultivators, furrowers, ridgers, trenchers and others).

There are cultivators which have 2 or 3 bars. This enables a better distribution of the weeding hoes on them.

ADJUSTMENT

When adjusting cultivators, bear in mind the following:

- the distance between furrows and the characteristics of the root formation of the plant,

- the inclination of the blades with respect to the soil,
- the depth of the root system of the plant to determine the working depth.

Distance between furrows. The great importance of the accuracy with which the sowing process was carried out can be seen when the cultivation work is being done. Two cases can occur. If we take a 4-row sowing machine which embraces 3 in-between row spaces as a basis:

- all distances between furrows are equal,
- the distances between furrows are equal by intervals of three furrows because the marker was wrongly adjusted or because there was no marker.

The first action to take is to measure the distances between furrows on the field, at least at 10 or 12 places.

When all distances between furrows are equal: To adjust the cultivator, a diagram is made on the ground, in which the furrows are at their true distances. Once the diagram is made, we adjust the cultivator, which has been previously placed on the diagram, following the indications in the figure. Bear in mind that if hilling discs are used they should be placed at a given distance from the foot of the plants (approximately 32 centimetres from the furrows).

When the distances between furrows are equal by intervals of three: This case is similar to the former but when operating remember to allow the tractor to enter with the front wheels of the tricycle on the middle furrow of the three having equal measurements. If it is not a tricycle, the centre-line of the tractor will pass through the previously indicated furrows.

The blades which pass by the middle of the in-between row space should be carefully adjusted because they serve as a guide for the wheels of the tractor in subsequent works. If the guide line is well traced, the output in the following cultivation works is greater and the handling of the tractor very easy.

Inclination of the blades with respect to the soil. Bear in mind the following: all blades should be uniform and have a suitable working angle. Consult the operator's manual.

It is necessary to make these adjustments on firm and level ground.

Working depth. This adjustment is also made on a firm ground in order to have a constant point of reference. The most common system for adjusting the depth is to place the part of the cultivator (skids or wheels) which control the depth on a board the thickness of which is equal to the desired depth. When the structure of the cultivator is a rigid one the tractor should be lifted. If it has depth control wheels, each of these should be lifted and placed on boards of the same thickness.

In disc cultivators or when using hilling devices the depth is determined by the angle given to the discs. The greater the angle with respect to the direction of travel, the greater the depth.

To make these adjustments consult the operator's manual.

ACCESSORIES

Down-the-row thinner

When the hoe blades pass over the furrows they till around the plant and mulch the soil. When they revolve fast the hoe blades up-root the weeds. It can be made to work at speeds of 10-15 kilometres per hour.

These are used for scarifying before the plant growth is too advanced. If the direction of rotation is reversed, they can be used as seed coverers.

Rotating guard

This guard (it is optional) rotates on the soil without dragging along fallen leaves or thrash. It removes large clods of earth while the pulverized soil passes through the guide and falls around the plants.

Fertilizing device

The same fertilizing devices used by the sowing machines are often used by the cultivators. For this it is necessary to have a drive wheel or a gear on the tractor in order to propel the distributor.

Other devices used are the gaseous nitrogen applicators.

OPERATION

For operating correctly, the operator should remember that:

- the weeding hoes should be adjusted and distributed on the toolbar in such a manner that they cover the total width of the furrow.
- During the first operations the plants have small roots that do not extend too much, thus allowing deeper work than during the subsequent operations.
- As the plants grow their roots extend. Thus cultivation work becomes more superficial.
- Lift the cultivator when you reach the end of the furrow.
- Sheet guards are used to keep the plants from being covered by soil pushed toward the furrow.
- Different types of weeding hoes can be combined depending on the work to be done.
- To make turning easy make alternate runs on the field. In this manner the turning radius increases.
- Always place a weeding hoe behind the wheels of the tractor to loosen the trodden and compacted soil.

MAINTENANCE

- Protect the weeding hoes and discs from rust during the storage period.
- Tighten nuts and bolts.
- Replace and repair damaged parts.
- Overall greasing.

OBSERVATION

Consult the operator's manual.

These consist of a tank or reservoir for the product, with an agitator which makes the mixing of the liquid easier, a pump with a pressure-regulating valve, hoses, tubings, one or more booms with nozzles and/or one or more spraying guns.

Figure 1 shows a simplified outline with the main component.

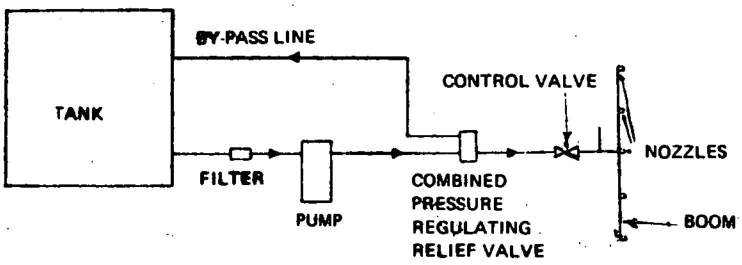


Fig. 1

TANK

These tanks vary in size, from 200 to 2000 litres, depending on the type of application, the range of the boom and the distance to travel for refilling with product.

These machines can be used for applying many different types of material: powders dissolved or in suspension, oils or emulsions. These materials are often corrosive and/or abrasive. The tank should be of a material resistant to them.

AGITATOR

Insoluble powder suspension and emulsion require mixing systems inside the tank. Mechanical as well as hydraulic agitators are used to obtain a good mixture.

Mechanical mixing

It is done by means of paddles mounted on a shaft arranged lengthwise to the tank and near the bottom. It revolves at a speed of 100 to 200 rpm. A higher speed could cause foam or an unsuitable mixture (Fig. 2).

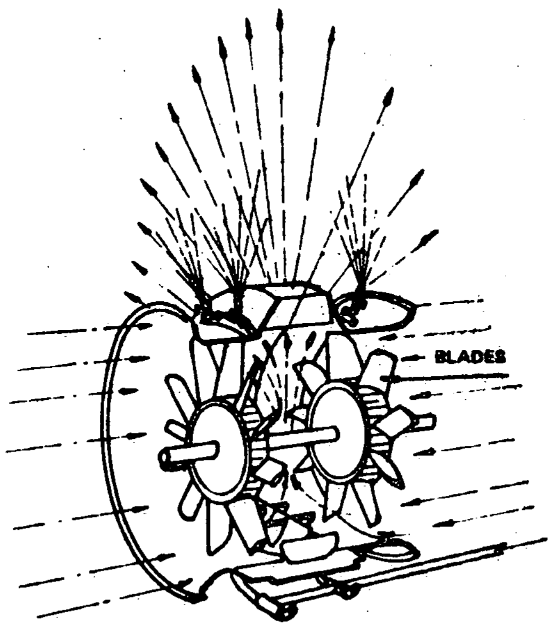


Fig. 2

Hydraulic mixing

It is usually done by the return of part of the liquid discharged by the pump through a series of holes or nozzles which are arranged on a pipe at the bottom of the tank. The main advantage is its simplicity. The pump should have a greater discharging capacity than that required for the application

PUMPS

Different types of pumps are used in spraying and misting machines. These can be classified as piston, gear, rotary and centrifugal.

Figure 3 shows a *piston pump* which basically consists of cylinder, piston and valves.

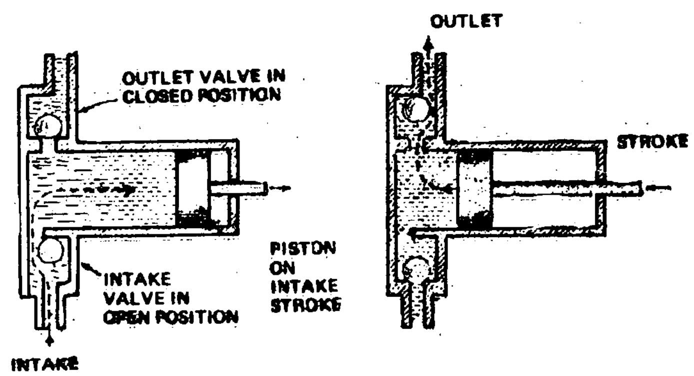


Fig. 3

Figure 4 shows a *gear pump*. These are seldom used in large machines.

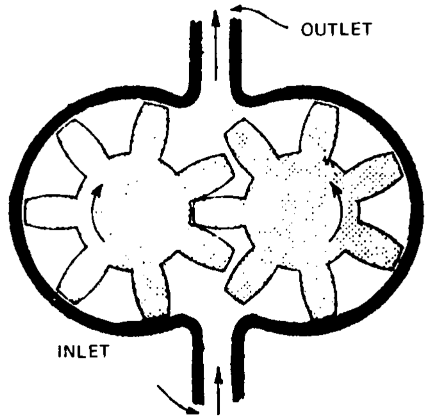


Fig. 4

Figure 5 shows a section of a *roller vane pump*.

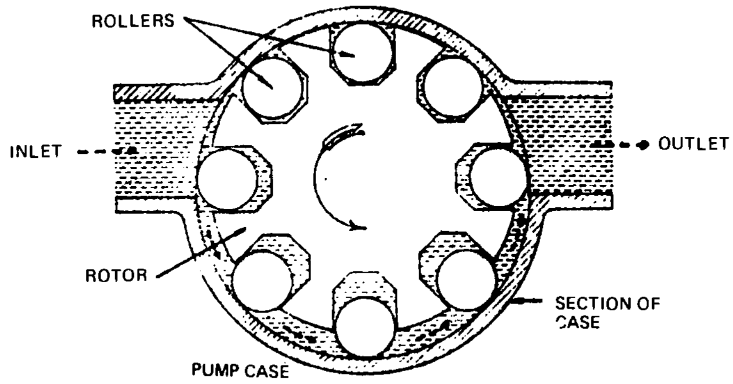


Fig. 5

Figure 6 shows the diagram of a *centrifugal pump*.

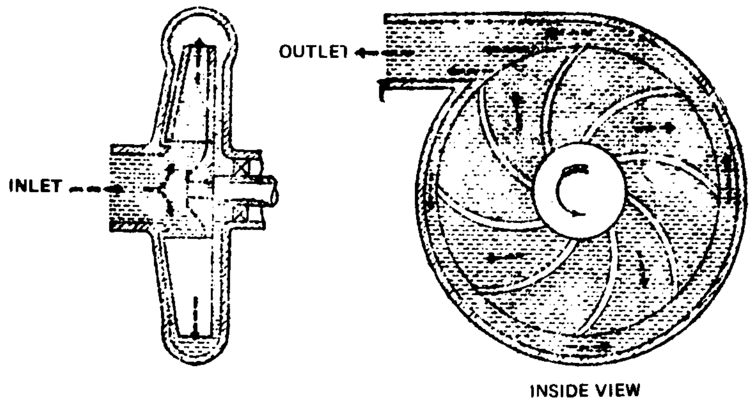


Fig. 6

The capacity required in pumps for sprayers mainly depends on the width of boom, the speed of the tractor and the maximum amount of liquid to be applied per hectare.

PRESSURE REGULATING DEVICES

These are required to maintain a given pressure at the outlet of the pump and to protect the equipment in case the outlet is closed or clogged if the pump in question has a positive displacement (Fig. 7).
The pressure is read on a gauge connected to the delivery line to the boom.

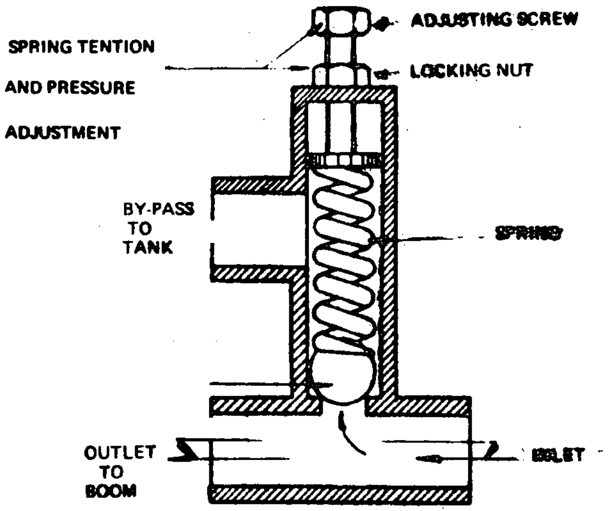


Fig. 7

ATOMIZING DEVICES

The atomizing devices in sprayers depend in general on the pressure of the liquid.

The most commonly used nozzles are of the conical and/or fan type.

Conical-type nozzles (Fig. 8).

The liquid is fed to a chamber to create turbulence through a lateral-tangential inlet passage or through spiral-form fixed passages made through discs or bodies inserted in a special manner. These passages cause the liquid to swirl. The hole is on the axis of the chamber in order to form the whirlpool. The liquid comes out forming a hollow or solid cone which later breaks down into droplets.

