AGRICULTURAL TECHNOLOGY

GRADE 12

basic education
Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

AGRICULTURAL TECHNOLOGY

GRADE 12

Grade 12 Term 1

Week 4 hours	Topic	Content
1	**PAT** **Design portfolio**	First part of PAT must be handed out to the learners. Learners are given three weeks to complete the design portfolio.
1	**Research task**	The research task must be handed out in the first week of the term and learners must hand it in at the end of the first term.

1-2	**Safety**	• Safety hazards:
		• three steps of a hazard control system
		• OHS Act: farm safety regulations according to the OHS Act for:
		  • Tractors
		  • Vehicles, tools and machinery
		  • Fire protection
		  • Orientation and training
		  • Chemical hazards
		  • Emergency preparation
		  • Farm buildings
		  • Farm yard
		  • Work environment
		Health hazards associated with the farm environment:
		  • Chemical hazards
		  • Biological hazards
		  • Physical agents
		  • Work design (ergonomic) hazards
		  • Work place stress

3	**Safety**	Tractor safety:
		• Roll-overs
		• Power take off shaft accidents (PTO)
		• Improper hitching;
		• Transport tractors safely
		• Identification of tractor hazards
		Noise pollution:
		  • The effect of noise pollution
		  • Prevention of noise induced hearing loss
		  • When is it too noisy?
		Basic general safety regulations:
		Safe handling and safety regulations applicable to all workshop equipment, farm equipment as well as skills and construction processes must be dealt with through the content during the year.

4	**PAT Manufacturing process**	Learners must start with the manufacturing of the PAT project/product. (Four half-hour periods must be allocated for this per cycle/week or afternoons)

4	**Structural materials**	Materials and structures:
		• Metal alloys: Types, composition and properties:
		• Stainless steel:
		  • manganese
		  • chromium
		  • nickel
		• Brass:
		  • copper
		  • zinc
		• Bronze:
		  • copper
		  • tin
		• Synthetic materials: properties, application and safety:
		  • Adhesives: silicon, PVC weld, cold glue, epoxy, latex and no more nails;
		  • Glass fibre, resin
		  • Vesconite
		  • Teflon

5-6	**Structural materials**	• Electric fences:
		  • Safety
		  • Causes of interference
		  • Testing
		  • Lightning protection
		  • Warning plates
		  • Maintenance
		  • Earth return safety system
		  • Poor earthing conditions
		  • OHS acts applicable to electrical fences
		• Different parts of electrical fences:
		  • energizers
		  • energy sources
		  • battery (care and maintenance)
		  • isolators
		  • wire tensioners
		  • wires
		  • posts
		  • standards/droppers

7-8	**Energy**	Alternative energy:
		• Wind energy:
		  • How to transform wind energy into a form of electrical power
		  • Buying and installing a wind turbine
		  • Advantages of wind energy
		  • Disadvantages of wind energy
		• Solar energy:
		  • What is “solar” power?
		  • Solar hot water panels
		  • Solar electric panels
		  • Producing electricity from solar energy
		  • The efficiency of solar cell
		  • Advantages of using solar energy
		  • Disadvantages of solar energy

9-10	**Energy**	• Geothermal energy:
		  • What is “geothermal” power?
		  • Harnessing of geothermal energy (power stations)
		  • Main problems
		  • Advantages of geothermal energy
		  • Disadvantages of geothermal energy
		• Bio-energy:
		  • What is “bio” fuel?
		  • Manufacturing bio diesel
		  • Advantages of bio fuel
		  • Disadvantages of bio fuel
		• Alternative fuels obtained from plant origin
		  • Ethanol
		  • Methanol
		  • Methane gas

	Test 1	Learners must write a formal test during the end of this term not shorter than 100 marks with a time allocation of 2 hours.
Formal assessment Term 1 Test 1 – 75% Research task – 25% PAT Design – 25% (The PAT marks must be used at the end of the year for the final PAT mark.)		Research task Term 1: one of the following: Teacher can also use his or her own topics • Alternative energy sources used in agriculture; • Electrical fences; • Accidents in an agricultural environment; and • Centre pivot irrigation.

3.10 Grade 12 Term 2

Week 4 hours	Topic	Content
	Practical Task 1	Teacher must do one practical task with the learners during this term.

1	**Construc-tion processes**	Skills and construction processes:
		• Welding:
		  • CO_2-welding: metal inserted gas welding (MIG welding) components, working. Advantages, disadvantages, safety, general problems, and application; and
		• Advanced welding techniques and their applications:
		  • Overhead welding
		  • Vertical up welding
		  • Horizontal square but weld
		  • Pipe welding
		  • Welding of galvanized iron
		  • Welding of cast iron
		  • Hard facing of worn parts\ implements
		  • Shrinking of welding joints
		• Oxy acetylene cutting and heating:
		  • Equipment, components and working
		• Plasma cutting:
		  • Application, handling and working

2-3	**Tools, equipment and systems**	Tools, equipment, mechanized implements and systems Harvesting or processing machines/equipment: identification, working and basic components: • Cutting machines • Hay rake • Bailing machines • Front-end loaders • Silage cutter • Harvesting machines • Hammer mill

4-5	**Tools and equipment**	Tractor systems
		• Tractor hydraulic systems: identification and working:
		  • Single action hydraulic cylinders
		  • Double action hydraulic cylinders
		  • Hydraulic oil
		• Three point coupling of a tractor: identification and working:
		  • Lifting arms
		  • Sensitivity element
		  • Top link
		  • Levelling box
		  • Power take off shaft (PTO)
		  • Tow bar
		• Mass displacement and pulling force of a tractor: factors influencing the mass displacement of a tractor positively or negatively.
		• Drive systems: identification and application:
		  • V-belts
		  • Flat belts
		  • Pulleys
		  • Chains

	Tools and equipment	Components of the drive system of a vehicle: Identification, description and purpose: • Gearbox and types of gears • Clutch • Differential • Final drive • Diff lock • Front wheel hub lock 4x4 • Universal joints • Grease nipples • Bearings Economics associated with tractors, equipment and tools: • Tractor expenses • Buying versus leasing of tractors/ equipment • Choice of a tractor • Standardization • Mechanization Pneumatic and hydraulic tools: Identification • Compressor • Hydraulic press • Air wrench • Hydraulic jack • Spray paint gun
6-7	**Irrigation and water supply**	Overhead irrigation systems as listed below (Macro irrigation systems application, working, construction, parts, components and accessories, maintenance and care, fault finding, problem solving): • Centre pivot irrigation system • Travelling sprinkler gun or hose reel irrigation machine • Lateral move (side roll, wheel line) irrigation • "Hand move" Portable sprinkler system
8-10	**Mid-year examination**	Learners must write an examination paper not shorter than 200 marks at the end of this term. Time allocation – 3 hours.
Formal Assessment Term 2 Mid-year examination – 75% Practical task 1 – 25%		**Examples of practical tasks**: teacher can also use his or her own examples: • Do hard facing welding on a worn component of a plough; • Repair a cast iron part by welding it; • Do maintenance on an electric fence; • Set up a small scale solar panel system on the farm; and • Calibrate a centre pivot irrigation system.

3.11 Grade 12 Term 3

Week 4 hours	Topic	Content
1	**PAT**	PAT must be finished in this term. Marks must be awarded according to the guidelines provided for the final product.
1	**Practical Task 2**	Teacher must do one practical task with the learners during this term.
2-4	**Irrigation and water supply**	Irrigation scheduling: • Reason • Method Water content measuring techniques and devices used in conjunction with effective water scheduling: • Soil water potential • Water content Waste water removal: (Septic tank): • Working • Design • Components • Maintenance • Treatment Different types of drainage systems used to get rid of excess water around farm buildings: • French drains • Channel drains • Downspouts • Slope drains • Drainage ditches Water purification/softening and filtration systems. Identification.

5	**Communication**	Introduction to agricultural related computer control programs: • Irrigation control systems • Computers controlling and monitoring engines, implements and equipment Computer information technology: • GPS • CIS • VRT remote sensing Different types of communication systems: • Two way radios • Telephones • Internet • Cell phones Sources for knowledge, skills and information: • Exhibitions • Seminars • Agricultural unions • Discussion groups
6	**Drawings**	Interpret building plans • Produce freehand design drawings of structures, buildings or implements • Introduce learners to basic software programs for designing buildings, structures or machine parts (This will not be examined)
6	**Measurements, calculations and calibrations**	Refer to PAT and simulations. • Problem solving in data collected • Use data, collected from measurements and cost calculations in purpose made fabrications • Effective use of tools, equipment and implements due to correct measurements, calibrations and adjustments
7-10	**Preparatory examination**	The examination paper will be 200 marks and the time allocation is 3 hours.
Formal assessment Term 3 Preparatory examination – 75% Practical task 2 – 25%		**Examples of practical tasks**: teacher can also use his or her own examples: • Do hard facing welding on a worn component of a plough; • Repair a cast iron part by welding it; • Do maintenance on an electric fence; • Set up a small scale solar panel system on the farm; and • Calibrate a centre pivot irrigation system.

3.12 Grade 12 Term 4

Week (4 hours/ week)	**Topic**	**Content**
1		Revision
2		Revision
3		Revision
4		Revision
5		Revision
6 - 10		End-of-year examination

Formal assessment Term 4 Promotion mark	Learners will write an external set paper of 200 marks and it will be marked externally. Time allocation is 3 hours.
PAT – 25% Design – 25% Construction process – 50% Final product – 25%	**S** **B** **A** Term 1 – 100 Term 2 – 100 Term 3 – 100 **Total 300÷12=25** **PAT** Design – 25 Construction process – 50 Final Product – 25 **Total 100÷4= 25** **November Examination** **Total 200÷4=50**
	Final mark: 100

CHAPTER 1

SAFETY

1. Safety Hazards

A safety hazard is anything that could cause a physical injury, such as a cut or fracture.

A Hazard Control System

Using the following **THREE** steps is a practical and effective way of controlling hazards. It can work for a "formal" or "informal" inspection.

The steps are:

- Spotting known and potential workplace hazards
- Assessing or identifying the risk of these hazards, and
- Making the changes that will eliminate or control the hazard

Step 1: Spot the Hazard

A hazard is any situation, activity, procedure, equipment or animal that could harm someone. When spotting hazards, focus on all farm tasks, equipment and substances. When listing hazards use:

- Common sense
- Information from past accidents, near accidents and other experiences
- Information from your family, employees, neighbors
- Product literature and information from suppliers.

Step 2: Assess the Risk

Next, determine the risk of harm for the hazard(s) you've spotted. The risk of harm is the chance (or likelihood) that the hazard will actually harm someone.

Risk assessment mainly depends on two factors:

- The likelihood of an incident – Is it likely or unlikely to occur?
- The severity of the incident – Could it cause death, serious injury, or minor injury?