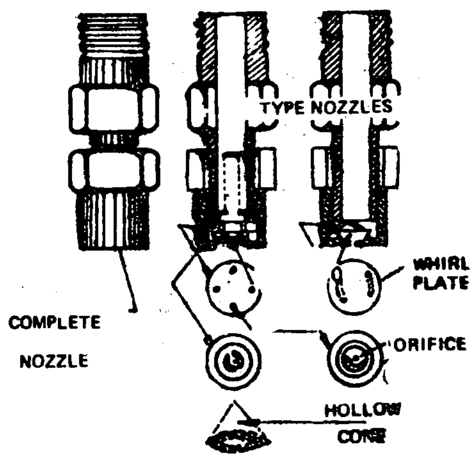


Fig. 8

High pressure sprayers (guns) used for spraying trees are of the adjustable type.

Fan-type nozzle (Fig. 9)

The liquid is atomized in the form of a flat fan. This form is obtained by means of a section or channel, cut through the outer face of the disc which has the outlet hole.

OBSERVATION

The fan type nozzles are only used for atomizing with low volume and pressure.

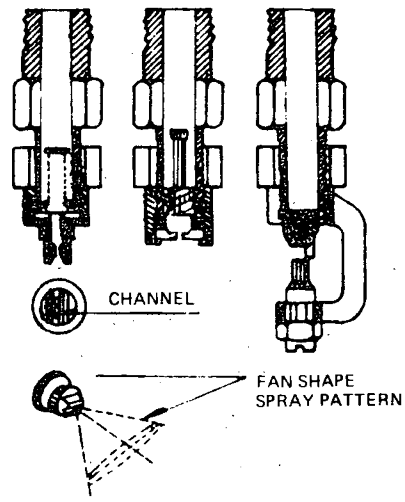


Fig. 9

TYPES OF SPRAYERS

There is a wide range of sprayers ranging from the small ones carried by a man on his back or shoulder, the handcart type sprayer, and the sprayers which are mounted on or towed by tractors and which have booms capable of covering 20 or more metres in width. Tractor-mounted sprayers are basically classified as follows:

LOW VOLUME SPRAYE⁻S (Fig. 10)

Thr capacity of the tanks vary from 200 to 400 litres depending on the length of the boom and the amount to be applied per hectare

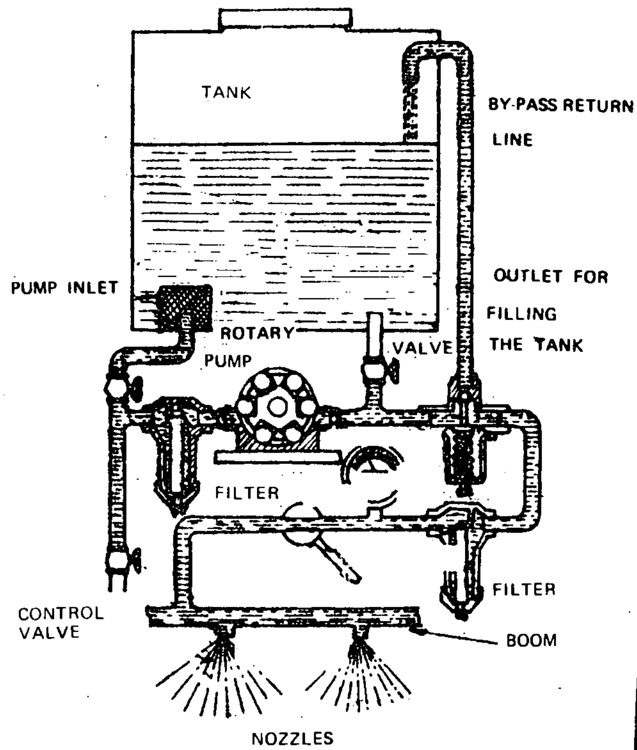


Fig. 10

Rotary pumps are widely used in low-volume sprayers. The liquid is pumped from the tank and discharged into the boom under pressure of 2 or 4 atmospheres. A pressure regulator with a gauge is connected to the delivery line to the boom. The width of the boom varies from 8 to 12 metres (Fig. 11).

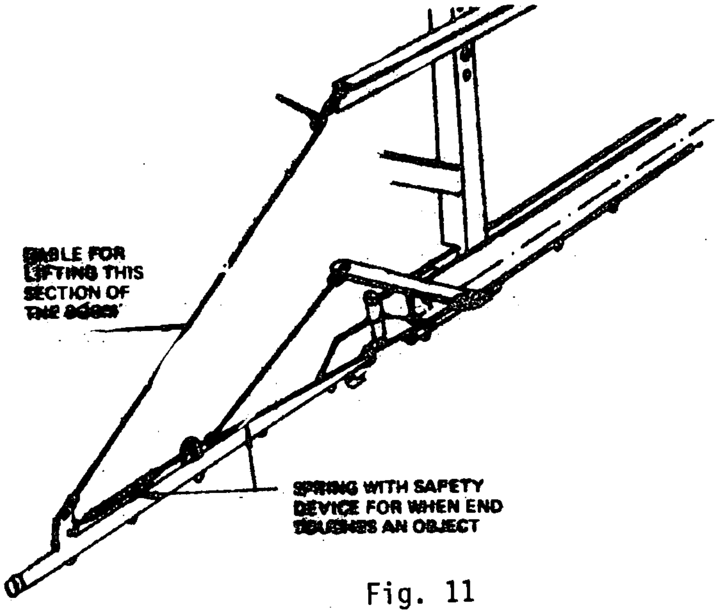


Fig. 11

HIGH-VOLUME SPRAYING (Fig. 12)

These are usually coupled to the drawbar of the tractor. They are mounted on two wheels and carry a tank of varying capacity (400 to 1500 litres).
Most of them are equipped with piston pumps and some with high-speed centrifugal pumps. In the case of pumps with positive displacement, such as piston pumps, the pressure varies from 4 to 40 atmospheres. With centrifugal type pumps very high pressures cannot be obtained.

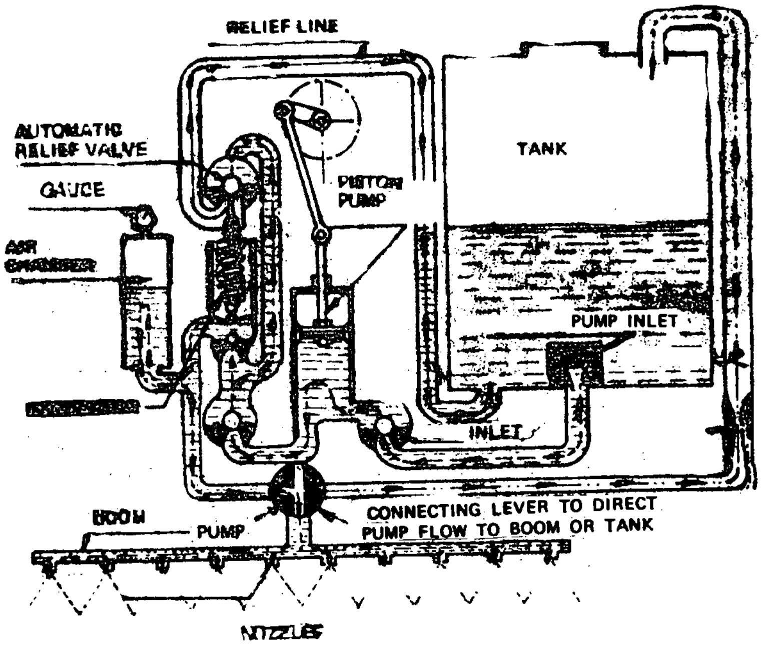


Fig. 12

In piston pumps an automatic relief valve and a regulator are essential to avoid damage to the equipment caused by excess pressure. To avoid irregular changes in pressure and to keep it uniform, there is an air chamber on the delivery side of the pump. The pump can be often used to refill the tank.

The width of the boom in high-pressure sprayers varies from 12 to 24 or more metres in length (Fig. 13).

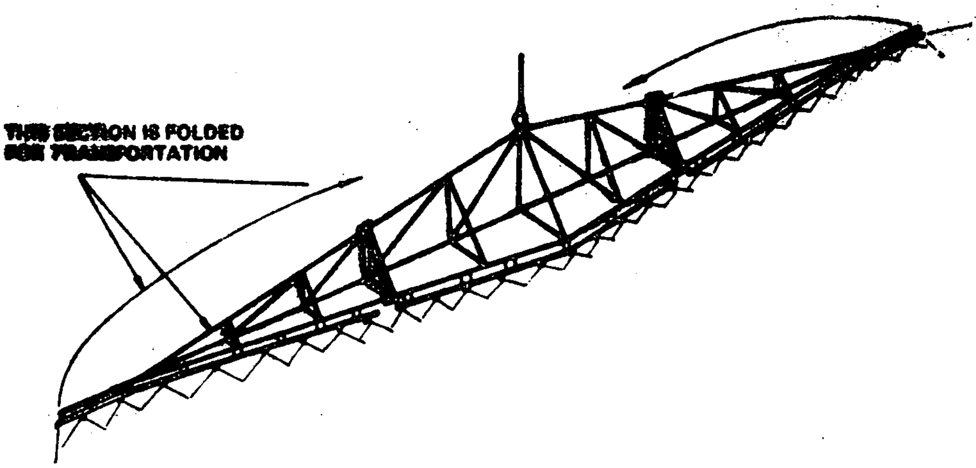


Fig.13

MIST BLOWERS

These consist of the following parts: a tank with an agitator, a pump with a pressure-regulating valve, hoses and pipes, an atomizing head at the air outlet of the blower and the blower.

These machines use a current of air to transport the drops of liquid. Therefore, these drops can be smaller. Their sizes vary from 75 to 100 microns, that is, the atomization is such that the product is applied as a mist.

TECHNICAL VOCABULARY

MIST BLOWER = Atomizer

These machines are used for the distribution of phyto-sanitary products in powdered form. They use a current of air to apply the powder which is suspended in it. It falls as a thin layer on the leaf surface.

STRUCTURE

Crop dusters consist of, hopper, feeding mechanism and blower nozzles (Fig. 1).

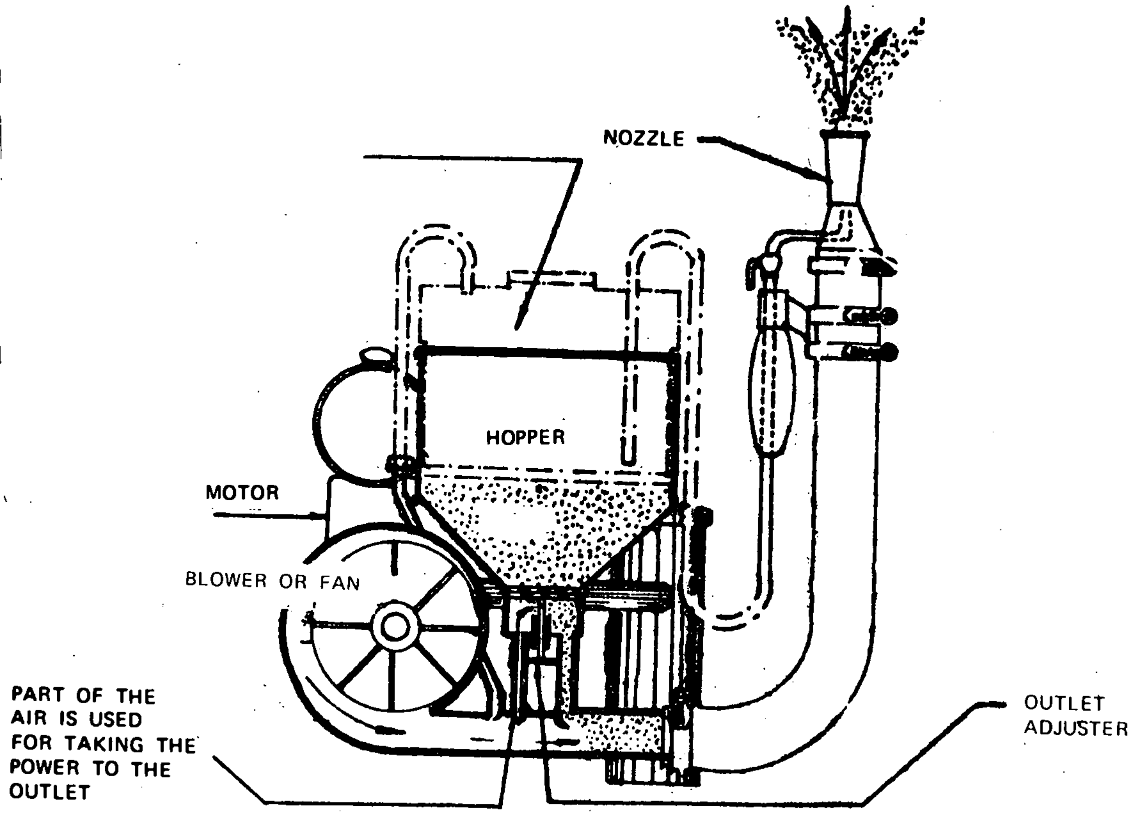


Fig. 1

The hopper consists of a metal or plastic tank, on the bottom of which a feeding and metering device is mounted.