To assess the risk of a hazard hurting someone, ask questions like:

- How many people come in contact with the hazard?
- How often?
- How seriously could someone be harmed?
- How quickly could a dangerous situation come up if something goes wrong?
- This will help you to decide which hazards should be taken care of immediately. Also, you can use this information to help you decide what to inspect, when to carry them out and how often.
- The risk also depends on factors such as the physical and mental abilities of the individual (e.g., young operator), the weather and terrain (e.g., mud on a wet road), and how the equipment is used (e.g., working on uneven or

hilly terrain).

- Keep an eye out for hazards every day.
- Don't overlook low-risk hazards. They can also have fatal consequences.

Step 3: Make the Change

There are several ways to control a hazard. Pick the way(s) that's reasonable and practical for the circumstances you face.

1. **Eliminate hazards** posed by equipment, animals, and the environment if at all possible. You could, for example, get rid of a faulty machine, sell a bull that is difficult to handle, put hilly terrain into pastureland rather than cultivate it.

2. **Substitute something safer** by using a different machine, material or work practice that poses less risk to perform the same task. For example, you could substitute a safer chemical for a hazardous chemical, or always use your safest tractor in steep terrain to minimize the risk of a rollover.

3. **Use engineering/design controls** when it's not possible to eliminate hazards or substitute safer materials or machinery. PTO and auger guards, rollover protective structures (ROPS) and brake locks are good examples of blocking controls used on farms. Design controls that isolate the worker/family from the hazard including childproof locks on pesticide sheds, fenced safe play areas away from the immediate work environment and locating grain bins away from electrical lines.

4. **Protect the workers** if other controls are inadequate. Protect workers through training, supervision, and personal protective equipment (PPE). For example, you should supervise new workers until you're sure they're competent to deal with hazardous situations. Use and provide proper clothes and masks for handling dangerous chemicals or biohazards. Ensure someone at the worksite is trained in giving first aid.

3. Farm Safety Regulations according to the OHS act.

3.1 Tractor

- Rollover protective structure used and seat
- belts installed
- All shields and guards (e.g., PTO) installed
- Proper hitching attachments (i.e., draw bar
- and safety chain) are used
- Hearing protection available (tractor cab or
- ear protection)

3.2 Vehicles, Tools, Machinery, etc.

- Tools, machinery, equipment maintained
- Vehicles maintained
- Lockout mechanism available
- All shields and guards installed
- Hearing protection available
- Hydraulic hoses in good repair
- All warning decals and engine shut-off
- instructions visible
- Lights and wipers working
- "Slow Moving Vehicle" sign attached
- Brakes in good working order
- Battery in good condition
- Operator's platform clear of debris
- Visibility clear
- Fire extinguisher on machines

3.3 Fire Protection

- Isolate all sources of ignition
- Extinguishers (full) in hazardous areas
- No smoking signs in hazardous areas
- Exits clearly marked in hazardous areas
- Proper electrical installation
- Flammable materials stored safely
- Fire emergency numbers listed near telephone
- Emergency fire plan posted

3.5 Chemical Hazard & Biohazard Protection

- Chemicals stored safely and
- labeled properly
- Biohazards identified and dealt
- with safely
- Warning signs posted
- Proper Personal Protective
- Equipment (PPE) available,
- such as eyewear and protective
- clothing, in good condition
- Emergency numbers posted

3.6 Other Emergency Preparation

- Emergency plan posted
- Emergency numbers posted
- First aid supplies for all workplaces

3.7 Farm Buildings

- Fire exits clear
- Aisles, stairs, ladders and floors
- uncluttered and in good repair
- Light and ventilation adequate
- Buildings free of hazardous materials
- Hazardous ladders/openings/
- protrusions guarded
- Toilet/waste disposal facilities
- adequate
- Electrical fixtures suitable

3.8 Farm Yard

- Assigned play area for children
- away from work areas
- Protection from enclosed
- spaces such as cisterns, wells,
- manure pits, feed silos
- Protection from dugouts

3.4 Orientation and Training • Workers trained in safety work procedures • Workers receive adequate supervision • Workers trained in proper lifting, moving and • repositioning	• Grain bins located away from • electrical hazards • Identify and post all overhead power lines where high equipment (e.g., grain augers) is used **3.9 Work Environment** • Adequate lighting and ventilation for the work tasks • Protection from extremes of temperature

4. Health Hazards

Think of a health hazard as any agent, situation, or condition that can cause an occupational illness. There are five types (look for each type during inspections):

4.1 **Chemical hazards**, such as battery acid, solvents and pesticides

4.2 **Biological hazards**, such as bacteria, viruses, dusts, and moulds. Biological hazards are often called "biohazards" (e.g., animal borne disease, moldy hay, tetanus)

4.3 **Physical agents** (energy) strong enough to cause harm, such as electrical currents, heat, light, vibration, noise, and radiation

4.4 **Work design (ergonomic) hazards**, such as lifting, moving or repositioning of heavy loads

4.5 **Workplace stress**, such as stress associated with work shifts, workload, and harassment

5. Tractor safety

5.1 Roll-overs are often caused by:

- cornering at high speeds
- driving off the shoulder of roads
- working on a steep ditch, hill or washout
- carrying loads too high in the front-end loader
- hitching too high when pulling heavy loads
- towing loads downhill too fast and/or without sufficient brakes
- sliding off loading ramps

5.2 To prevent PTO accidents:

- stop the PTO before dismounting
- ensure that safety shields are in place before work begins
- replace cracked or defective safety shields immediately
- keep clothing, hair and all body parts away from a rotating PTO
- never step over a rotating PTO shaft – walk around or turn off the equipment
- keep universal joints in phase – refer to the operator's manual
- always use the driveline or PTO shaft recommended for your machine. Never use the driveline of one brand of machine in another model
- position the tractor's drawbar properly

5.3 Improperly hitching a tractor to an implement can be lethal. To prevent accidents:

- make sure that no one is behind the tractor
- slowly back it to the implement
- apply the emergency brake
- put the transmission in neutral
- dismount and hitch up

5.4 Transport tractors safely

5.4.1 Traffic rules must be followed whenever transporting tractors or machinery on public roadways.

- lock brake pedals together
- drive with lights and flashers on
- display a slow-moving vehicle sign

5.4.2 When transporting tractors:

- watch out for traffic hazards
- know equipment clearance requirements
- know the size and weight of the equipment

5.5 Tractor Hazard Spot the Hazard	Assess the Risk	Make the Change
Extra riders on machinery	Serious injury or death from falling off and being run over or otherwise injured	No extra riders
Bystanders near machinery	Serious injury or death from running over or pinning bystander	Install mirrors, improve sight lines, stop look and listen, keep children and spectators away from work area, check area before starting, install backup beeper
Equipment in poor condition, jump starting	Serious injury or death from run over after jump starting, from crushing injury caused by faulty hydraulics	Do regular maintenance, always do a pre-operational safety check. No jump starting
High/poor hitching	Serious injury or death from backwards rollover, rollover caused by a too heavy load for the tractor, going in the ditch, runaway loads	Never hitch above drawbar, use proper drawpin/clevis, extra weight for tractor front end, use engine for braking when going downhill with heavy load
Front end loader improper, too large or too high	Serious injury or death from large hay bale that can topple onto driver or bystander. Excess weight can cause rollover, particularly in uneven terrain; high bucket can result in contact with power lines	Ensure proper sized bucket for size of tractor, don't use manure bucket for moving large bales, use restraining devices or tines, drive with bucket low to the ground
Unguarded PTO	Serious injury or death from step over of PTO, starting of PTO, being entangled while performing repairs	Avoid PTO, use tight clothing, tie shoes, keep children from work area, disengage PTO where possible
Ignition of fuel	Death or injury from unanticipated combustion	Don't spill fuel on a hot engine, don't smoke near ignitable materials, don't refuel inside a building, keep children from work area, have fire extinguishers handy

6. NOISE POLLUTION

6.1 Working in a noisy environment can destroy your hearing. Noise can also:

- reduce your working ability
- increase your risk of having an accident
- increase stress and fatigue

6.2 Noise induced hearing loss is preventable.

- Protect your workers hearing by reducing or controlling noise at its source.
- When purchasing equipment, consider the long term benefits of obtaining the quietest suitable equipment.
- Make sure that the cabs of your equipment are well lined with sound-insulating materials.
- Minimize vibration in equipment by using rubber mounts.
- Keep exhaust systems well maintained.
- Use mufflers or silencers on motors, air hoses, and other equipment.
- Eliminate direct contact between metal-to-metal surfaces.
- Transfer exhausts noise to remote locations.
- Use barriers, vibration isolators and/or sound-absorbing materials.
- Keep the radio or stereo volume in the cab at a reasonable level; loud

6.3 It's Too Noisy If:

- someone standing a meter away from you needs to speak loudly or even shout in order to be heard
- you hear a "ringing" or "buzzing" in your ears after being in a noisy environment
- your hearing seems to be better at the start of the day than at the end.

CHAPTER 2

MATERIALS AND STRUCTURES

METAL ALLOYS

STAINLESS STEEL

1. Name the influences that the following alloy elements have on stainless steel.

Chromium

- Increases resistance against corrosion
- Promotes the hardening of steel
- Improves strength
- Improves resistance to the formation of scale
- Improves tensile strength
- Decreases magnetism
- Most chromium steels can be welded well.

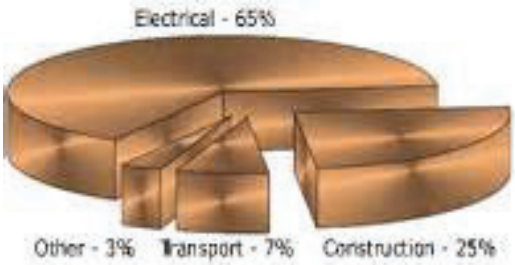
Manganese

- It combats corrosion
- Gives steel a coarser structure
- Changes the band structure, at the same time causing a reduction in striking strength
- Increases tensile strength
- Reduces the critical cooling tempo and by doing so improves hardening
- Increases resistance against wear
- Reduces magnetism.

Nickel

- It improves the amount of toughness and the hardening ability
- One of nickel's greatest advantages is that it gives steel a fair amount of toughness at low temperatures
- Used with chromium, nickel helps to increase the hardening ability of steel much more than when only one of the elements is used on its own
- Steel which is alloyed with chromium and nickel is resistant to air, water and many chemical acids and alkali.

2. COPPER (Cu)



Copper is hidden away in everyday objects around our homes, including phones, water pipes, locks and electrical wiring.

In history

People have been using copper since 9000 BC. One of the reasons copper is so important is that it can be made into alloys. That means it can be combined with other metals to make new alloys, like brass and bronze. These are harder, stronger and more corrosion resistant than pure copper.

For its properties

Copper is an excellent conductor of electricity and heat; it is strong, ductile and easily joined by soldering or brazing, and it is hygienic, easy to alloy and resists corrosion.

3. BRASS (Cu3Zn2)

Brass and bronze is an alloy made from copper and zinc,

Brass is a buttery yellow alloy of zinc and copper which has been manufactured for thousands of years in many parts of the world. Its uses vary depending on the percentages of zinc and copper, and which other metals have been added to alloy to bring out specific properties, but they include

Basic brass has approximately 67% copper and 33% zinc, making it stronger and more durable than copper, although not as strong as metals like steel. Alloys with even less zinc start to turn reddish in colour, and are sometimes called red brass.

Brass is usually the first-choice material for many of the components for equipment made in the general, electrical and precision engineering industries. Brass is specified because of the unique combination of properties, matched by no other material, that make it indispensable where along, cost-effective service life is required.

The generic term ‘brass’ covers a wide range of copper-zinc alloys with differing combinations of **properties**, including:

- Strength
- Machinability
- Ductility

- Wear resistance
- Hardness
- Colour
- Conductivity (electrical and thermal)
- Corrosion resistance
- Antimicrobial
- Brasses can easily be cast to shape or fabricated by extrusion, rolling, drawing, hot stamping and cold forming.
    - The machinability of brass sets the standard by which other materials are judged.
    - Brasses are ideal for a very wide range of applications.
    - Brass is frequently the cheapest material to select.
    - The correct choice of brass is important if manufacturing and operating requirements are to be met in the most cost-effective way.

To suit every need, there are over sixty Standard compositions for brass with copper contents ranging from 58% to 95%. Apart from the major alloying element, zinc, small additions (less than 5%) of other alloying elements are made to modify the properties so that the resulting material is fit for a given purpose.

Some common applications for brass

Music instruments Rods, Rivets, Pinions, Motion sensors, Unions, Terminals, Spindles, Screws, Jets, Injectors, Cable glands, Valve spindles, Shafts, Marine fittings, Plumbing fittings, Gas fittings, Pneumatic fittings, Sections Bathroom hardware, Terminals, Tracks, Valve bodies, Balance weights, Valves, Spark resistant mining components, Shower parts, Hollows Automotive components, Nuts, Cable connectors, Bearings Nuts, Hot Stampings n/a, Tube fittings, Electrical components, Plumbing hardware, Synchromesh gearings, Cavity wall ties, Mining equipment, Plumbing fittings, Cartridge cases for weapons, Pipes, Weather-stripping, and household ornaments

Annealing (full)

In order to fully soften most brasses, heat to 500-550ºC for 1⁄2 to1 hour at temperature, then either air cool or, especially for alpha alloys, ensure that excessive grain growth is prevented by a quench or rapid furnace cool.

Stress relieving

In order to relieve internal stresses without loss of properties a low-temperature anneal such as 1⁄2 to 1 hour at 250-300ºC should be used, dependent on section size.

Temper annealing

Many brasses cold worked too hard temper can be partially softened to produce intermediate tempers by carefully controlled heat treatment. Time and temperatures need to be established by experiment, starting from, say, 1⁄2 hour at 400ºC and altering time and/or temperature to achieve the desired temper. Results are monitored by measuring hardness, grain size, directionality or other relevant properties.

Joining brasses

Soldering

Soldering is easily carried out using any of the lead/tin or lead free solders to EN 29453, and either an active or non-active flux. Sudden heating of stressed parts in contact with molten solder can result in cracking of the material due to inter granular solder penetration. In such cases parts should be stress relieved before soldering. After soldering it is good practice to remove any flux residues in order to reduce the tendency for these to cause staining or corrosion.

The lead-free tin-based solders are chosen for use where the presence of lead may be undesirable.

Brazing

All the brasses are readily joined by brazing alloys covered by EN 1044. When a flux is used it is likely to cause corrosion if allowed to remain in place on the component. It should be washed off as soon as practicable. This is easy if the component is still warm after brazing but the brass should not be quenched directly from the brazing temperature or quench-cracks may be caused.

4. BRONZE

The difference between bronze and brass is:

The difference is that bronze is mainly copper plus tin (not zinc) in various proportions and brass is mainly a copper-zinc alloy.

Bronze deer figurine dating from between the 9th and 6th centuries BC

Bronze is an alloy consisting primarily of copper, usually with tin as the main additive. It is hard and tough, and it

was so significant in antiquity that the Bronze Age was named after the metal. However, historical pieces were often made interchangeably of brasses (copper and zinc), and bronzes with different compositions, so modern museum and scholarly descriptions of older objects increasingly use the more inclusive term “copper alloy” instead.

The discovery of bronze enabled people to create metal objects which were better than previously possible. Tools, weapons, armor, and various building materials, like decorative tiles, made of bronze were harder and more durable than their stone and copper (“Chalcolithic”) predecessors.

Though bronze is generally harder than wrought iron, the Bronze Age gave way to the Iron Age because iron was easier to find and to process into a poor grade of metal; although it can be made into higher grades, doing that takes significantly more effort and skill. Bronze was still used during the Iron Age. For example, officers in the Roman army had bronze swords

Properties

- Bronze resists corrosion (especially seawater corrosion)
- Resists metal fatigue more than steel
- Better conductor of heat and electricity than most steels.
- High electrical conductivity
- Low-friction properties of bearing bronze,
- Resonant qualities of bell bronze
- Resistance to corrosion by sea water.

Uses

Bronze sculpture, bearings, clips, electrical connectors and springs.

Spring bronze, weather stripping building restoration cannons, electric motors. Phosphor bronze is particularly suited to precision-grade bearings and springs. It is also used in guitar and piano strings.

Unlike steel, bronze struck against a hard surface will not generate sparks, so it (along with beryllium copper) is used to make hammers, mallets, wrenches and other durable tools to be used in explosive atmospheres or in the presence of flammable vapors.

Bronze is used to make bronze wool for woodworking applications where steel wool would discolor oak.

Bronze statues, Bronze Musical instruments, Bronze Medals

5. TIN (Sn)

Discovery of Tin

Tin has been known since ancient times.

The Bronze Age began in about 3000 BC and tin was used in bronze, which contains roughly ninety percent copper and ten percent tin.

The addition of tin to bronze alloys improves their properties compared with pure copper: for example, bronze is harder and more easily cast than copper.

The ancient Greeks obtained their tin by sea-trade and referred to the source as 'The Cassiterides', meaning Tin Islands.

These islands were most likely to have been in Great Britain or Spain where there are large tin deposits

Characteristics:

Tin is a silvery-white, soft, malleable metal that can be highly polished.

Tin has a highly crystalline structure and when a tin bar is bent, a 'tin cry' is heard, due to the breaking of these crystals.

It resists oxygen and water but dissolves in acids and bases. Exposed surfaces form an oxide film. When heated in air, tin forms tin(IV) oxide (stannic oxide) which is feebly acidic.

Tin has two allotropic forms at normal pressure, gray tin and white tin. Pure white tin slowly tends to become the gray powder (gray tin), a change commonly called 'tin pest' at temperatures below 13.2 ^{o}C. Gray tin has no metallic properties

at all. Commercial quality tins are resistant to tin pest as a result of the inhibiting effects of minor impurities.

Uses of Tin

Tin is used as a coating on the surface of other metals to prevent corrosion. 'Tin' cans, for example, are made of tin-coated steel.

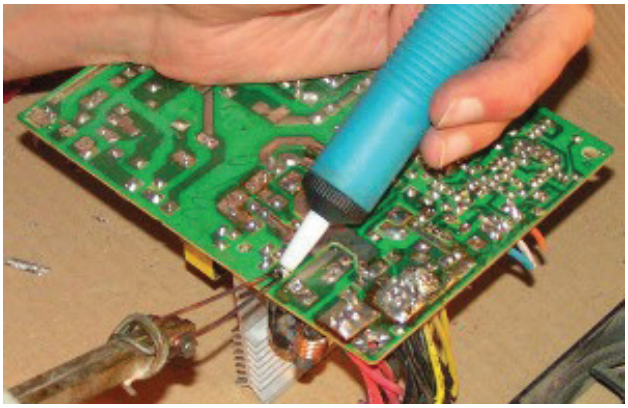
Alloys of tin are commercially important in, for example, soft solder, pewter, bronze and phosphor bronze.

Tin chloride (stannous chloride, $SnCl_2$) is used as a mordant in dyeing textiles and for increasing the weight of silk.

Stannous fluoride (SnF_2) is used in some toothpastes

cans made from tin

PC boards soldering using.



SYNTHETIC MATERIALS

ADHESIVES

1. Name the two most important aspects, which must be considered when an adhesive is chosen?

- Type of material to be joined.
- Conditions under which this joint will be used.

2. Name some types of adhesives.

- Epoxy.
- Silicon.
- Resorcinol.
- Latex.
- PVA/PVC
- Cold glue
- No more nails

3. Name the conditions under which an adhesive could be used and describe each shortly.

a) Heat resistance (Temperature)

- The adhesive itself should not distort, melt or burn when heated.
- Some kinds of plastic are extremely heat resistant like Bakelite, and some are not heat resistant like Perspex, which easily changes shape when heated.

b) Water-resistance

When placed in humid conditions, a water resistant adhesive should be used to make a joint.

c) Elasticity

Some adhesives get very hard and brittle when they dry. If we want to join elastic materials, we would use an adhesive, which would still be elastic after it has become dry. Ex. Bostic, Prestic.

d) Load capacity

The adhesive should be able to withstand mass or tension.

e) Inflammability

If an adhesive are to be used to join synthetic materials where it is subjected to open flames or heat the adhesive itself must comply with the same properties.

f) Duration of cohesion.

The period of time that an adhesive will stick after having been applied.

g) Duration of usability

Period of time during which the mixed adhesive remains usable before setting. Catalyst and the accelerator can have a influence on the speed at witch this happens.

4. Describe the difference between the cohesion and adhesion properties of an adhesive.

Cohesion

Inherent strength of the adhesive.

Adhesion

Ability of the molecules of an adhesive to cling to the molecules of other substances.

5. What can you recommend to improve the cohesion properties of an adhesive?

a. Apply a thin base coat if the surface is very porous.

b. Apply only a thin layer of adhesive.

c. Apply adhesive to both surfaces.

d. To thick layer of adhesive will result in a weak joint.

GLASS FIBRE

1. What is a resin?

They are low viscosity fluids that can be transformed to tough flexible solids by adding a hardening agent.

2. Name seven precautionary measures when working with glass fibre.

- Catalyst and accelerator should always be stored separately.(Explosion)
- Remove all resin catalyst and accelerator from skin.
- Wear gloves if skin is sensitive.
- Use acetone in well ventilated room.
- Handle resin casting carefully they are brittle.
- Glass fibre matting has small pieces of fibre that can penetrate the skin.
- Don't breath in glass fibre or get it in your eyes.

3. Why should the catalyst and accelerator be stored separately?

They can cause an explosive mixture.

4. What is the hardening agent also called?

Catalyst.

5. Name ten characteristics of glass fibre.

- Lightness.
- Water tight.
- Non-conductive of electricity.
- Can be formed into any shape.
- Easy to colour.