CONVENTIONAL FEEDING AND METERING MECHANISM

It consists of an adjustable gate situated on the bottom of the hopper, which meters the amount of powder that reaches the outlet of the fan, and an agitator situated at the top. This agitator forces the powder out through the gate and keeps it moving, keeping it from forming lumps or sticking. With this system, feeding is somewhat uneven.

There is another system which offers a more uniform feeding. It consists of an auger conveyor which carries the material to the blower.

FAN

Several types can be used. Among these are the centrifugal type with multiple vanes, arranged radially, and the impelling or flow type arranged axially.

The trend is towards the use of high volume fans. These can discharge large volumes of air at lower speeds, compared to those previously used. The volume of discharge in large machines may reach up to 900 m^3 per minute at speeds up to 130 kilometres per hour.

DISCHARGE EQUIPMENT

It may have one discharge-nozzle, multiple ones, or a hollow boom. The units having multiple discharge-nozzles for row crops have a group of hoses or flexible tubes connected to a multiple distributor or to outlets situated on the rim of the blower box.

The discharge nozzles are distributed along the boom. They are placed as near to the plants as possible and as is practical. To obtain a uniform discharge through the different nozzles it is necessary that the hoses have approximately the same length.

Hollow booms with 7 to 14 cm in diameter are used in row crops to carry the powder and distribute it through openings spaced appropriately.

Long booms consist of several shorter ones or sections. The blower discharges the powder in each section individually.

ADVANTAGES AND DISADVANTAGES OF CROP DUSTERS

The advantages are:

- Water is not used, thus a substantial saving in transportation costs is realised.

-The treatment is carried out quickly, as compared with sprayers.
-The efficiency of certain types of material is better when they are in powder form.

The disadvantages are:

- Little adherence, and therefore, the powder does not last long on the plants.
- Difficult or impossible to apply material when there are strong winds.
- Certain materials which are toxic to man or domestic animals demand too careful application and may be risky.

WARNING

IN CASE OF POISONING FOLLOW THE INSTRUCTIONS ON THE PACKAGE CONTAINING THE MATERIAL AND CONSULT A DOCTOR.

OBSERVATION

Adjustments should be done following recommendations. An uneven distribution will not reach the expected goals. If more product than advised is applied, it will be expensive. If less product than advised is applied, the control will not be effective.

MAINTENANCE

Washing the machine is very important. No residues of the product should remain, mainly if it is to be used for application of another material.

Lubricate moving parts. Adjust the tension of the belts and/or chains. Tighten nuts and bolts.

These machines are built for the mechanical harvesting of potatoes and to reduce the usual waste which occurs when the ordinary plough or manual methods are used.

They are attached to the tractor drawbar and generally operated by the power-take-off shaft.

TYPES

There are two common types: angular bed and level bed. The latter may be a double bed (Fig. 1).

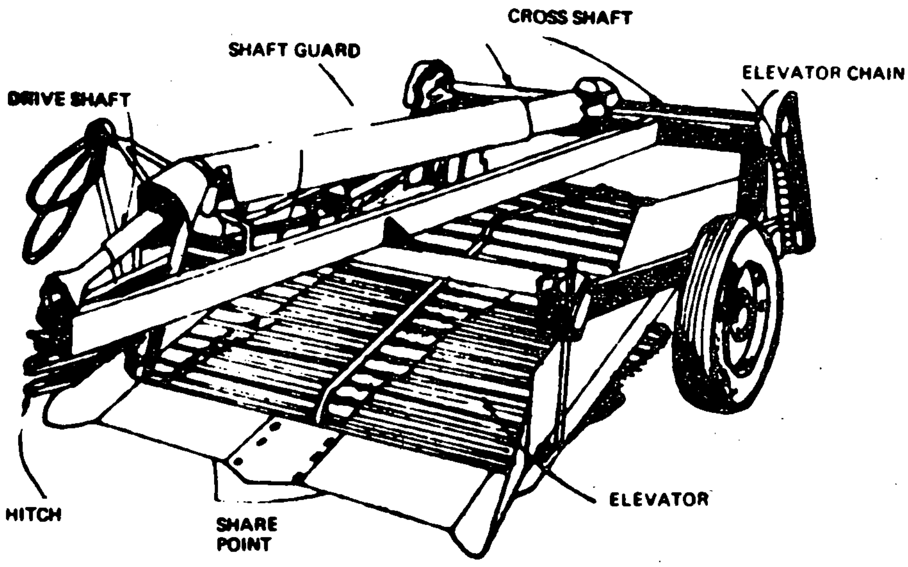


Fig. 1

This type of harvester is adapted to light sandy soils and is capable of working with dense vegetation. In it a single shovel harvests two rows, passing vegetation, earth and potatoes through the double elevator.

OPERATION

The wide steel shovel goes under the plants lifting and taking them to the elevator together with soil and other vegetation. The working depth is adjusted in such a manner that the implement passes under all the tubers without cutting or leaving them.

The elevator is an endless chain which moves towards the rear of the machine. The loose earth falls through the elevator assisted by its agitation.

This movement can be increased or reduced, depending on the condition of the soil, by changing the sprocket and pinions which control the agitation.

The shovel is lifted or lowered by a mechanical lever or by a remote control hydraulic cylinder.

A shielded drive shaft protected by a sliding clutch transmits the power of the tractor to operate the elevators and the separator mechanism. The wheels can be lifted or lowered. By adjusting it to the proper height better performance may be done. The looser the earth, the lower the wheels can go until the surface of the elevator is aligned with the share. On harder ground, they should be lifted until they form a step between the share and the elevator. This step helps to break-up the clods of earth.

Circular blades can be coupled to the bed, one at each side of the share to cut large stems and weeds. Its use reduces the volume of earth which the elevator has to discard and therefore, the weight of the machine. The task of previously cutting or pulling out the stems of the potato plant eases the harvesting job of the machine.

Modern potato diggers allow for a wide range of adjustments which enable them to adapt to the varying conditions which can arise in the field and they not only dig out potatoes, but also clean, select and pack them.

To adjust the implement consult the operator's manual.

MAINTENANCE

The potato digger does an efficient job where there is sand, lifting up tons of earth, leaves and potatoes. Under those conditions special attention should be given to lubrication.

The useful life of the machine will be extended and its work will be efficiently done if by periodic inspections, worn or broken parts are detected and replaced, and fastenings tightened regularly.

This machine is designed for cutting or mowing forage of certain characteristics, height and size which are to be used as animal feed. They are also used for keeping meadows and lawns clear of weeds.

CLASSIFICATION

They are built in different types and models to be towed or mounted on the tractor. There are also semi-mounted types. The integral-mounted ones may be:

- *front-mounted.* These go in front of the tractor. Figure 1 shows a walking garden type tractor operating a front-mounted mowing machine.

- *rear-mounted* and offset. It is so arranged to keep the tractor from running over the vegetation to be mowed (Figure 2).

- *centrally* mounted and offset. It is mounted between the front and rear wheels to make the view of the work easier for the tractor operator. Figure 3 shows a centrally mounted mower and its propeller shaft.

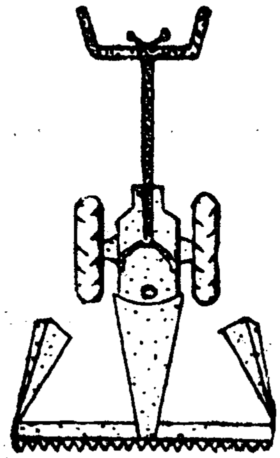


Fig. 1

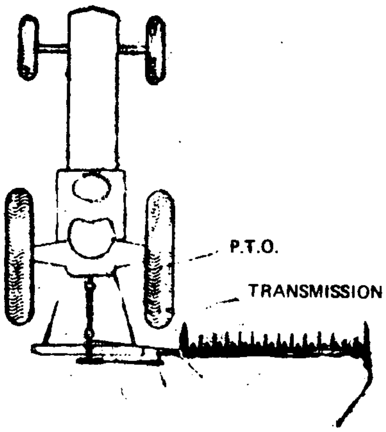


Fig. 2

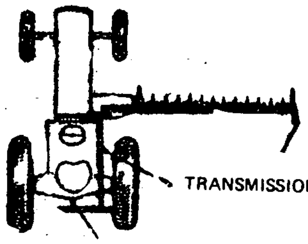


Fig. 3

DESCRIPTION

These machines consist of various parts which make up the transmission, cutting and adjusting mechanisms.

PROPELLER SHAFT

It transmits the movement from the power take-off shaft of the tractor, or of its own wheels in animal drawn machines, to the main pulley.

It consists of various elements shown in Figure 4. The drawbar of a trailed implement is also shown.

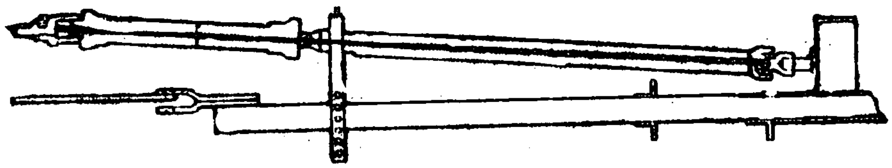


Fig. 4

MAIN PULLEY

It transmits the movement, by means of one or more "V" belts, to the eccentric mechanism which drives the connecting rod and the knife.

CONNECTING ROD

It is connected by one of its ends, called *foot*, to the flywheel. The other end carries the knife.

CUTTER BAR

It consists of several elements: steel bar, wear plates, fingers, knife sections, etc. Figure 5 shows them.

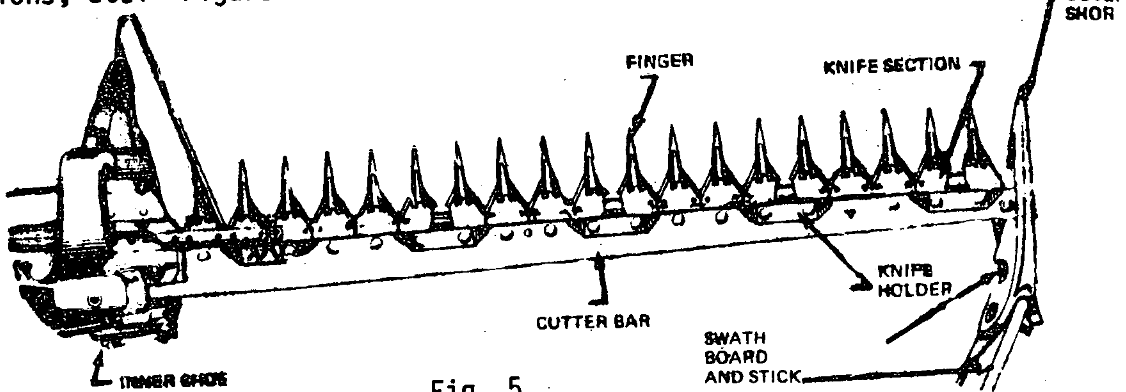


Fig. 5

The material is cut by the knife sections and ledger plates which are fixed to the fingers. Figure 6 shows a section of the cutter bar and its parts.

The movement of the knife is to and fro (reciprocating). The fingers separate and carry the material to the cutting elements which give scissors-like action.

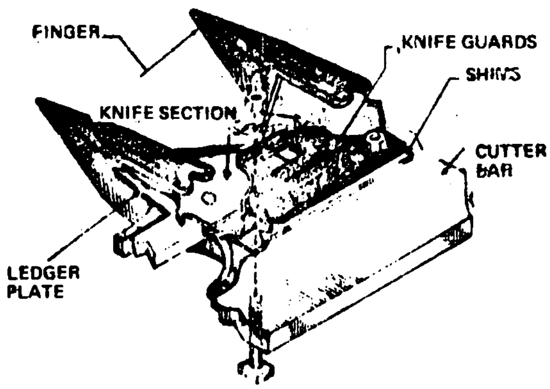


Fig. 6

SHOES

These protect the ends of the bar. The outer one also supports the free end of the cutting unit and carries the swathboard which separates the part to be cut from the standing crop.

PROPELLER SHAFT GUARD

This protects the operator from fractures which may occur on the shaft and also from the possible danger from a revolving element.

TILT ADJUSTMENT

It makes tilting the bar easier.

SWATH STICK

It is mounted on the outer shoe and it allows the operator to see the end of the bar while it also helps in putting together the mowed crop.

FINGERS

These are castings or steel parts which carry a trapezoidal plate called ledger plate which is riveted or welded at its centre. The ledger plate is made of hardened and tempered steel. Together with the section it serves for cutting the material (Fig. 7).