- Colour fast.
- Can be sawn, drilled, and filled.
- Toughness.
- Brittle when struck.
- Easy repaired when break.

6. **Name five examples of glass fibre products.**

- Lampshades.
- Fruit bowls.
- Golf clubs.
- Boats.
- Cycles, Golf clubs.

VESCONITE

1. What is vesconite?

Vesconite is a specialized thermoplastic made from internally lubricated polymers.

Properties of Vesconite

- Vesconite is a proven exceptional plain bearing material, giving long life in applications requiring the lowest rates of wear. Even in dirty and unlubricated conditions Vesconite gives long life with low maintenance and low friction.
- Whether dry or underwater, unlubricated or lubricated, a very low friction coefficient means Vescontie is ideal for many marine applications. Water is an excellent lubricant for Vesconite making it suitable for both dry and immersed applications.
- Vescontie has many advantages compared to composites, elastomers, bronze, phenolic laminates, cutless rubber, nylon and lignum vitae. Unlike nylon, some elastomeric materials and phenolic laminates Vesconite is dimensionally stable.
- Underwater or in humid conditions, Vesconite will not swell and seize or soften and wear like nylon.
- Vesconite's internal lubricants make it well suited to upper rudder bearing applications where there are long periods between greasing or no greasing at all, or where water lubrication cannot be ensured when operation with light ballasts.
- Vesconite is extremely versatile combining the advantages of metallic and non-metallic bearings and bushes to outperform in most plain bearing applications.
- Long wear life
  Vesconite gives up to ten times the service life of phosphor bronze in poorly lubricated conditions.
- Vesconite keeps size – no water swell for most synthetic bearing materials water swell is a major problem and an excessive clearance is often used to compensate. Greater clearance allows increased vibration and faster bearing wear - greatly shortening lifespan.
- Vesconite is one of the most dimensionally stable synthetic materials available as it does not swell in water (see diagram below). Therefore, Vesconite bearings may be machined to the correct clearance without fear of swelling.

Vesconite remains hard
Softening caused by humidity and immersed conditions has disadvantages for traditional synthetic bearing materials like those based on elastomers and nylons, which soften and lose their compression strength in water.

Vesconite does not delaminate
Delamination occurs when liquid penetrates the bearing layers causing it to peel or break off, creating weakness, an uneven surface and excessive clearance.

Vesconite has low friction
Compared to most elastomers, rubbers, nylons and laminates; Vescontie has a low static and dynamic friction which remains in tough working environments; whether dry or wet, lightly or heavily loaded.

SOS: Save Our Shafts
Because of its low friction, Vesconite saves your shafts and liners. Reduced wear and increased service life limit maintenance or early replacement providing financial saving of expensive components.

Vesconite does not corrode
Vesconite is not subject to electrolytic corrosion, a major problem with traditional metallic bearing materials.

Easy removal of Vesconite bearings
Since no electrolytic corrosion occurs with Vesconite, it does not seize like metallic bearings and Vesconite bearings are therefore easy to remove.

Safety and health
Vesconite does not contain any asbestos, lead, hazardous fibres or substances making safe to machine and handle.

Easy to machine
Compared to metallic, cutless, bronze or synthetic bearing materials Vesconite is very easy and safe to machine on standard metal or wood working machinery.

Vesconite vs white metal
Vesconite has a higher design load limit than white metal (Babbitt), a higher fatigue strength and two to three times the wear life.

Product Range
Bushings
Thrust washers
Solid rods
Plates and Wear Strips

Applications in Agriculture include:

Tractors

- King pin bushes for most makes of tractors
- Bushes for brake and clutch systems
- Steering linkage bushes
- Front axle swivel bushes
- Lift arm bushes
- Pivot bush

Planters

PNU Monosem wears plates for the Monosem planter.

Pressure wheel bushes
Drive shaft needle bearings can also be replaced by Vesconite.

Combine Harvesters
Variable speed pulley bush

Windmills
Vesconite is of special value in windmill applications. Many metal to metal bearing situations, which result in high wear rates, can instead be bushed with Vesconite for longer life.

Many windmill white metal bushes have also been replaced by Vesconite.

Irrigation

Irrigation

Various bushes in gearboxes of centre pivot irrigation systems.

Trailers
Shackle pin and trunnion bushes for use on high and low speed agricultural trailers.

Why use Vesconite?

- has a very low coefficient of friction
- can be used in dry or lubricated applications
- dimensionally stable
- does not swell and seize on shafts
- does not soften or delaminate

Advantages of Vesconite

- easy to fit and remove
- does not corrode and is non-conductive
- will not wear shafts & liners like traditional bearing materials
- resistant to a wide range of chemicals

TEFLON

Description of Teflon

- One of the most versatile and familiar products of chemical engineering, Teflon, was discovered by accident. There are many such tales to be found in the history of industrial chemistry, from vulcanized rubber to saccharin to Post-Its, all of which were stumbled upon by researchers looking for other things.
- So common, in fact, are unplanned discoveries of this sort that one might expect would-be inventors to simply mix random chemicals all day long until they come up with something valuable.

Teflon is polytetrafluoroethene (PTFE).

- Teflon is the plastic with the lowest coefficient of friction.
- It is also used as a non-stick coating for pans and other cookware.
- Teflon is very unreactive, and so is often used in containers and pipework for reactive chemicals. Its melting point is 327 °C.
- Teflon is sometimes said to be a spin-off from the US space program with more down-to-earth applications, but actually its first significant use was in the Manhattan Project, as a material to contain highly-reactive uranium hexafluoride.
- It was first sold commercially in 1946.

Advantages:

- Inert to practically all commercial chemicals, acids, alcohols, coolants, elastomers, hydrocarbons, solvents, synthetic compounds and hydraulic fluids.
- Rated for steam to 250 psi (406 degrees F) - has low volumetric expansion characteristics - easy to clean and sterilize.
- Not affected by continuous flexing, vibration or impulse pressures - withstands alternating hot and cold cycling
- Easier to move, handle and install than rubber hose with a comparable burst pressure rating.
- The low coefficient of friction of Teflon and anti-stick properties lowers pressure drop while maintaining good service pressures.
- Jackson Hose of Teflon has optional conductive liner for removing static build up through the flow path.
- Will not contaminate material, fluid or gas conducted - Teflon is an FDA recognized material for food handling and pharmaceutical applications.
- Handles substances such as adhesives, asphalt, dyes, greases, glue, latex, lacquers and paints with ease.
- No moisture absorption, ideal as a pigtail in bulk gas handling and pneumatic systems where a low dew point is critical
- Impervious to weather and can be stored for extended periods of time without aging. It will not age during service.

Here are five advantages of Teflon coating services:

- The electrical properties of Teflon are unparalleled. In cases where you're dealing with various frequencies, there is no better sealant than Teflon. Its dissipation factor is low, and yet Teflon has high dielectric strength.
- Most chemicals don't affect Teflon. Most industries use some type of chemical, and Teflon coating services will keep other materials covered so that those hazardous chemicals won't harm them.
- Teflon is heat and cold resistant. Not all kinds of coatings can withstand both blazing hot and freezing cold temperatures, especially those as extreme as 600 degrees Fahrenheit or -454 degrees Fahrenheit.
- Since Teflon is non-stick, it basically cleans itself. Teflon coating services are a great way to keep machines clean because liquids just slide right off of surfaces that are coated with it.
- The coefficient of friction is low. There are several types of Teflon coatings, but they are all very smooth and do not put up much resistance, so any moving parts that are coated with it slide gently and easily

Uses

In the 21st century, in addition to its widespread use in manufacturing and industry, PTFE is used on all sorts of everyday items. Many people are familiar with non-stick cooking pots and pans that have been coated with Teflon®. Automobile wiper blades also are commonly coated with PTFE, which helps keep the blades from squeaking as they pass back and forth across the windshield. PTFE also is used as a carpet or fabric protector because it repels liquids, allowing spills to be wiped up without leaving a stain. It has been used on all-weather clothing, to coat eyeglass lenses, as a fingernail protector and even in a line of hair care products. Magazines for guns, Teflon tape, Teflon coated cooking pans, Teflon tape for sealing fittings, Car wash products, O-Rings, Oil and water seals. Teflon Taps, fittings, non-return valves. Flanges, Pipe saddles.













ELECTRICAL FENCES

Electric fencing is a very popular, versatile and effective form of fencing and can be used in both temporary and permanent fencing situations. This information guide will give you the customer a better understanding of electric fencing and an insight in to how the products are used.

1. Name a view safety requirements and regulations applicable to electric fences

- Electric fences shall be installed and operated so that they cause no electrical hazard to persons, animals or their surroundings.
- Electric fence constructions, which are likely to lead to entanglement of animals or persons, shall be avoided.
- An electric fence shall not be supplied from more than one energizer
- The gap between two separate electric fences with different energizers shall be at least 2m.
- If this gap is to be closed, this should be effected by means of a electrically non conductive material.
- Barbed or razor wire shall not be electrified by an energizer.
- Any part of an electric fence which is installed along a public path or highway shall be identified by warning plates securely fastened to the fence posts
- Except for low output battery operated energizers, the energizer earth electrode shall penetrate the ground to a depth of at least 1m.
- Connecting leads that are run inside buildings shall be effectively insulated from the earth structural parts of the building.
- Connecting leads that are run underground shall be run in a conduit of insulating material.
- Care shall be taken to avoid damage to the connecting leads due to the effects of animal hooves or tractor

wheels sinking into the ground.

- Connecting leads shall not be installed in the same conduit as the mains supply wiring, communication cables or data cables.
- Connecting leads and electric fence wires shall not cross above overhead power or communication lines.
- If connecting leads and electric fences are installed near an overhead power line the clearances shall be:

Power Line Voltage: Under 1000 volts - **Clearance:** 3 Meters

Power Line Voltage: 1000 - 33,000 volts - **Clearance:** 4 Meters

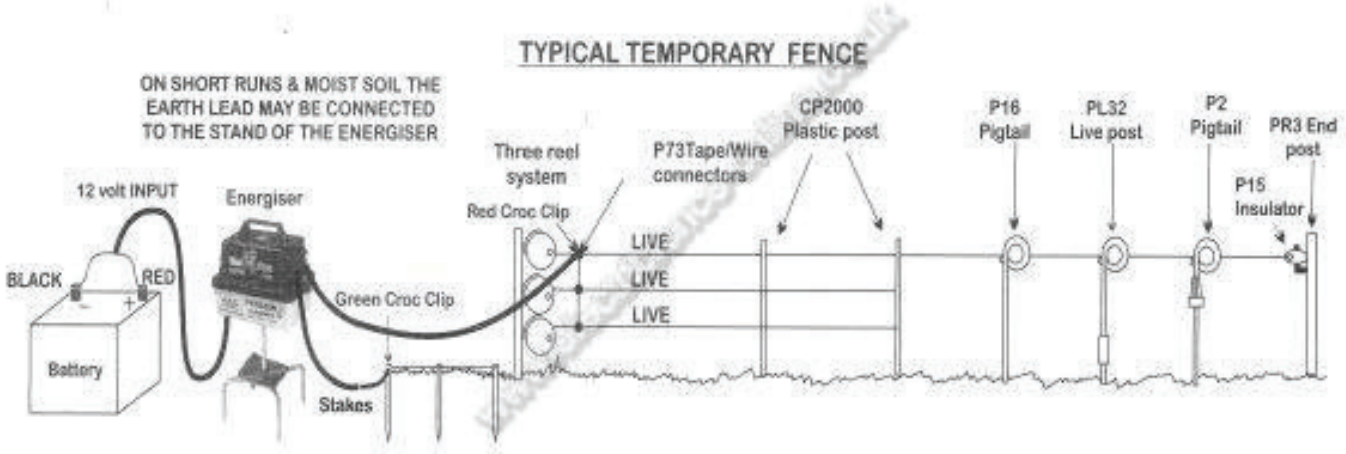
Power Line Voltage: Over 33,000 volts - **Clearance:** 8 Meters

- If connecting leads and electric fence wires are installed near an overhead power line, their height above ground shall not exceed 2m. This height applies either side of the orthogonal projection of the outermost conductors of the power line on the ground surface, for a distance of - 2m for power lines not exceeding 1000V - 15m for power lines exceeding 1000V.
- A distance of 10m shall be maintained between the energizer Earth Spike and any other earthing system such as the power supply system protective earth or the telecommunication system earth.
- Electric fences intended for deterring birds, household pet containment or training animals such as cows need only be supplied from low output energizers to obtain satisfactory and safe performance.
- In electric fences intended for deterring birds from roosting on buildings, no electric fence wire shall be connected to the Earth Spike.
- Where an electric animal fence crosses a public pathway, a non-electrified gate shall be incorporated in the electric fence at that point

2. **Energizers do not cause interference**. This is normally caused by bad joints, leaking insulation or vegetation touching the fence line.

3. **If you are experiencing interference please follow the checklist below**:

- The Energizer Earth system must be sufficient.
- The Energizer Earth System must be 10m away from the mains supply, safety Earth and buried water pipes.
- The energizer **MUST NOT** be connected to the mains supply safety earth or to the water supply pipes.
- The mains power supply plugs and sockets for the radio and the energizer must be in good working order. No Loose Connections.
- The energizer earth cable must not touch buildings, which can act as a broadcast aerial. Use double insulated (HTG) cable or run the wire to earth using insulators.
- The energizer's ground system should be at least 10m away from radios and buried telephone wires.
- Avoid running the electric fence line parallel to power or telephone lines.
- Use only top quality insulators. Sparking inside cracked or poor quality insulators causes interference.
- Vegetation touching the fence line close to the radio can also cause sparking and therefore interference.
- To locate sparking caused by leakage, faulty joins, broken wires or faulty insulators, walk the fence line with a transistor radio tuned off station on the AM band on high volume. The clicking will get louder as the fault is approached.



4. Name the procedure that you must follow when testing the earth system of an electrical wire.

a) Firstly short out the live fence line to ground, either with a metal stake or by laying the fence line on the ground for about 100 meters and at least 30 meters away from the energizer.

b) Switch the energizer ON.

c) Measure the voltage between the GROUND and the Earth Spike with a meter. If this is above 200 volts the earth installation is inefficient. Check the connections or increase the number of Earth Spikes.

d) If you get a shock from the Earth Spike before you short the fence line, then there is a poor Earth **AND** possibly a fault on the fence line as well. (Check for vegetation on the line or faulty insulators).

LIGHTNING PROTECTION

5. Name two methods of preventing lightning from damaging your energizer.

a) Installing lightning protectors.

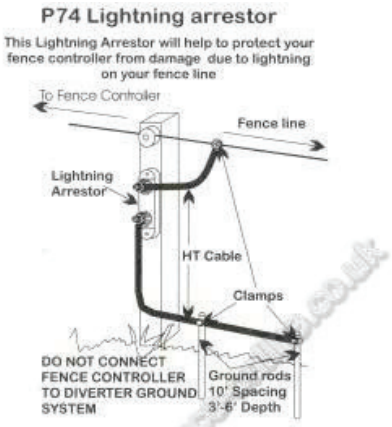
b) Switch off all electricity during thunderstorms.

Lightning strikes can damage energizers. Damage can be minimized by disconnecting the energizer from the fence line and disconnecting it from the power supply during electrical storms.

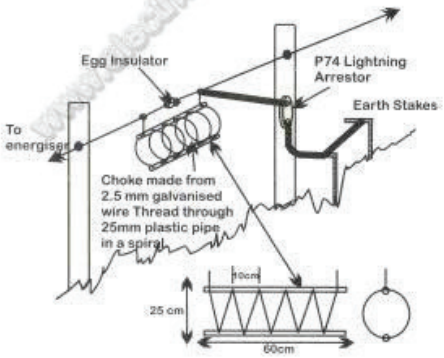
A Lightning arrestor kit is recommended to minimize damage to your energizer. Lightning always finds the easiest path to ground. Therefore the ground system of the lightning arrestor must be as good as or better than the energizer ground.

The choke can be made quite simply and causes a blocking effect for the extremely high voltage of the lightning so that it jumps the silicon carbide discs in the arrestor and is diverted to ground.

In areas where lightning is a major problem it would be advantageous to have additional arrestors dispersed over the farm in damp areas.



For extra protection a choke may be added with the P74 arrestor.



6. **Name the requirements for the warning plates on an electric fence**.

a) Firmly clamped to the fence wires at intervals recommended to be of approximately 10 meters to 50 meters, but not exceeding 90 meters.

b) The warning signs shall be at least 100mm x 200mm.

c) The background color of both sides shall be yellow.

d) The inscription shall be black and shall be the "**TAKE CARE - ELECTRIC FENCE".**

e) The inscription shall be indelible, inscribed on both sides and have a height of at least 25mm.

7. **Name a few general electric fencing tips when maintaining an electrical fence.**

a) Regularly check the fence line for vegetation growing over the fence line of fallen branches, as this will reduce the voltage on the line.

b) Check for damaged or broken wires, damaged isolators or loose connections.

8. Describe the earth return system of an electric fence shortly

a) The earthing system is an integral part of your energizer's performance. As with all energizers there must be a return path through the ground and Earth Spike back to the energizer in order to complete the loop.

b) Always bear in mind that all electrical circuits must form a complete loop from the positive (live) to the negative (earth) is just as much part of the circuit as the fence line and the animal is the missing link that completes the loop.

c) Vegetation will also complete the loop causing the output voltage of the energizer to drop. Therefore it is very important to keep any growth on the line to a minimum to ensure the animal receives the maximum shock from the energizer.

9. Describe two ways of increasing the earth efficiency for particularly poor earth conditions. (Sand, peat, gravel, very dry soil, snow or frozen ground)

a) Increasing the number of Earth Spikes.

b) Run an earth return wire in parallel to the fence line and connecting it to Earth Spikes at regular intervals.

10. **Occupational Health and Safety Act, 1993**

Rules and regulations for Electric fences

1. No user shall install a fence energizer which delivers impulses of electrical energy to an electric fence which are not equal to or within the following values:

Peak value of voltage	10 kV
Maximum duration of impulse	50 ms
Minimum interval between impulses	0.75s
Maximum quantity of electricity per impulse	2.5 mC
Maximum energy discharge per impulse measured at a resistance of 500 ohms	8 J

2. The user shall ensure that every fence energizer is:

   a. constructed so as to exclude dust and water; and

   b. not installed in dusty locations or locations where there is a fire hazard.

3. The user shall not install a fence energizer which receives its energy from an electric supply system:

   a. in locations where the energizer is likely to sustain mechanical damage or be tampered with;

   b. on any pole of an overhead power or communication line except poles which carry the conductors of the energizer; and

   c. unless the output circuit is isolated from the supply by means of a double-wound isolating transformer.

4. The user of a fence energizer shall:

   a. cause the earth of every fence energizer to be free and at least 2 m away from the earth of any other electrical system; and

   b. not electrify barbed-wire but only smooth wire or such articles as will enable a person touching it to let go immediately: Provided that smooth wires attached to barbed wire fences may be electrified.

5. In the case of a fence energizer which receives its energy from a battery charged by means of charging apparatus which receives power from an electric supply, the user shall ensure that the charging apparatus is of double-wound isolation construction.

6. When an electric fence is installed along a public road or in an urban area the user shall-

a. as far as is practicable mount the electrified wires or articles in such positions that persons cannot inadvertently come into contact therewith; and

b. display notices conspicuously, warning people that the property is protected by an electric fence.

11. Some Components of an Electric Fence

Below contains information about the parts of a highly effective electric fence system used to control, contain or exclude animals on your farm or ranch - or even your garden.

Insulators are used to fasten electrified wire to fence posts without losing energy through the posts. They can be porcelain or plastic and are available in many designs for various fence post types.

INSULATORS

Electric fence wire comes in many lengths, strengths and materials, but they all have one main purpose: to carry the electric fence charge throughout the length of the fence.

FENCE WIRE

Improper grounding leads to a useless electric fence. In 90% of all cases where the electric fence doesn't work, you can bet it's because of erroneous or faulty grounding setup.

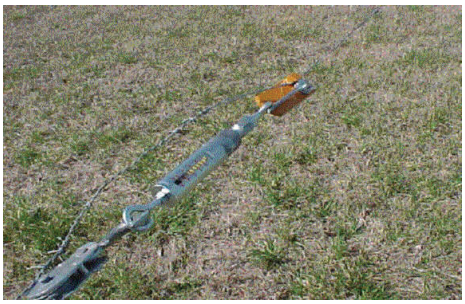
GROUNDING

You should have one gate handle for every electrified wire. The handles are usually made of plastic or rubber. Gate handle kits are a convenient way to install the gate handles.

THE CHARGER

The charger (or energizer) is the "heart" of the electric fence system. It converts main or battery power into a high voltage pulse or "shock" as felt by the animal when it touches the fence. In the past, electric fence chargers shorted out easily. Today's chargers are low impedance, meaning they are designed to effectively shock though vegetation and other foreign materials touching the fence.

Power Source



Battery (dry disposable or 12 volt wet rechargeable), depending on model. Mains and solar systems are available.

Fence Wire Tensioners

a) Spring which can tension up to 1.6 mm wires

b) Wire Strainers Tensioners

GENERAL QUESTIONS:

Electrical fences are used on farms for self-protection and protection of property.

1. Indicate any FOUR safety measures that need to be implemented when erecting electrical fences on a farm where people may come into contact with them.