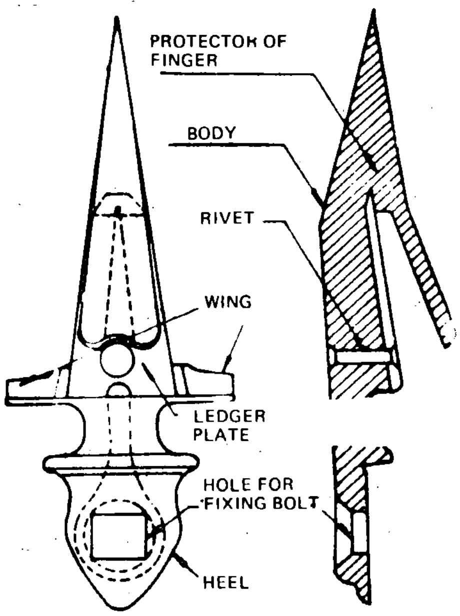


Fig. 7

Depending on the various types of material to be cut, different types of fingers are used, as shown in Figure 8.

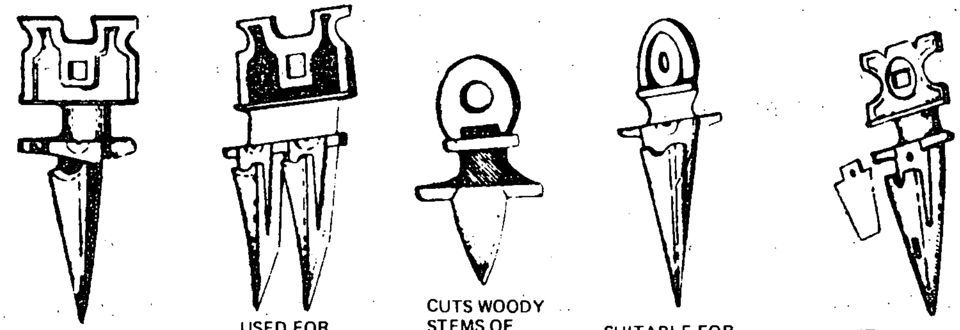


Fig. 8

When the forage is entangled the long fingers shown in Figure 9 are used. They lift the material and take it to the cutting elements. This type of finger is usually detachable. It may be mounted on the normal one.

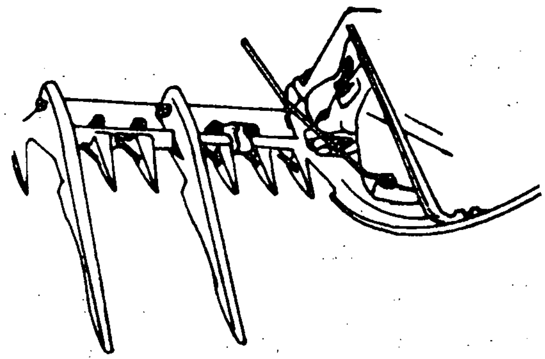


Fig. 9

When dealing with dry and hard material (strawy), serrated fingers are used. The material does not move forward because of the serrations. This makes for a clean cut.

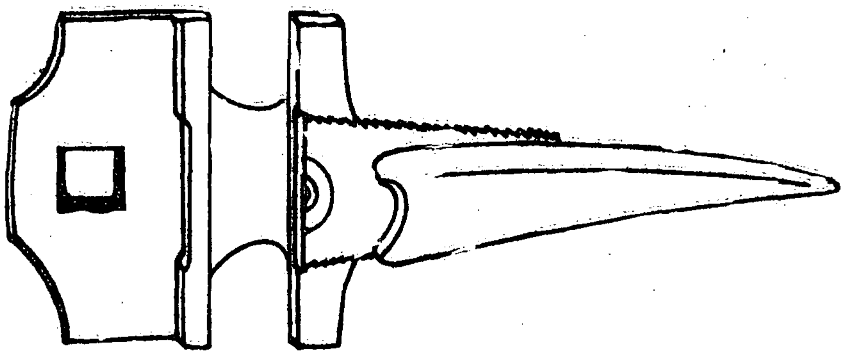


Fig. 10

OPERATION AND ADJUSTMENTS

The operation is similar in all types. The power take-off shaft gives the movement which is carried to the crank wheel by means of a drive shaft. The mechanism which causes the reciprocating movement of the blade is an eccentric flywheel. It consists of a drive pulley which is moved by the main pulley or directly by the drive shaft.

On the surface of this flywheel and off its centre there is a bolt which joins the connecting rod (Fig. 11).

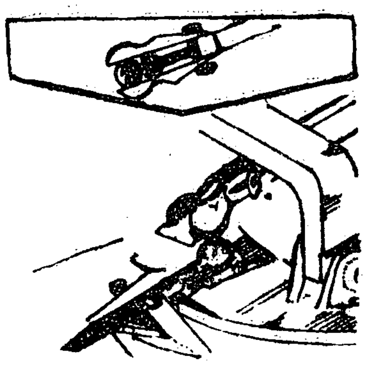


Fig. 11

When the flywheel turns it transmits a lengthwise reciprocating movement to the connecting rod. In turn the connecting rod transmits this movement to the knife by means of its ball socket coupling.

The mowing machine has a special mechanism for avoiding fractures. This mechanism allows the bar to move backwards and remain parallel to the advance when an obstacle is met.

All mowing machines of this type are equipped with a mechanical or hydraulic system which allows the cutter bar to be lifted to the vertical position for transporting, or lowered to the horizontal working position.

The safety clutch (Fig. 12) should be tightened enough, in order to work without slipping but, at the same time, sufficiently loose so that it trips when necessary. Figure 12 shows a sliding safety clutch and Figure 13 shows another one called ratchet clutch.

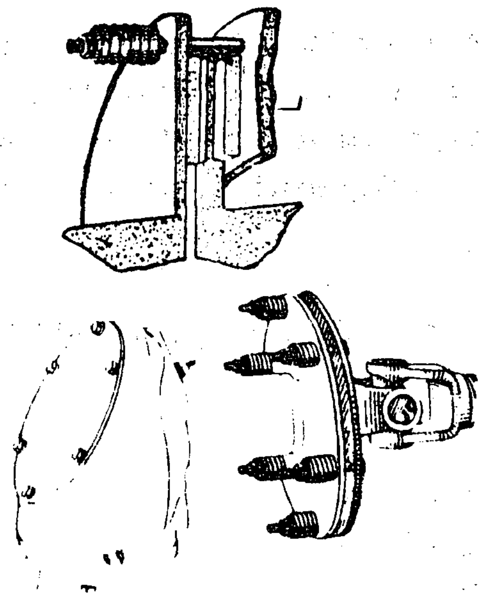


Fig. 12

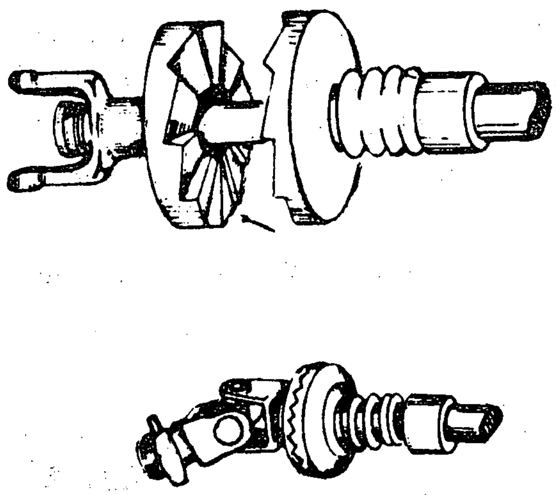


Fig. 13

The cutter bar should work in a horizontal position when seen crosswise, except when the pasture is thin or very entangled and dense. In this case the points of the fingers can be slightly tilted.

The centre of the sections should be under the fingers at the end of each stroke of the connecting rod. That is, in each cutting movement the sections should go from the centre of one finger to the centre of another. Figure 14 shows both positions. This regulation is called knife register.

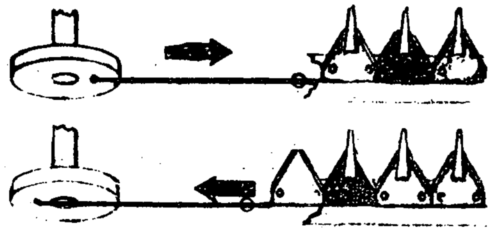


Fig. 14

The knife should move easily on the cutter bar.

Fingers, protective plates, wear plates and swath board should be in good condition and properly adjusted. A proper adjustment of the cutter bar parts reduces the side thrust of the tractor and makes smaller the demand of power for operating the machine.

The fingers help to hold the forage when it is being cut. The regular finger has a cutting edge situated 5 centimetres from the point, 9.5 millimetres below the lip of the finger and a clearance of 0.4 to 0.7 millimetres between the knife section and the finger cutting face (Fig. 15).

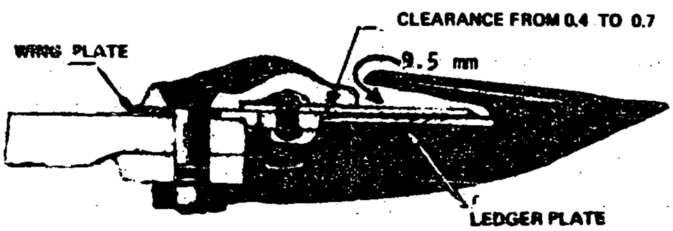


Fig. 15

Because the machines are of different models and trade marks, consult the operator's manual in relation to the implement in question.

COMMON PROBLEMS OF THE MOWING MACHINES AND THEIR CAUSES

Too heavy draft. Probable causes:

- Improper assembly. Consult the manual.
- Lack of lubrication.
- Cutter bar lagging.
- Wear on parts of the cutting section.
- Offset knife.
- Sections or fingers broken and/or loose.
- Knife clip too tight.
- Insufficient tension in the lifting spring.
- Cutter bar too low.
- Cutter bar too tilted.

Side thrust and uneven cut.

- These are caused by many of the above-mentioned factors.
- Uneven adjustment of the inner and outer shoes.

Fracture of sections and fingers.

- Excessive wear.
- Twisted connecting rod.
- Offset or loose fingers.
- Sections and fingers with improper clearance.
- Connecting rod bushing worn.
- Knife back bent or improperly adjusted.
- Cutter bar lagging or too low.

Cutter bar obstructed by pasture.

- Parts of the lifting equipment improperly adjusted.
- Improperly adjusted lifting spring.
- Loose bolts on the outer shoe.
- Improperly adjusted swath board.

ACCESSORIES

In order to work on stony lands special cutter bars with fingers for stones are necessary.

To cut weeds, but not pasture, high skids can be used.

There are special fingers for cutting weed, stems and thick bushes. They lack lips and their points are almost blunt.

MAINTENANCE AND CAUTION

WHEN BEGINNING THE WORK CHECK ADJUSTMENTS AND GRADUATIONS.
WHEN ON THE FIELD MAKE ONE CLOCKWISE TURN WITH THE CUTTER BAR DIRECTED TO THE CENTRE OF THE FIELD.
WHEN CUTTING CORNERS REDUCE THE SPEED OF THE TRACTOR. DO NOT REDUCE THE SPEED OF THE MACHINE.
IF THE FORAGE IS DENSE OR HEAVY MOVE THE TRACTOR AT A LOW SPEED.
LUBRICATE THE MOWING MACHINE FREQUENTLY.
WHEN STORING THE MACHINE REMOVE THE DRIVE BELT TO KEEP IT FROM DEFORMING.

OBSERVATION

To change parts, adjust and repair, consult the operator's manual.

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RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: ( )
Level: 2
Subject: 1.5-75

This implement is moved by the power take-off or by an auxillary engine and used for cutting and loading on the trailer, chopped or whole forage. The forage thus cut is used as immediate cattle feed or kept as silage.