- Amperage may never be higher than **0.002** Amps, or the voltage may never exceed **10 000** Volts.
- Warning signs must be secured to the fence to warn people not to come into contact with the fence.
- Electrical fences must never be erected parallel under overhead power lines because a higher current can be induced in the fence by the overhead power lines.
- Make sure that the wires are not earthed.

2. What type of material can be used as an insulator between the wire and the post to prevent a short circuit?

Ceramic, rubber, plastic, anything that does not conduct electricity

3. The wires of a electric fence must be very strong because of the enormous tension in the wires. What type of wire are used to erect an electric fence, what must the minimum thickness be and with what is this wire covered to prevent rust?

Steel wire that is 3mm thick and galvanized.

4. What must safety signs warn people off?

Electricity/Shock/High voltage

5. Name things to remember when you place safety signs against electric fences?

- Place on all gates, doors and fences to warn people of potential dangerous situations or places.
- Signs must be large and colourful so that people/children and illiterate persons can identify and or notice it easily.
- High enough to be out of reach of thieves
- High enough to be out of reach of vandals
- High enough to be out of reach of animals

6. Insulation material used in the roofs of buildings must adhere to certain safety precautions. List FOUR of these precautionary measures.

- Must not be harmful or dangerous to people when inhaled or touched.
- Should not burn easily.
- Rodents and insects must not be able to eat it or build their nests in it (treated with an anti pest agent).
- Should be light.

CHAPTER 3

ENERGY

ALTERNATIVE ENERGYSOURCES

1. WIND ENERGY

1.1 How to transform wind energy into a form of electrical power

It is a fairly simple process and works on the same principle as most power production techniques.

- In order to generate wind power you need to be able to capture energy from the force of the wind.
- This is done usually through the use of a wind turbine with a propeller blade type design.
- The propeller design is common in horizontal wind turbines, as the less popular design of vertical wind turbines use a different method to capture wind energy.
- Once you have the capability of capturing the winds energy, this harnessed energy can be used to drive turbines, attached to a generator, which enables the generator to produce power.

1.2 Buying and installing a wind turbine

- Before purchasing **small wind turbines** for your farm you should consider the surrounding environment of the placement location, and if it meets the requirements for a wind turbine installation to be cost effective and efficient.
- If you live in the countryside, and are surrounded by many fields and open spaces, then the average wind speed approaching your home may be more powerful than inner town or city locations.
- Another factor to consider is the way the land around you lies.
- If there are any large hills or mountains close by, then the placement of wind turbines may not be your best option.
- Wind turbines require a substantial wind speed to generate electricity efficiently. The faster the wind, the more output in watts you can generate (but you cannot go over your turbines capacity.)

- If there is a forest or collection of trees nearby, then you may decide to opt for a different means of renewable energy such as solar, or geothermal power due to a possible poor wind speed.
- Before purchasing any turbines, you should consider researching and maybe even hiring a professional to do a survey on the surrounding area, to determine if a wind turbine would be economically viable in your surrounding area.

- If the surrounding area is fit to generate power from the wind, you may wish to go and purchase a wind turbine (like the one below), and choose where you plan to install it.
- Many people suggest attaching small home turbines on a pole in a well exposed area, to harness the majority of the winds force.
- Once installed in an open space, above any large objects, make sure your turbine is facing the most common wind direction. Some wind turbines are able to adjust themselves to face the position of the wind.
- It is important that you receive expert advice when planning to purchase a wind turbine,
- An electrician may be able to hook the turbine up to your power supply to provide your home with an extra boost in electricity, reducing the amount of power you use from your electricity provider.
- Wind turbine placement is one of the key factors as to whether or not your project will be efficient.
- Some people combine wind energy technologies with solar, and/or geothermal energy systems in a bid to provide a greater level of efficiency in various scenarios.

1.3 Advantages of wind energy

- Wind power has no fuel costs
- Low or negligible costs for maintenance.
- Wind power has no clean-up costs, but fossil fuels do.
- No carbon tax costs.
- Natural gas and oil imports can be reduced
- There is no reason why South Africa could not only make wind turbines for its own need, but become a wind turbine exporter creating jobs and earning foreign currency.
- Wind turbines are emissions-free, which means they do not contribute to air pollution.
- Wind is a renewable energy source unlike fossil fuels, which are an exhaustible source of energy.
- As a result, large numbers of wind turbines could reduce dependence on other energy sources, providing a more dependable source of energy in the long term.
- Wind energy is much less expensive than other sources of energy. While the cost of residential energy averages over 12 cents per kilowatt hour, the average cost of wind energy is just five to six cents per kilowatt hour.
- Wind turbines are a great resource to generate energy in remote locations, such as mountain communities and remote countryside.

1.4 Disadvantages of wind energy

- The main disadvantage regarding wind power is down to the winds unreliability factor. In many areas, the winds strength is too low to support a wind turbine or wind farm, and this is where the use of solar could be a great alternative.
- Wind turbines generally produce allot less electricity than the average fossil fuelled power station, requiring multiple wind turbines to be built in order to make an impact.
- Wind turbine construction can be very expensive and costly to surrounding wildlife during the build process.
- The noise pollution from commercial wind turbines is sometimes similar to a small jet engine. This is fine if you live miles away, where you will hardly notice the noise, but what if you live within a few hundred meters of a turbine? This is a major disadvantage.
- Protests and/or petitions usually confront any proposed wind farm development. People feel the countryside should be left intact for everyone to enjoy it's beauty.

1.5 QUESTIONS AND ANSWERS

The diagram below shows structures that are used to produce electric energy.

1.5.1 **Name the energy source that this structures utilise to generate electric energy?**

Wind.

1.5.2 Discuss shortly the technical aspects of a wind turbine.

- Wind turbines, made up of two or three propeller-type blades mounted around a large rotor; resemble large fans mounted on towers.
- The rotor is connected to a main shaft, which spins a generator to create electricity.
- When placed 100 feet or more above the ground, the turbines take advantage of fast winds to spin the blades and capture energy.
- The turbines can produce energy for individual homes or businesses, or they can be attached to the electrical grid to create energy for more widespread use.

1.5.3 Describe shortly how this structure generates electrical energy.

Wind power works by converting the kinetic energy present in wind first into mechanical energy and then into electrical energy.

- Wind turns a turbine's blades, which are shaped to catch the wind.
- This turning motion is then transferred by gears to the turbine's rotor, causing the turbine to generate electricity.

1.5.4 The above structures can be up to 100 meters high with blades as large as aeroplane wings with the result that strong winds and storms can seriously damage the construction. What can be done to prevent the blades from damage when turning to fast during a storm?

Change the pitch of the blades.

1.5.5 Which apparatus can be used to change the direct current, produced by the wind generator, to alternating current that can be used on the farm?

Alternator.

1.5.6 How can you store the energy produced from this device for use during windless days.

Batteries.

1.6 Owners of small wind systems enjoy:

- Decades of free electricity after initial-cost recovery
- Increased property values
- Reliable electricity
- Relief from high and volatile prices of other forms of electricity
- Personal energy independence
- Ability to support clean energy and fight global warming in a tangible way

2. SOLAR ENERGY

2.1 WHAT IS SOLAR POWER?

a) Solar power is electricity generated from the levels of natural energy contained within the suns rays (solar radiation).

b) The sun has been in existence for billions of years. Everyday, the sun shines down on our earth, shooting its solar energy in our direction. This solar energy is commonly known as solar radiation, and contains a significant amount of energy we are able to harness.

c) The suns rays contain photons. These photons are capable of transforming electrons into conduction electrons, which means they are able to carry an electrical charge.

2.2 SOLAR HOT WATER PANELS

- The use of solar panels to heat water is becoming increasingly popular around the world due to the energy and money saving associated with this method.
- A good solar hot water panel system is able to provide an average household with around a third of its annual hot water supply. While this may not sound much, it can reduce energy costs by a considerable amount.
- Now imagine if you could combine not only a solar panel hot water heating system, but also an average solar electricity system. This would save a heap on energy and electricity bills.
- The combination of a solar hot water panel with other renewable energy technologies, such as solar panels, or a home wind turbine can work quite well together in providing a source of cheap, clean, and renewable energy for our homes.
- Integration is key for the success of a solar electricity system, so be sure to consult an expert in this field when planning installation.

2.3 SOLAR ELECTRIC PANELS

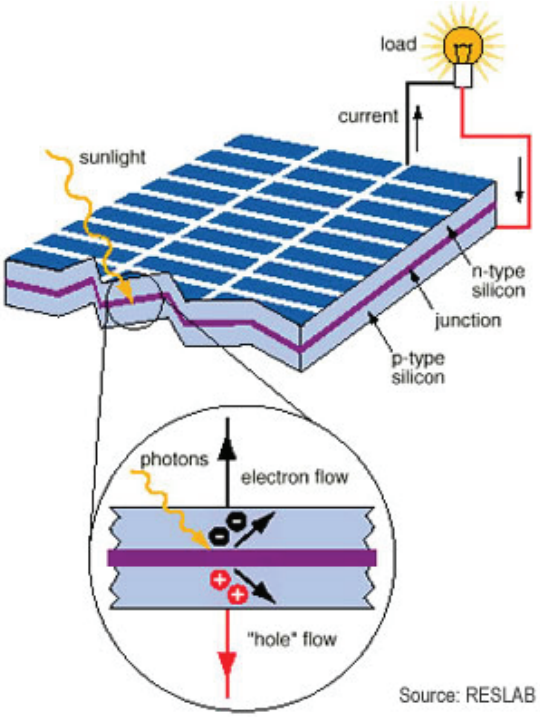
a) Solar (or photovoltaic) cells, are a very useful way of providing electricity to remote areas (as mentioned earlier), where the use of electricity may be important, yet the laying of high voltage cable may not be viable. The best example of the importance of solar energy to provide electricity in remote locations can be found on satellites. For many years, satellites have been using solar panels to catch the suns rays, in order to provide power to the equipment on board.

b) Photovoltaic cells can be aligned as an array, as shown in the image to the top of this page. There are many advantages of using a solar cell array, with various panels fitted along a mounting system. One of the main advantages is that we are able to combine various numbers of cells to provide a greater output of electricity, and this method makes solar electricity a viable option to power small homes and businesses.

c) The increasing efficiency of solar energy technologies means we are able to purchase and install panels, knowing we are likely to receive an efficient way of harnessing energy from the suns rays to turn into electricity for use in our homes.

d) It is quite possible for a household to run completely off photovoltaic electricity from the use of solar panels.

2.4 How do you produce electricity from solar energy



- Before you are able to produce electricity through solar energy, there needs to be some form of solar cell or panel.
- The solar panels are made of a semi-conductive material; the most common material is silicon.
- The semi-conductive material contains electrons which are quite happy just sitting there.
- When photons (contained within the suns rays) hit the solar cells, the electrons absorb this solar energy, transforming them into conduction electrons.
- If the energy of these photons is great enough, then the electrons are able to become free, and carry an electric charge through a circuit to the destination.