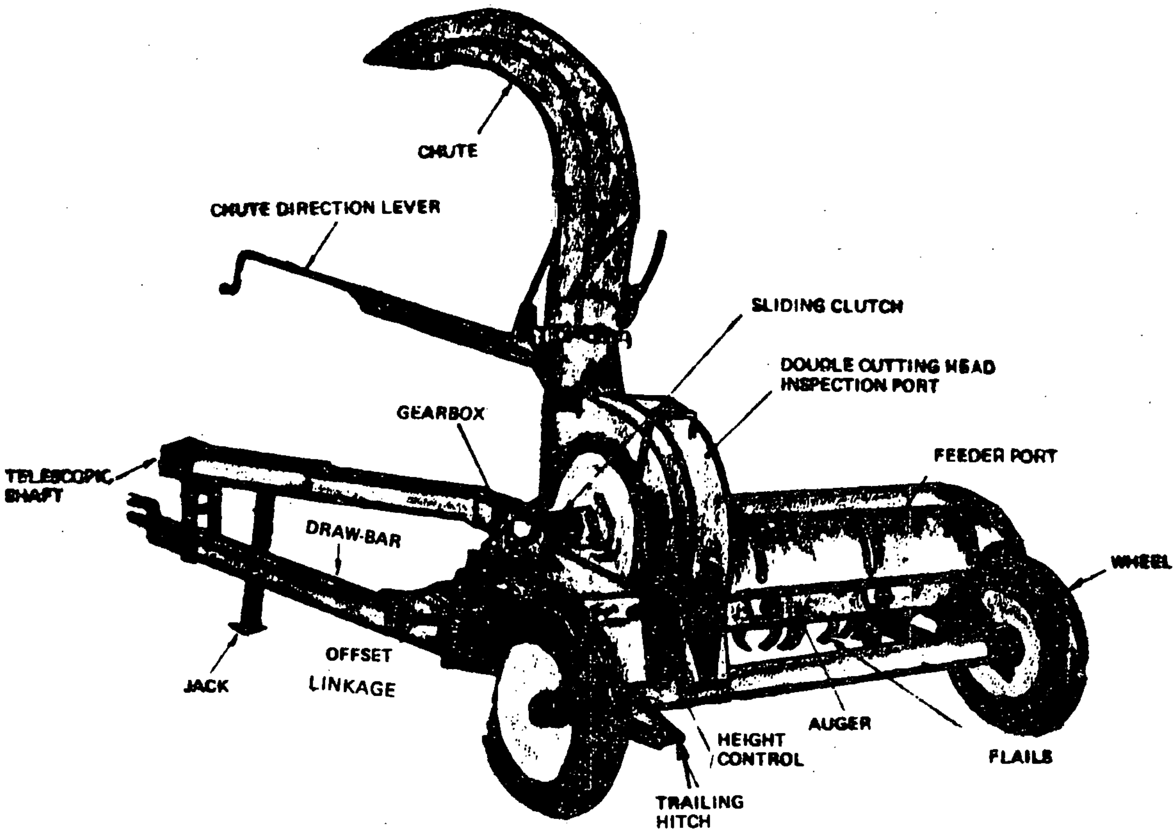

Fig. 1

DESCRIPTION

It consists of a *rotor* the *shaft* of which is horizontal and perpendicular to the direction of movement with 2, 3, or 4 rows of *flails*. It is moved by a *transmission* which is driven by the power take-off of the tractor. It may have a *chopper* and a blower which sends the forage through the adjustable chute.

FLAILS

These are of different forms and sizes. They are mounted in rows of varying number.

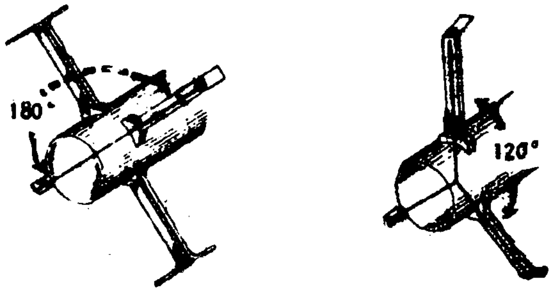

Fig. 2

TRANSMISSION

It has a clutch, which protects the drive and allows it to continue its rotation in case the cutting mechanisms get stuck because of an overload or accident. The gearbox joins the drive shaft to the cutting mechanism.

BLOWER

It receives the cut forage and blows it out the chute. It can, at the same time, chop it into small pieces (double-cut machines).

CHUTE

It can be directed and can throw the forage into a trailer which is hitched to the rear of the harvester or to a vehicle moving alongside and independently to it.

PROPELLER SHAFT

When the harvester does not have its own engine its shaft is coupled to the power take-off shaft of the tractor. The power take-off is a long telescopic shaft, with 2 or 3 universal joints and supports. It is used for adjusting the height to that of the tractor and to align the assembly.

TYPES

Depending on how they are driven they can be:

- integral-mounted,
- trailed with pneumatic tyres and moved by:
  - power take-off,
  - auxillary engine
- self-propelled.

Depending on their elements they can be:

- *single-cut harvesters,*
- *double-cut harvesters.*

OPERATION

Single-cut mechanism. It consists of a rotor which cuts the standing forage and blows or sends it through a discharge chute into the trailer. Figure 3 shows the parts common to this group.

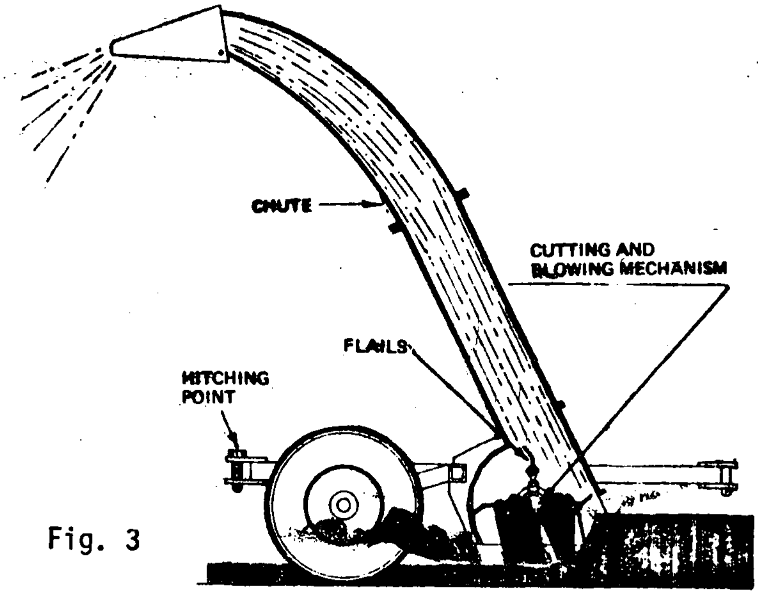

Fig. 3

With collector. These implements do not cut the standing forage. They collect it from the rows previously harvested. They are used when the forage has to previously undergo a wilting process.

These consist of retractible tines which pick up the forage from the land and of a double-spiral auger which feeds a central roller or a cutter head with helical blades. Figure 4 shows the set and Figure 5 shows the cutter head in detail.

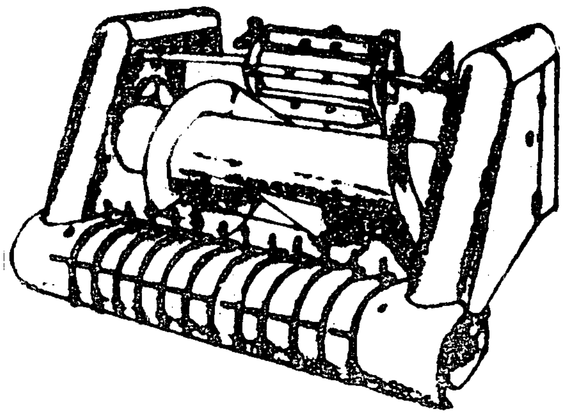

Fig. 4

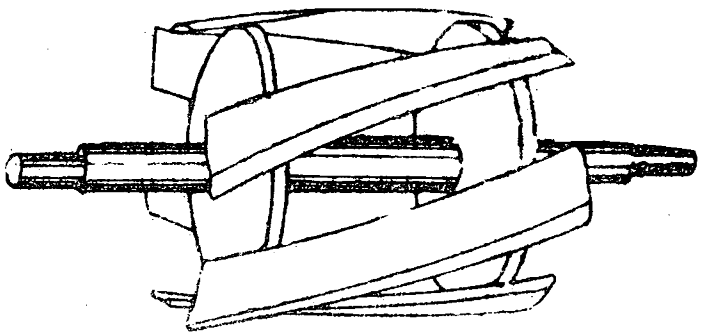

Fig. 5

Double-cut mechanism.

These machines consist of a rotor with hammers or flails attached to it (Fig. 1) which rotates perpendicularly to the implement's direction of travel. The forage harvested in this manner is sent to an auger or conveyor which transports it to a flywheel cutter-head and then blown (Fig. 6).

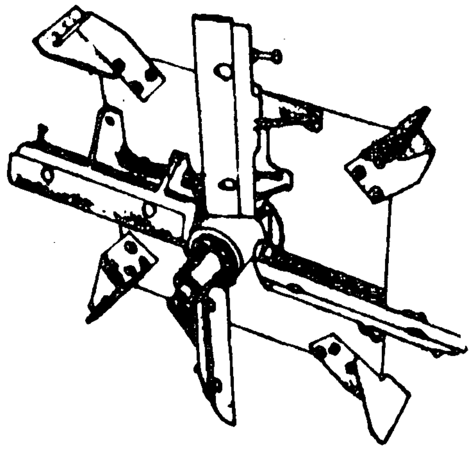

Fig. 6

The flywheel has impeller blades which send the material through the discharge chute and chopping knives which cut the forage when it enters the housing. The knives carry out their cuts in a combined action with shear plates situated at the opening through which the forage enters.

Figure 7 shows a harvester with a double-cut mechanism. In it the flow of the forage can be followed.

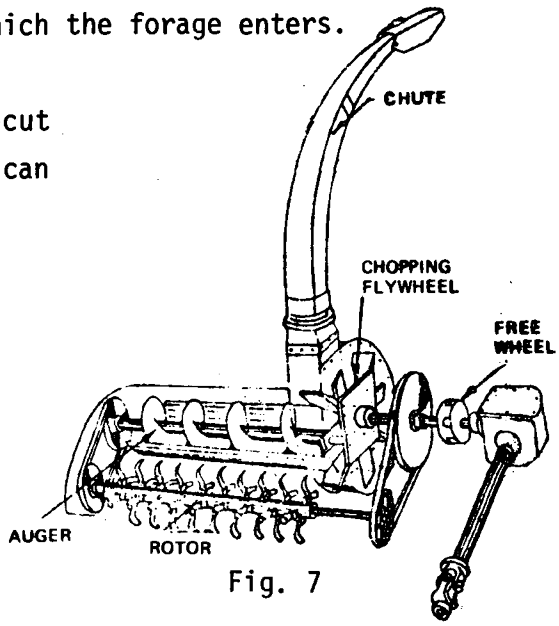

Fig. 7

The final size of the pieces of forage is important depending on its use. For direct cattle feed or for silage processes (silos, acid, sweet, etc.). For direct cattle feed they are cut in pieces 5-10 cm long. For silage, pieces of 2-3 cm are used. In the first case the length of cut depends on the speed of the rotor in relation to the speed with which the machine travels. In the second case the length of cut can be increased by removing blades from the cutter head.

MAINTENANCE

Occasionally the knives should be sharpened. For this they can be easily removed. Tools can also be used for doing this work without having to remove the knives.

Lubricate following the periods recommended in the operator's manual pertaining to the machine in question.

Clean and wash the machine thoroughly after work. Plant residues and their juices contain corrosive substances which when fermented form acids which attack the different parts.

After the harvest season remove the belts and keep them in a dry and dark place. Also jack-up the machine.

CAUTION

COMPLETELY STOP THE MACHINE FOR INSPECTING, LUBRICATING, ADJUSTING, CLEANING AND WHEN COMING OFF THE TRACTOR.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 1.5-73

This is an implement which is used in the haymaking process to turn over the forage and arrange it in swaths after it has been cut and conditioned.

In this manner the hay-drying process is quicker and uniform, and it eases the subsequent baling operation and/or storage for the seasons when forage is scarce.

The raking machines gather the forage in parallel, uniformly spaced swaths. The work should be done smoothly to avoid the loss of leaves, thus harming the quality of the product. This smooth work makes drying and subsequent collection easier.

CLASSIFICATION

DUMP RAKE

Originally designed for animal traction, some have a drawbar for hitching them to farm tractors.

SIDE DELIVERY RAKE

These can be integral-mounted or trailed. They are moved by the power take-off or drive wheels. They are of various types or designs:

- *drum,*
- *chain,*
- *disc or wheels.*

DESCRIPTION

DUMP RAKE

It consists of a frame and two large wheels which have a set of steel tines. These are semi-circular, independent and parallel forming a concave cage open in the direction of travel of the machine. The tines lift the forage and a lifting mechanism of the cage allows the tractor operator, when it is full, to empty the forage mass all together. Figure 1 shows the most important parts of this machine.

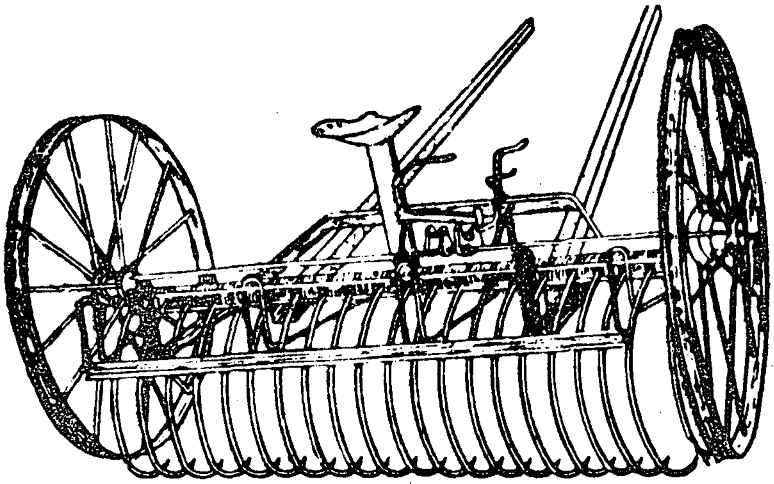

Fig. 1

SIDE DELIVERY RAKES

DRUM RAKE

It consists of 3, 4 or 5 sets of tines (combs) arranged at an angle of approximately 40° with respect to the direction of travel. These sets of tines are mounted on two oblique plates, and the whole group makes up the drum. See Figure 2.

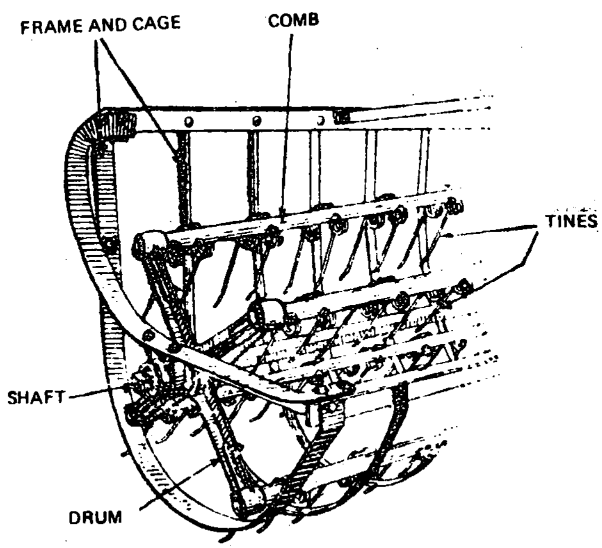

Fig. 2

CHAIN RAKE

It consists of a suspended frame with two chains arranged crosswise to the direction of travel and which are joined by numerous bars with tines.

The chains move perpendicularly to the direction of travel of the tractor (Fig. 3).

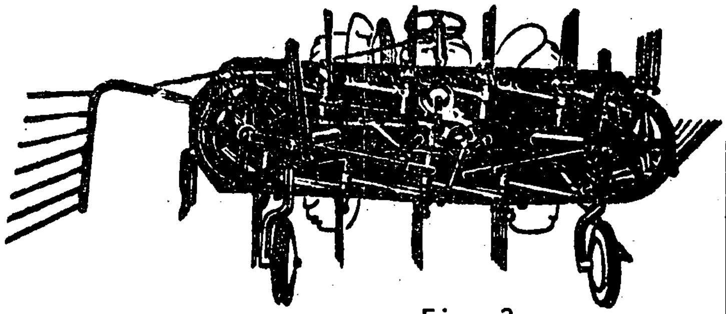

Fig. 3

Figure 4 shows a simplified diagram of how the chain rake operates.

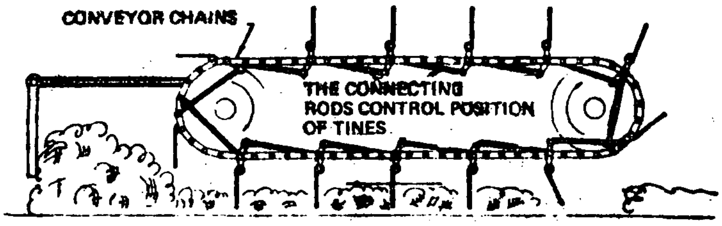

Fig. 4

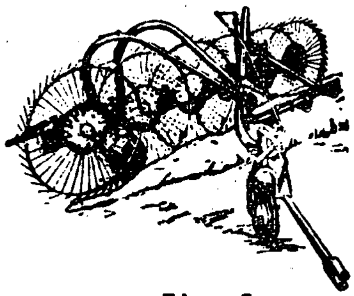

Fig. 5

RAKE-WHEEL MACHINE

It consists of a frame which carries wheels independent to each other and measure 110-130 cm in diameter with long tines around the rim. The wheels are slanted with respect to the direction of travel. They rest on the soil and turn when they come into contact with the cut forage (Fig. 5).

Each wheel is mounted in such a manner that it floats independently from the implement. This arrangement allows it to follow the contour or profile of the land, thus leaving none of the crop behind.

OPERATION

Extreme care should be taken when releasing the clutch in those implements moved by the power take-off of the tractor. It is convenient to have tractors equipped with double-clutch. These have a releasing effect at the first part of the run of the pedal to the power take-off shaft and only when

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it reaches the upper end of its run, the tractor moves. The advantage is that the tractor is ready for swathing (it has the necessary speed of rotation) before it begins to advance on the field.

Swath turning should be done in the same direction in which the moving was done. In this manner the stalks remain on the outside of the row and the leaves at the centre. The stalks are thus more exposed to the action of the natural agents (light, heat) and the leaves do not become too dry.

MAINTENANCE

- Inspect and adjust the tension of the belts.
- Check and tighten nuts and bolts.
- Straighten bent tines and replace broken ones.
- Grease as advised in the operator's manual.

These machines are used for hastening the curing process of the cut forage which is necessary for haymaking and for obtaining a higher quality product for animal feed (Fig. 1).

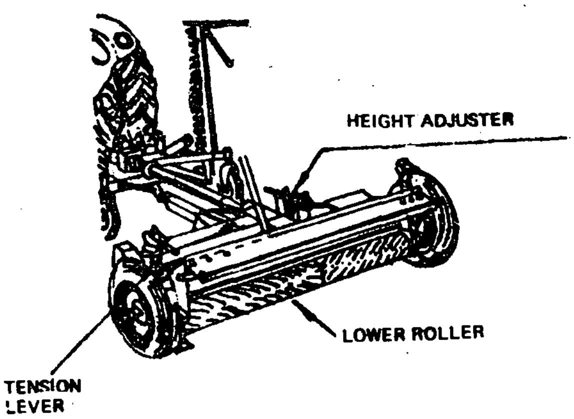

Fig. 1

ROLLERS

These are vital parts of the machine. They are made of corrugated or smooth metal. In the latter case they may be coated with rubber or other suitable compound. They are two in number and make contact. Those coated with rubber afford an easier handling of the hay and a more uniform crushing. The corrugated ones crush and break the hay at regular intervals. These rollers press, break or crimp the stems, without damaging the leaves.

Figure 2 shows the mechanism of a conditioner with smooth rollers. It has a pick-up which is also a roller but with tines.

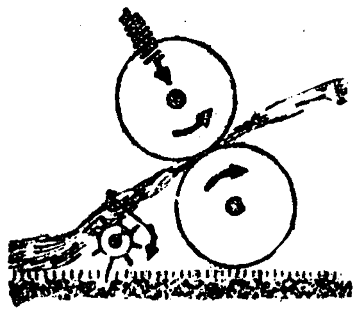

Fig. 2

Figure 3 shows the mechanism of a conditioner consisting of rollers covered with rubber. Observe that the diameters, in this case, are different.

Figure 4 shows fluted rollers and a detail of how the stems are broken.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: ( )
Level: 2
Subject: 1.5-83

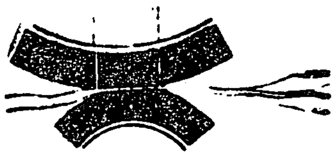

Fig. 3

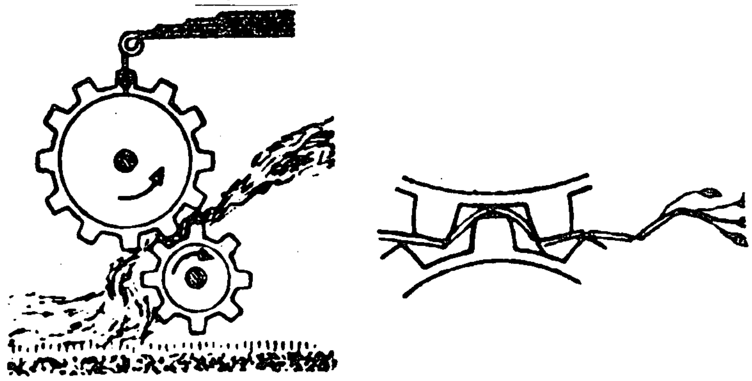

Fig. 4

ROLLER PRESSURE ADJUSTER

It provides adjustment of the pressure between rollers. This pressure should be suitable to the good handling of the forage.

HEIGHT ADJUSTER

With it the rollers can be lifted and lowered to the convenient height to provide necessary clearance between them.

CHARACTERISTICS

This machine can work in an independent manner or hitched simultaneously with the mower. Thus, two operations are done at the same time. This saves time and labour, and avoids further compaction of the soil. This machine collects, and bruises the stems of the forage to allow the moisture to evaporate from them at the same rate as in the leaves. In cases where this is not done, the leaves become excessively dry and when the hay is being collected they fall off and are lost.

The forage thus dealt with, speeds up its drying process in up to 50%, depending on the climate and the weather conditions – humidity, exposure to the sun, temperature, etc. It also keeps the leaves from becoming too frail and falling off. When this happens it causes considerable losses in the quality and quantity of hay.

An object of the exercise is to hasten the haymaking process. In this way vitamins and proteins are conserved in larger amounts and the leaves retain their natural colour which is a sign of their quality.

The hay becomes more palatable for the animals, less waste occurs and there is a better net result.

ADJUSTMENTS

The rollers should be placed at approximately 10 centimetres from the ground. When the crop is heavy it could be convenient to raise the height, or lower it in the opposite case.

To adjust the height turn the crank clockwise to increase it. Turn it in the opposite direction to reduce it.

When the implement is being transported lift the rollers to the maximum height.

To change the clearance (mesh) between rollers disconnect the cam, turn the adjustment nut (clockwise, to bring them closer; in the opposite direction, to separate them). Both ends should be equally separated. The clearance should be of approximately 22 millimetres. After the adjustment, move the cam upward to connect it.

The crop, its size, species and conditions, determine the tension suitable to the roller. When the crop is heavy it demands more tension than when it is light.

The tension can be adjusted. To do so, move the cam downward, remove the pin from the adjusting bolt and turn the nut of the cam, whether to increase or reduce it. Both sides should remain equal. Replace the pin and turn the cam upward.

OPERATION

This machine is driven by the power take-off shaft coupled to the drive shaft.

The cut forage is lifted from the ground and passes between the surface of the rollers. There, the stems are bruised at intervals of 4 or 5 centimetres. Tiny leaves and stems pass without harm.

The tractor should be operated between 6 and 7 kilometres per hour. When the crop is heavy or the land is uneven the speed should be reduced.

Check that the drive chain has the proper tension.

The safety clutch rarely needs adjustment.

In normal situations the fluted rollers should mesh superficially in order to work smoothly, silently and with minimum wear.

MAINTENANCE

The change of lubricant in the gearbox and greasing of all the parts indicated in the manual should be done following the periods indicated by the manufacturer.

When working in dusty fields do not lubricate the drive chain.

Check bolts and nuts. Tighten the loose ones and replace those missing.
Inspect the rollers. Check for damage and wear.

CAUTION

OPERATING THE CONDITIONER WHEN EMPTY DAMAGES THE ROLLERS. WHEN MAKING ADJUSTMENTS, LUBRICATING, GREASING OR REPAIRING, THE MACHINE SHOULD NOT BE WORKING. WHEN THE MACHINE IS WORKING, THE OPERATOR AS WELL AS OTHER PERSONS SHOULD NOT BE BEHIND IT. BEFORE GETTING OFF THE TRACTOR STOP THE POWER TAKE-OFF SHAFT.

OBSERVATION

When making hay where there is plenty undergrowth or foreign objects, the machine may get stuck. Stop it and disconnect the releasing cams before cleaning it.

For operating and adjusting always consult the operator's manual.

This machine picks up the hay or straw from a swath compresses and ties it with a cord or wire. It makes a bale which can be easily handled and stored. It is later used as cattle feed or bedding.

DESCRIPTION

A baler is a trailed machine with systems for collecting cut forage, feeding it to a baling chamber and tying the bale.

Figure 1 shows the flow of forage in a baler. It begins when the hay is collected by means of a pick-up with retractable tines and then taken (crosswise to the travel of the machine) by an auger to the bale chamber where it is compressed by a plunger and is afterward tied by a tying system into bales the length of which can be varied at will.

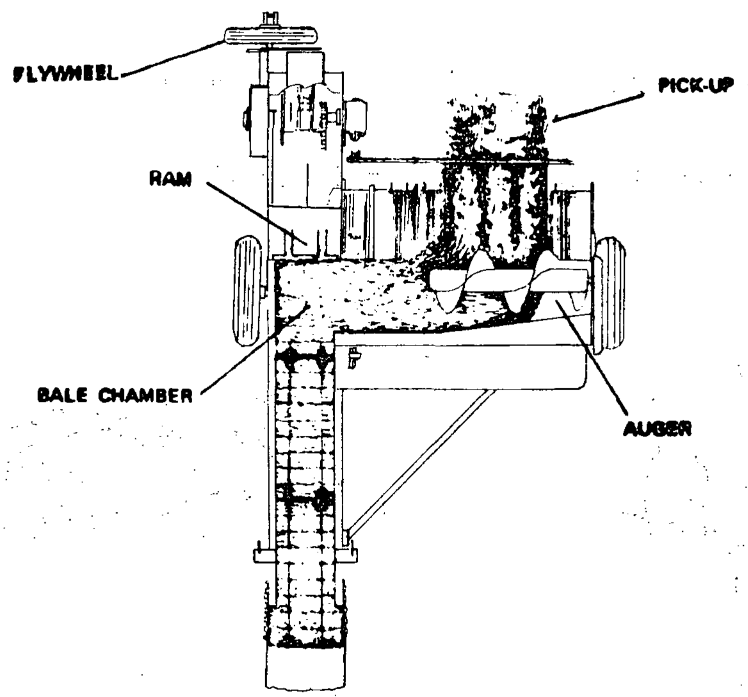

Fig. 1

PICK-UP
This is the front part of the machine. It collects the forage previously arranged in swaths, and propells it toward the feeding system.