2.5 The efficiency of SOLAR CELL's is down to SIX main factors and they are;

- That the cell is not working to its full potential (e.g. some electrons may be lost),
- The second factor is when the electrons release heat; the panel also becomes warm, interfering with other aspects of the solar cells.
- Number of solar panels determine the efficiency of the system
- Expensive natural energy technologies produce more efficient than cheaper ones
- Another factor which affects solar panel efficiency is location.
- Obviously nearer the equator, you will receive a slightly better output with a given cell, but solar cells should always be facing the direction of the sun, and have no objects blocking the suns rays.

2.6 Name FIVE advantages of using solar energy.

- First and foremost, solar power technology is limitless.
- Solar power technology , on the other hand, is completely clean, with no residues, waste or by-products of any kind. environmentally friendly energy source
- Thanks to improving technology, solar is also extremely portable.
- Solar power can create more energy than is necessary for a single family needs.
- Extra power from solar panels can be fed back into the power grid, providing clean, free energy to people throughout an entire community.

2.7 Name FOUR disadvantages of solar energy.

- Some areas of the world are not able to benefit from photovoltaic energy due to the climate, weather patterns, or high levels of pollution.
- Sun energy is not available during the night time
- A cloudy day makes this energy source ineffective.
- Produce low amounts of energy at low voltage and amperage

2.8 QUESTIONS AND ANSWERS

2.8.1 Sun energy is one of the greatest sources of energy but also a source that is mostly untapped.

If we can manage to use the energy from the sun more productively we will have no more energy problems in the world.

1. Name the TWO types of energy that are directly generated from solar energy, and name a device that can convert each type effectively.

a) Heat. Solar/Sun geyser, solar cooker.

b) Electricity. Solar cell/ Photo-electric cells

2. This panel produce direct current at low voltage and watts.

What must be used to change the current to alternating current if an alternating current motor is used?

Inverter/transformer.

3. Can the energy from this source be used during night time?

Give an explanation for your answer.

Yes.

The electric energy produced during daytime can be used to charge a battery that can be used during night time.

3. GEOTHERMAL ENERGY

3.1 What is geothermal power?

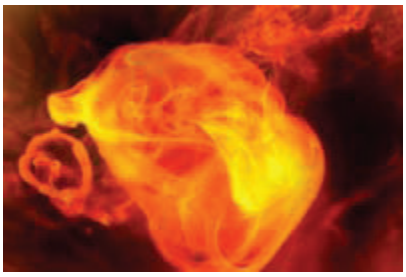
- The ground beneath our feet contains a considerable level of energy in the form of heat. All of this geothermal energy has the potential to generate **geothermal power** to provide large amounts of electricity.
- We have used geothermal energy in the form of hot springs for centuries; however, the first attempt to generate electricity from this energy source did not occur until the 20th century.
- The production of electricity from geothermal energy sources can be a highly powerful and efficient method of usage, yet location is key for an efficient geothermal power station.
- There are only a handful of locations across the world which is capable of producing viable and efficient levels of electricity from geothermal energy sources. As a result of this, as of 2007, less than 1% of the worlds electricity supply comes from geothermal sources.

- To harness geothermal energy and transform this into electricity, geothermal power stations are used, in a variety of designs.

3.2 Harnessing of geothermal energy (power stations.)

- A **geothermal power plant** uses its geothermal activity to generate power. This type of natural energy production is extremely environmentally friendly and used in many geothermal hot spots around the globe.
- To harness the energy, deep holes are drilled into the earth (much like when drilling for oil) until a significant geothermal hot spot is found.
- When the heat source has been discovered, a pipe is attached deep down inside the hole which allows hot steam from deep within the earths crust to rise up to the surface.
- The pressurized steam is then channeled into a turbine which begins to turn under the large force of the steam.
- This turbine is linked to the generator and so the generator also begins to turn, generating electricity.
- We then pump cold water down a new pipe which is heated by the earth and then sent back up the first pipe to repeat the process.

3.3 Main problems with geothermal energy



- **The main problems** with geothermal energy is that firstly, you must not pump too much cold water into the earth, as this could cool the rocks too much, resulting in your geothermal heat source cooling down. Secondly, geothermal power plants must be careful of escaping gases from deep within the earth.
- A very good way of thinking about geothermal energy is remembering that all our continents lie on molten rock deep within the earth, this rock produces tremendous levels of heat that we are able to extract, just think of your nation lying on a bed of fire.
- Geothermal power is one of the most renewable energy sources that exist on our planet today; the earth will contain this heat for our lifetime. If this heat disappears, our planet will become too cold to survive on.

3.4 Advantages of geothermal energy

- So the first advantage of using geothermal heat to power a power station is that, unlike most power stations, a geothermal system does not create any pollution. It may once in a while release some gases from deep down inside the earth, that may be slightly harmful, but these can be contained quite easily.
- The cost of the land to build a geothermal power plant on, is usually less expensive than if you were planning to construct an; oil, gas, coal, or nuclear power plant. The main reason for this is land space, as geothermal plants take up very little room, so you don't need to purchase a larger area of land.

- Another factor that comes into this is that because geothermal energy is very clean, you may receive tax cuts, and/or no environmental bills or quotas to comply with the countries carbon emission scheme (if they have one).
- No fuel is used to generate the power, which in return, means the running costs for the plants are very low as there are no costs for purchasing, transporting, or cleaning up of fuels you may consider purchasing to generate the power.
- The overall financial aspect of these plants is outstanding; you only need to provide power to the water pumps, which can be generated by the power plant itself anyway.

3.5 Disadvantages of geothermal energy

- Geothermal heat is extracted from deep within the earths surface, and this is the main disadvantage concerning finding a suitable build location,
- There are some other deciding factors that may convince a constructor to build a different type of renewable energy power plant in a different location, such as a wind turbine.
- So, we have established the main disadvantages of building a geothermal energy plant mainly lie in the exploration stage. During exploration, researchers will do a land survey (which may take several years to complete) and then post their findings to the company that contracted the survey.
- Many companies who order surveys are often disappointed, as quite often the land they were interested in cannot support a geothermal energy plant. To extract the heat we have to find certain hot spots within the earths crust, these are very common around volcanos and fault lines, but who wants to build their geothermal energy plant next to a volcano?
- Some areas of land may have the sufficient hot rocks to supply hot water to a power station, but what if these areas are contained in harsh areas of the world (near the poles) or high up in mountains. Some very good proven spots have been found in New Zealand, Iceland, Norway and Sweden.
- The questions that are usually asked during a survey are; is the rock soft enough to drill through, do the rocks deep down contain sufficient heat, will this heat be sustainable for a significant amount of time, is the environment fit for a power plant. If the answer to these basic questions is yes, a more in depth survey should go ahead.
- Another big disadvantage of geothermal energy extraction is that in many cases, a site that has happily been extracting steam and turning it into power for many years, may suddenly stop producing steam. This can happen and last for around 10 years in some cases.
- Developers of such sites must be careful and aware that in some cases, harmful gases can escape from deep within the earth, through the holes drilled by the constructors. The plant must be able to contain any leaked gases, but disposing of the gas can be very tricky to do safely.

4. BIO ENERGY

4.1 What is Biofuel?

- Biofuel or bio-organic fuel is any plant or animal matter which can be combusted and used as a fuel. Biofuels are one of the new ranges of renewable energy sources in the world today. So, what are the **advantages** and **disadvantages** of biofuel?
- Motivations for renewable fuel development
- Petroleum is a finite resource that is rapidly depleting. Of the worldwide total remaining petroleum reserves of approximately 1,277,702,000,000 barrels (about one half of the original virgin reserves) and a worldwide usage rate of 25,000,000,000 per year, only about 50 years worth of petroleum is predicted to remain at the current depletion rate.
- Petroleum is imperative for the following industries: fuel (home heating, jet fuel, gasoline, diesel, etc.) transportation, agriculture, pharmaceutical, plastics/resins, man-made fibers, synthetic rubber, and explosives.
- If the modern world remains reliant on petroleum as a source of energy, the price of crude oil could increase markedly, destabilizing economies worldwide.
- Consequently, renewable fuel drivers include: high oil prices, imbalance of trade, instability in oil exporting regions of the world, the potential for windfall profits for farmers and industries, avoidance of economic depression, avoidance of scarcity of products due to a volatile 'peak oil' scenario expected to begin as early as 2021,[1] (though peak oil is not a new idea) and a slowing of global warming that may usher in unprecedented climate change.
- Furthermore, the global debate on climate change, along with regional geopolitical instabilities have challenged nations to act to develop both alternative and carbon-neutral sources of energy.
- Renewable fuels are therefore becoming attractive to many governments, who are beginning to see sustainable energy independence as a valuable asset.

4.2

Manufacturing biodiesel from vegetable oils e.g. soy, canola, sunflower seed, algae or animal fats, involves the base-catalysed **transisterification of fatty acids** with methanol or ethanol to give the corresponding methyl esters or ethyl esters.

4.3 Advantages of biofuel

- The main advantage that biofuel has over other energy sources is the cost factor. With the ever increasing prices of crude oil, biofuel offers a cheaper solution to our energy needs. One of the main reasons for this low cost is that biofuels are made from plant and animal waste.
- Biodegradable and do not harm the environment when combusted.
- They are also comparatively lot less polluting. Lesser carbon emissions means that these fuels are environment friendly which is the need of the world today.
- For conventional fuels it takes years to regenerate whereas there is no such problem for biofuels.
- Doesn't require any radical changes to switch to the use of biofuels - unlike the difficulties in switching to other renewable energy sources such as solar and wind power.
- Are renewable sources of energy as you can just keep producing more.
- Ethanol is very inexpensive to produce.
- Can help prevent engine knocking.

4.4 Disadvantages biofuel

- Low energy output of the fuels. Doubts have been raised whether biofuel will ever be able to replace the conventional fuels because critics argue that they do not the heat capacity to do it.
- Also, due to the novelty, the production cost of the fuel is very high currently.
- Also, certain food crops like maize are needed to make them which may lead to an imbalance.
- There is a huge quantity of water required which may affect the local water resources.
- The more land to produce crops for biofuels, more habitats will be lost for animals and wild plants.
- If biofuel become lucrative for farmers, they may grow crops for biofuel production instead of food production.
- Less food production will increase prices and cause a rise in inflation.

4.5 The following ALTERNATIVE FUELS are obtained from plant origin.

a) **Ethanol**

Is made by fermenting and then distilling starch and sugar crops -- maize, sorghum, potatoes, wheat, sugar-cane, cornstalks, fruit or vegetable waste.

b) **Methanol**

Is an alternative fuel made from woody plant fiber, coal or natural gas; it is used primarily as a supplement to gasoline. It can be harvested from the methane gas in landfills in addition to fermented waste products such as sewage and manure.

Pure methanol is not sold as a stand-alone motor fuel, although in its pure form it is commonly used as racing fuel.