RURAL SECTOR
Agriculture

SUBJECT CLASSIFICATION
Plant: -
Level: 2
Subject: 1.5-84

Figure 2 shows the retractable tines located on the pick-up reel which has an offset shaft.

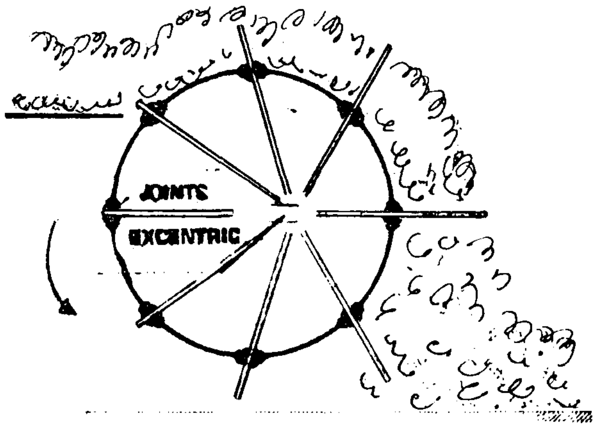

Fig. 2

Figure 2 shows another retractable-tine system mounted on a drum.

Figure 4 shows the parts of a chain or belt pick-up.

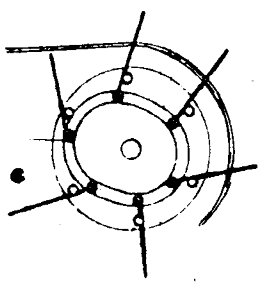

Fig. 3

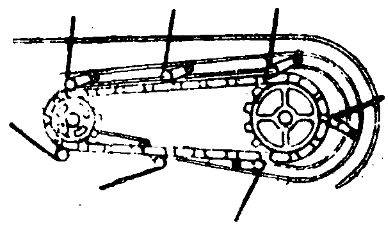

Fig. 4

One of the most used pick-ups is shown in Figure 5. The tines are controlled by cams running on a guide.

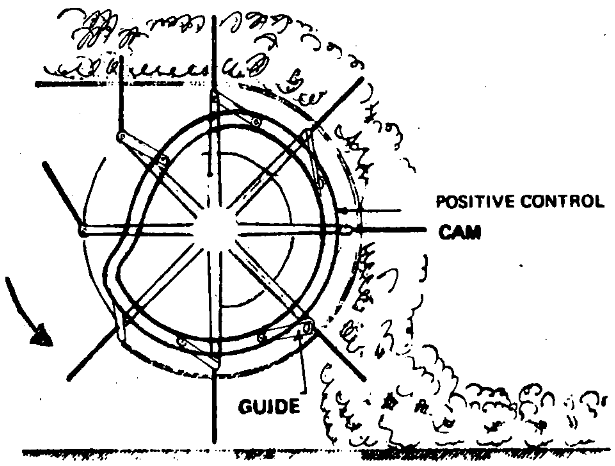

Fig. 5

FEEDER

This is usually an auger or revolving cylinder with a high spiral flange. It receives the forage from the pick-up reel and takes it to the bale chamber where it is compressed by the plunger. See Figure 1. Other balers use chains or canvas conveyors with tines to carry the forage to the chamber.

BALE CHAMBER

This is a metal case, the section of which is rectangular. Its structure is very strong. Here the hay is compressed by a plunger.

It has wedges or retainers (Fig. 6) on its sides. These provide adjustment for varying the density of bales.

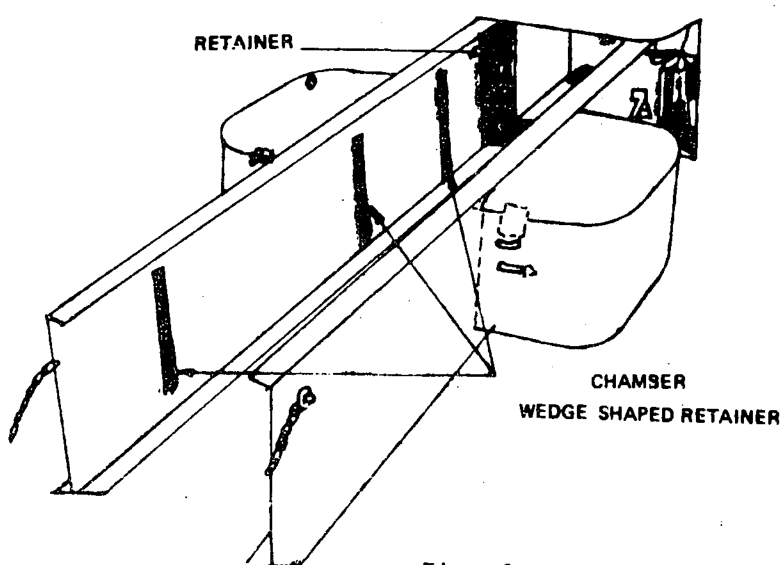

Fig. 6

At the delivery end of the bale chamber further provision is made to allow for adjustment of the density of the bale (Fig. 7).

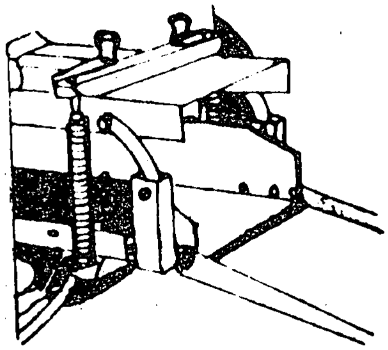

Fig. 7

The final density of the bale depends on the forage (or straw), its moisture content and the resistance is offers to the movement of the plunger in the bale chamber.

PLUNGER

It compresses the hay and in several strokes forms the bale. It is made by joining plates of steel and wood. It has slots through which the needles pass.

It carries on the side nearest to the hay inlet, a knife which in each stroke cuts the forage as it enters from the feeder.

METERING MECHANISM

The length of the bale can be varied by means of a metering wheel system.

The metering wheel is fixed on the bale box or on one side, and is in contact with the forage. When the forage advances by the action of the plunger it moves the wheel which at the end of the set run triggers the tying mechanism.

By using the metering wheel, the length of the bale can be varied in different ways:

- changing the wheel for one of a different size. With the smaller ones, shorter bales are obtained.

- by using models with adjustable teeth.
- by mounting sprockets of different sizes.

TYING MECHANISM

This is a combination of several parts which use wire or cord to tie the bale.

When the measuring mechanism triggers the tying system, the process, which is carried out in several stages, starts.

Let us describe tying with cord:

The needles place the cord in the knotter mechanism, then the knot is tied by the knotter bills. The needles return to their former position and wait for the action of the metering wheel to repeat the same operation.

The needles pass through slots which are on the plunger head, and not through the hay. They remain in the chamber a fraction of a second, when the plunger is at the end of its stroke.

They are usually protected by a safety bolt or spring.

Each bale has a double tie. All the machines have two needles.

When using cord for tying, keep dirt and thread from getting into the knotter.

After placing the balls of thread in the boxes, according to the instructions in the manufacturer's manual, thread the needles, following the path corresponding to each, and apply correct tension to the cord in order to allow the knotter mechanism to operate properly.

After tying each bale the cord is held by one end in the twine retaining ring by a three-finger retainer. When the bale is formed the cord is drawn from the ball at the proper tension.

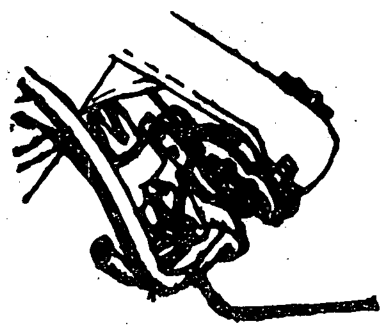

Fig. 8

The needle has passed the cord through the guide on the arm of the knife, across the bills and through a slot on the knotter wheel.

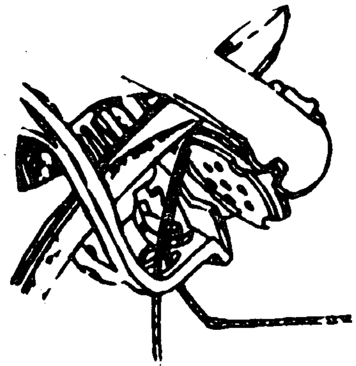

Fig. 9

The knotter wheel has turned to join the ends of the cord coming from the retainer wheel and from the tensioner. The bills have begun to make a turn.

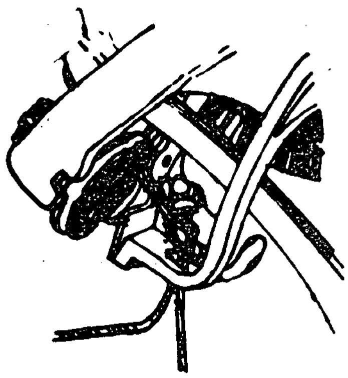

Fig. 10

The bills have made a complete turn forming a loop with the cord around it. The bills have opened up to receive the cord. The knife advances to cut between the bill and the retainer wheel. The needles have begun to withdraw leaving the cord in another slot of the retainer wheel.

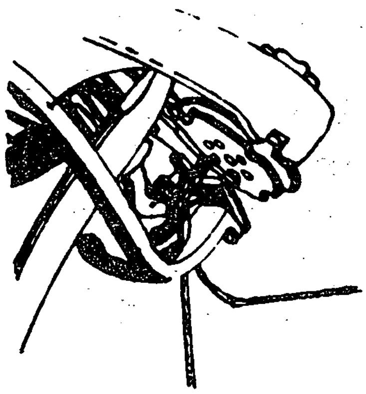

Fig. 11

The bills are now closed, the cord is cut, and the arm of the knife is about to remove the cord from the hook while the latter holds the ends.

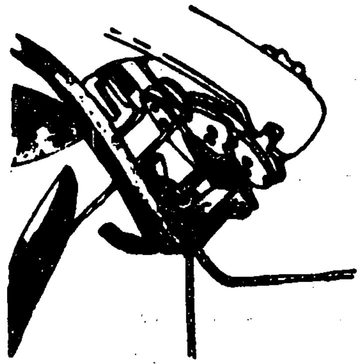

Fig. 12

The knot is now made and is ready to be removed from the bills.

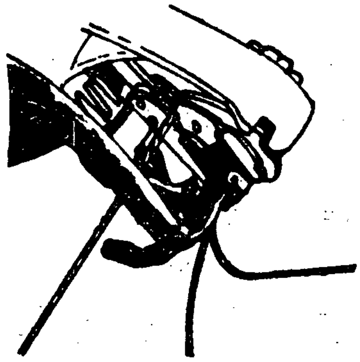

Fig. 13

CHASSIS

The chassis consists of frame, drawbar and wheels. The frame mainly supports the chamber and its supports. It may consist of angled iron or welded or riveted flat bars.

A strong crossbar is welded to the frame: The wheels are mounted on small axles at both ends. The wheels may be of different sizes. The bigger one goes on the side where the chamber is because it is heavier. There are double wheels for soft ground.

To transport the baler the drawbar can be adjusted at the side. In this manner it will move behind the tractor. The drawbar has a hook for lifting or lowering the front of the baler thus levelling it. Some drawbars have trunbuckles on the hook for accurate adjustment and to keep the drawbar from hitting that of the tractor.

With a light tractor, the drawbar of the machine carries a wheel to keep the weight from overloading the drawbar of the tractor.

OPERATION

The baler is driven by the power take-off shaft of the tractor or by its own engine.

The pick-up mechanism is on the right side. The tractor, when operating, moves on the left side of the baler. The baler collects the swath in the direction in which the hay was cut and laid.

The plunger of the compressing mechanism is a heavy rectangular frame made of steel and wood. The plunger pushes the hay.

The chamber in which the bale is formed is rectangular and long; it extends form the front to the rear of the baler. There is a model in which the chamber is situated perpendicularly to the direction of travel.

The plunger pushes the hay towards the rear of the chamber. The opening through which the loose hay passes in order to be compressed is at the middle of the chamber, in some balers on the sides and in others by the upper part.

The bale is partially compressed by the packers, thus offering resistance to the plunger. In this manner it is well packed. Sometimes there are two or three bales in the chamber at the same time. This feature varies with the machine.

Most of the balers have retainers which stop the bale from backing out following the plunger after the latter has compressed it.

The retainers are out of the reach of the plunger, are wedge shaped and allow the hay to move forward only. They keep the bale compressed and allow a large load to enter the box.

Sometimes with the same purpose, projections directed towards the rear of the chamber are used.

When hay is being baled, because it is leathery and flexible, wedge-shaped retainers are bolted to several points of the sides.

The plunger is moved by a rod (or connecting rod) which is a solid piece of metal.

When the plunger is at rest the needles move and tie the bale. Almost all the balers do their tying when the plunger is at rest at the end of its stroke.

ADJUSTMENTS

The height of the pick-up is variable. When it is low it does less damage to the hay. When it is high it allows the stones to fall to the ground.

All pick-ups are articulated near the axle, and the front can be lifted or lowered by means of a lever or by adjusting the guide wheels.

To keep the feeder arms from breaking, their movement should be synchronized with the operation of the plunger. The feeder arms and the compressing plunger are moved by chains.

These parts do not have safety clutches because if they should slip, the parts would be out of time. As a protection they have pins which shear when there is an overload. They are usually placed on the flywheel. The balers driven by power take-off may have the flywheel between the tractor and the main drive mechanism.

The adjustments of the compressing mechanism should be accurate. The knives should be kept well sharpened and adjusted.

If there is play due to wear in the plunger, it will continue to compress well, but the knives might hit against each other or be so separated that the hay will go between both of them and wedge them. The machine will work with difficulty, the bolt of the flywheel will shear and the bales will be improperly cut.

During the baling process the speed of the plunger should be checked. In many machines it varies from 42 to 65 strokes per minute. The average of 50 is generally adequate. The speed of the machine should be adjusted as recommended by the manufacturer.

The density of the bales is determined by the mechanical tension which is exerted at the rear of the bale chamber.

OPERATION

When a baler is driven by the power take-off shaft of the tractor the speed of the shaft should not be changed, it should be kept constant.

The tines of the pick-up have guide wheels which keep the height above the ground uniform and they are articulated to that effect.
The pick-up is lifted when it is being transported.

Some plunger heads are made of wood and have corner pieces which slide along the corners of the box. Some balers have plastic guides. The material is not relevant, what is important is to be able to easily adjust it when it is worn.

Balers with side openings on the bale chamber are lower than those with top openings. The top opening allows the use of a vertical plunger.

Pressure is produced mechanically on the packers by means of nuts with levers which press the springs against the packers. There are several balers with a system of levers which compress the four sides of the chamber. At least one model uses a hydraulic pump to maintain a relative constant pressure on the packer. It has a gauge for showing the tension which is applied. By turning the valve, the tension can be adjusted to the suitable one.

Another model has an automatic hydraulic mechanism to keep the bale at a constant density irrespective of the crop variations.

The hay should be raked in uniform swaths. This is important and basic for good baling. There should be no heaps, nor places with little hay in the swaths.

The baling operation should be carried out following the direction in which the swaths are laid.

MAINTENANCE

Good servicing will maintain the baler in good working condition. Keep the chamber free from rust. Remove all hay when the work season is over.

Lubricate and grease thoroughly. Adjust loose parts and repair the damaged ones. Keep in a dry place.

At the end of the day release the tension of the bale chamber.

CAUTION
FOR ANY ADJUSTMENT, REPAIR OR LUBRICATION, STOP THE MACHINE.

OBSERVATIONS
Balers have different safety devices. Make sure they are working properly.

When changing the safety bolt in the flywheel hub, use one with the same characteristics.

In order for the machine to give a better performance and last longer consult the manufacturer's manual.

The application of pesticides is effective when done according to the recommended dosage of the product and the distribution is uniform. These conditions depend on several factors.

NOZZLE DISCHARGE

The amount discharged by a particular nozzle is approximately proportional to the square root of the pressure. The amount discharged is also proportional to the area of the orifice. If the area of the orifice is increased, the output will also increase.

> OBSERVATION
> Manufacturers offer tables with the volume of discharge for different types of nozzles at different pressures.

ANGLE OF ATOMIZATION

The nozzles of the sprayers have angles of atomization which vary from 60^{0} to 120^{0}. The angle decreases considerably when the pressure drops from 3 to 5 atomospheres.

Below 1½ atomospheres the performance of the majority of nozzles is very poor.

SPACING OF NOZZLES AND HEIGHT OF THE BOOM

In order to obtain a uniform covering a certain overlapping of the discharge areas of the neighbouring nozzles is required. This depends on the type of atomization. The lateral distribution of the liquid can be shown by what is called a distribution profile. These profiles vary according to the nozzles which are used and to their spacing (Fig. 1).

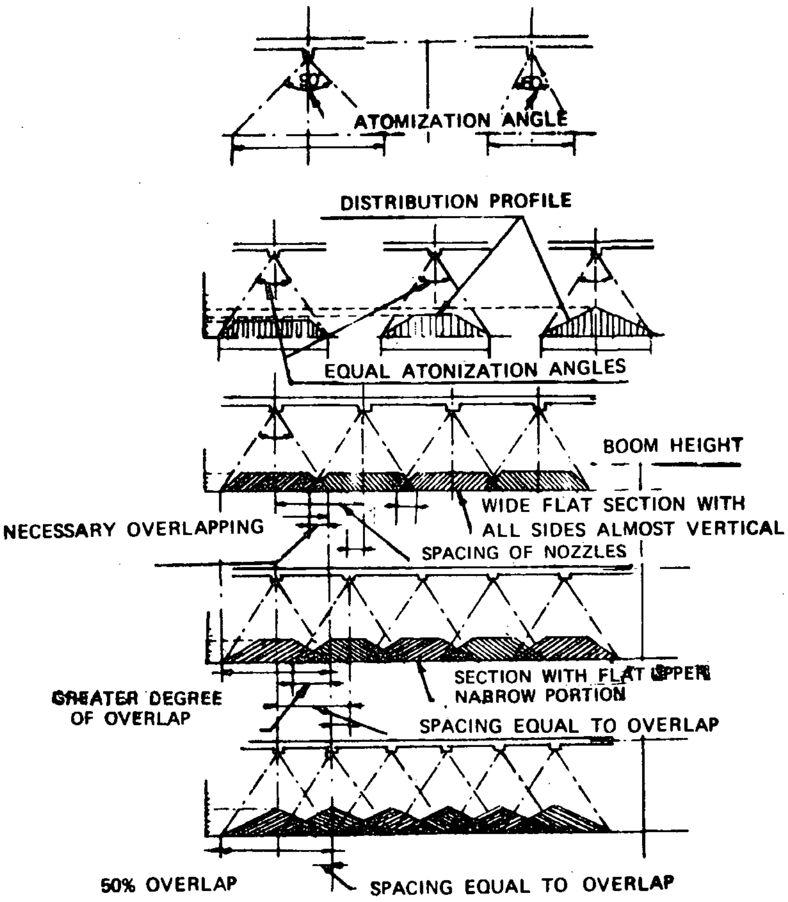

Fig. 1

There are nozzles which present a flat wide section across the middle portion with almost vertical sides. This indicates a regular uniform distribution.

Other nozzles show a distribution profile with sides gradually slanted and a narrower upper portion. This means that in the middle portion there is a smaller area, with an equal distribution, and from the middle to the sides, the amount discharged gradually decreases.

Other nozzles have a very narrow distribution: They have a bulky middle portion and the sides are tilted. In this case the distribution gradually decreases from the centre to the sides without any area of uniform distribution.

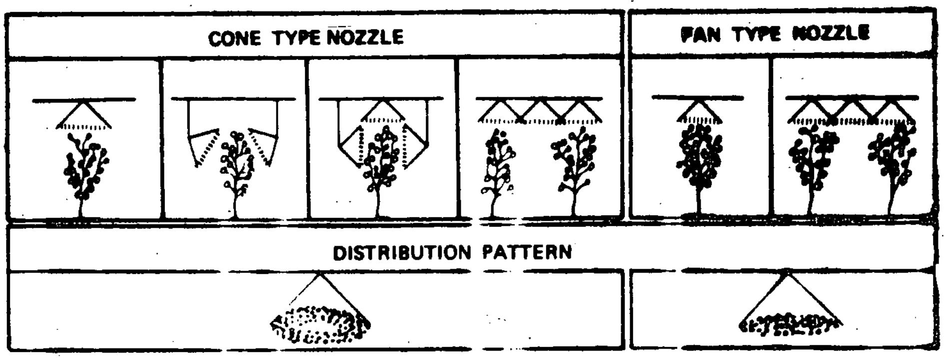

Fig. 2

Nozzles, which have a spreading pattern with a wide flat section along the centre, do not require much overlapping in order to obtain a uniform coverage. The other nozzles in which the atomization gradually decreases in height from the centre to the sides, require a greater overlapping. The space between nozzles should be such, as to obtain a reasonable height for the boom.

Besides the required overlapping, the spacing between nozzles depends on the amount which they can discharge and on the amount per hectare desired.

For an equal application per hectare, spacing between nozzles of a small discharge capacity should be smaller than the spacing between nozzles with a larger capacity.

The amount discharged per nozzle, per minute, at a certain pressure multiplied by the number of nozzles on the boom gives us the total amount of liquid discharged per minute. The pump should have the capacity to satisfy the total amount to be discharged by the nozzles. In the case of using hydraulic mixing the capacity of the pump should exceed the total amount of liquid discharged per minute, because a percentage of the liquid returns to the tank, causing agitation.

The selection of the proper height of the boom depends on the following factors:

- spaces between nozzles,
- angle of atomization of the nozzles,
- degree of overlapping required for a uniform coverage,
- connection of nozzles to boom; the direction of the spray depends on it: vertical, slanted or upward (Fig. 3).

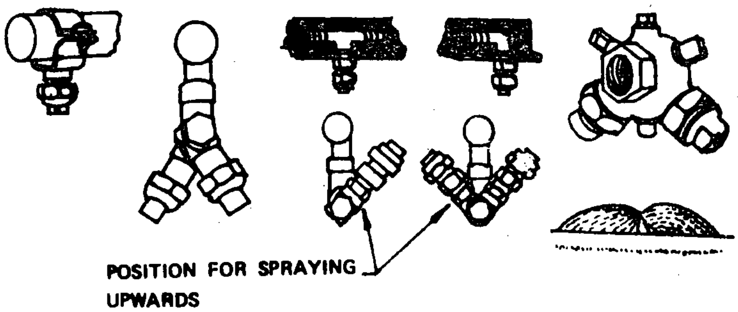

Fig. 3

By increasing the height of the boom a greater overlapping results. This is so, particularly with nozzles having large atomization angles.

If the boom is placed at double the required height, for a uniform coverage, double coverage is obtained and the sensitivity to smaller changes in height is reduced.

If the application is such that the boom has to be kept low to reduce the swaying caused by the wind to the minimum, then the nozzles should be at a smaller distance from each other. However, a smaller distance between nozzles, when the applied volume is the same, implies using nozzles with a smaller outlet, which will result in a finer atomization. and greater possibilities of the nozzles getting clogged.

In place of reducing the distance between nozzles to obtain a double coverage with a low boom, the same effect could be obtained with nozzles which have a wider angle of atomization.

AMOUNT APPLIED

The amount of liquid applied per hectare by a sprayer depends on the following:

Distance between nozzles. The smaller the distance, the larger the amount discharged.

Amount discharged per nozzle. Larger amounts discharged per nozzle implies larger amounts discharged per hectare.

Pressure at the nozzles. The amount discharged per nozzle depends on the pressure. The application per hectare will be larger when the pressure at the nozzle is increased.

Running speed of the machine. The slower the machine moves on the field, the larger the application per hectare. The amount applied in litres per hectare can be calculated, thus:

$$\text{Amount applied per hectare} = \frac{60000 \times b}{a \times v}$$

a = Distance between nozzles in centimetres.
b = Amount discharged per nozzle in litres per minute at a given pressure.
v = Travel speed in kilometres per hour.

MAINTENANCE

Lubricate as specified by the manufacturer.

Other important maintenance services are:

- Frequent cleaning of sieve filters at the intake of the tank, the pump filter, main filter at the outlet of the boom, and nozzle filters.

- Washing the machine thoroughly to stop crusts from forming on it. This precaution should even be greater when the equipment is used to spray with herbicides rather than other products (fungicides and insecticides). In this case, it is recommended to wash the machine with a 2 or 3% soda or a 1% ammonia solution and allow the solution to remain as long as necessary to neutralize the effect of the herbicide.

- Change the discs of the nozzles periodically when products which cause great wear (e.g. suspensions) are used.

- Check the pump periodically.

- Drain the equipment at the beginning of the idle season.

- Do not leave fluids in the machine when freezing temperatures might occur.

USE

The operation of sprayers is not difficult.

Special care should be taken when handling the products to avoid toxic effects.

During the operation use a safety mask.

Once adjusted, the speed of the tractor should be constant.

The spraying capacity varies with the width of the application and the amount of product used per hectare, which determines the travel speed and the frequency of refilling.