Advantages of methanol

- It offers lower exhaust emissions and higher vehicle performance.
- It can easily be made into hydrogen, offering a promising future for use in methanol direct fuels cells.
- Methanol has a lower risk of flammability than gasoline.
- **Methane gas** from earth gas or landfills.

CHAPTER 4

SKILLS AND CONSTRUCTION PROCESSES

WELDING

MIG/MAG WELDING

(MIG = Metal Insert Gas)(MAG = Metal Active Gas)

1. M.I.G./ M.A.G.S. Advantages

- Higher welding speeds
- Greater deposition rates
- Less post welding cleaning (e.g. no slag to chip off weld)
- Better weld pool visibility
- No stub end losses or wasted man hours caused by changing electrodes
- Low skill factor required to operate M.I.G / M.A.G.S welding torch
- Positional welding offers no problems when compared to other processes. (Use dip or pulsed mode of transfer)
- The process is easily automated
- No fluxes required in most cases
- Ultra low hydrogen process

2. M.I.G./M.A.G.S. Disadvantages

- Higher initial setup cost
- Atmosphere surrounding the welding process has to be stable (hence the shielding gasses), therefore this process is limited to draught free conditions
- Higher maintenance costs due to extra electronic components
- The setting of plant variables requires a high skill level
- Less efficient where high duty cycle requirements are necessary
- Radiation effects are more severe

3. M.I.G./M.A.G.S. Welding - Common Welding Defects

These are the most common defects with some of the most probable causes

Defect

Probable Cause

Porosity

-Gas flow too low or too high
-Blocked nozzle
-Leaking gas lines
-Draughty conditions
-Nozzles distance from work is too great
-Painted, wet or oily plate

-Wet or rusty electrode/wire

Lack of penetration

-Current too low
-Preparation too narrow
-Root face too large
-Root gap too small
-Worn contact tip causing irregular arc
-Incorrect alignment of plates

Spatter

-Inadequate inductance
-voltage too low
-Rusty or primed plate

Undercut

-Speed too fast
-Current too high
-Poor technique

Lack of fusion

-Voltage too low
-Current too low or too high
-Irregular surface
-Wrong torch angle

Cracking

-Inadequate pre-heat on high tensile and low alloys
-Incorrect composition of electrode
-Root pass too small in restrained joint
-Spray transfer welding with current too high
-Deep narrow weld bead (with centre line cracking)
-Inadequate filling of crater

4. GUIDE TO MIG WELDING

This is a basic guide on how to weld using a metal inert gas (MIG) welder. MIG welding is the process of using electricity to melt and join pieces of metal together. MIG welding is generally regarded as one of the easiest type of welding to learn. Welding is a skill that needs to be developed over time, with a piece of metal in front of you, suitable protection and a welding torch in your hands.

5. WHAT IS MIG WELDING?

MIG welding was developed in the 1940's and 60 years later the general principle is still very much the same. MIG welding uses an arc of electricity to create a short circuit between a continuously fed anode (+ the wire-fed welding torch) and a cathode (- the metal being welded)

The heat produced by the short circuit, along with a non-reactive (hence inert) gas locally melts the metal and allows them to mix together. Once the heat is removed, the metal begins to cool and solidify, and forms a new piece of fused metal.

A few years ago the full name - Metal Inert Gas (MIG) welding was changed to Gas Metal Arc Welding (GMAW) but if you call it that most people won't know what the you are talking about - the name MIG welding has certainly stuck.

MIG welding is useful because you can use it to weld many different types of metals: carbon steel, stainless steel, aluminium, magnesium, copper, nickel, silicon bronze and other alloys.

6. Here are some advantages to MIG welding:

- The ability to join a wide range of metals and thicknesses
- All-position welding capability
- A good weld bead
- A minimum of weld splatter
- Easy to learn

7. Here are some disadvantages of MIG welding:

- MIG welding can only be used on thin to medium thick metals
- The use of an inert gas makes this type of welding less portable than arc welding which requires no external source of shielding gas.
- Produces a less controlled weld as compared to TIG (Tungsten Inert Gas Welding)

8. HOW DOES THE MIG WELDER WORK?

A MIG welder has a couple of different parts. If you open one up you will be able to see something like the pictures below

9. The Welder

- Inside the welder you will find a spool of MIG wire and a series of rollers that pushes the wire out to the welding torch.
- There isn't much going on inside this part of the welder, so it's worth it to take just a minute and familiarize yourself with the different parts.
- If the wire feed jams up for any reason you will want to check this part of the machine out.
- On larger power MIG welders you the wire feed unit can be separate as in pictures below.
- A welder with internal feed assembly is commonly known as a compact MIG welder.
- The large spool of wire should be held on with a tension nut.
- The nut should be tight enough to keep the spool from unravelling so to avoids over-run (birds nesting) when trigger released, but not so tight that the rollers can't pull the wire from the spool.
- If you follow the wire from the spool you can see that it goes into a set of rollers that pull the wire off of the big roll, this then pushes the wire up to the torch to the tip ready for welding.

10. The Gas Supply

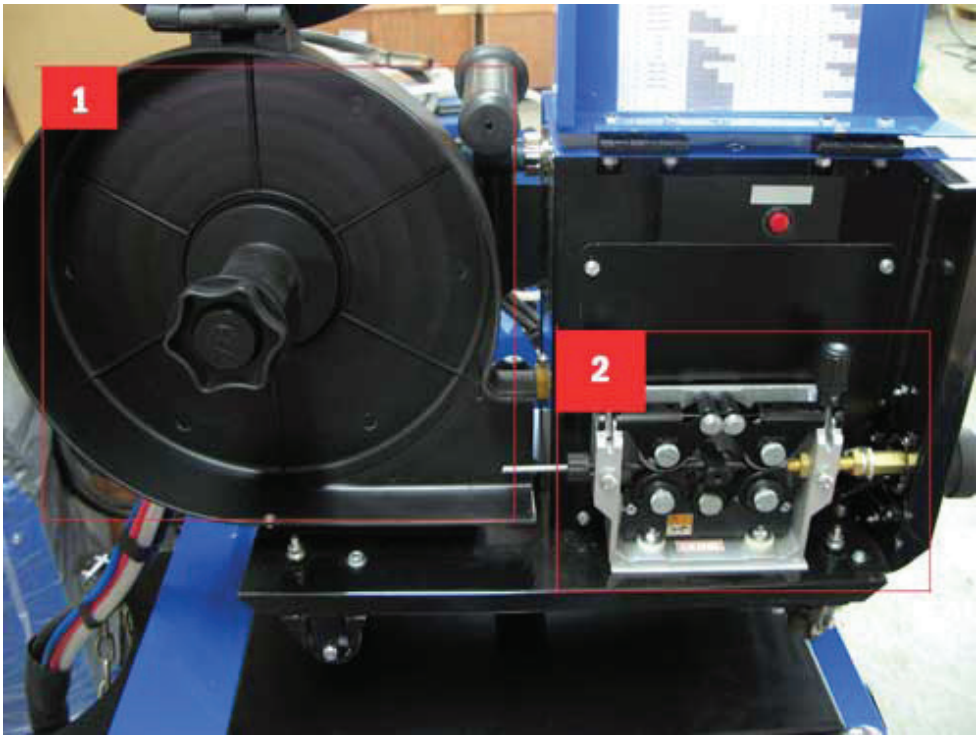
- Assuming you are using a shielding gas with your MIG welder there will be a cylinder of gas behind the MIG.
- This is either 100% Argon or a mixture of CO_2 and Argon.
- This gas shields the weld as it forms.
- Without the gas your welds will look brown, splattered and just generally not very nice. Open the main valve of the cylinder and make sure that there is some gas in it.
- Your gauges should be reading between 0 and 2500 PSI in the tank and the regulator should be set between 15 and 25 PSI depending on how you like to set things up and the type of welding torch you are using.
- When welding in areas with a draught you may need to run more gas pressure to avoid getting porosity in the weld.
- Once the wire passes through the rollers it is sent down a set of hoses which lead to the welding torch.
- The hoses carry the charged electrode and the argon gas.

11. The Welding Torch

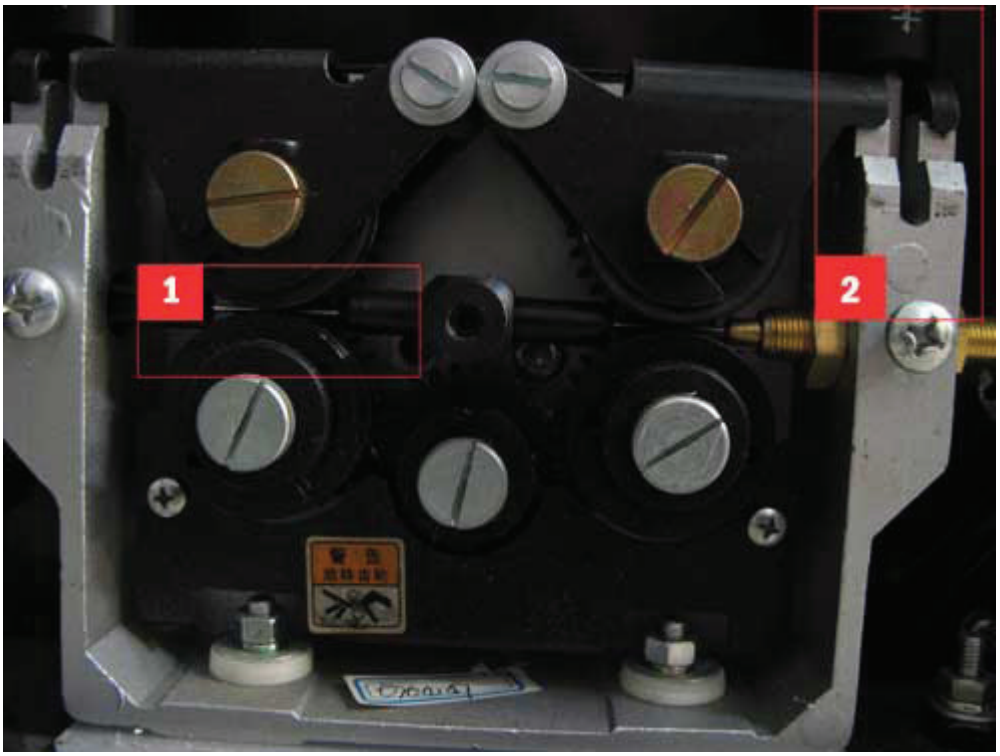
- The welding torch is the business end of things.
- It's where most of your attention will be directed during the welding process.
- The MIG torch consists of a trigger that controls the wire feed and the flow of electricity.
- The wire is guided by a replaceable copper tip that is made for each specific welder.
- Tips vary in size to fit whatever diameter wire you happen to be welding with.
- Most likely this part of the welder will already be set up for you.
- The outside of the tip of torch is covered by a metal shroud which protects the electrode and directs the flow of gas out the tip of the torch.

12. The Earth Clamp

- The earth clamp is the cathode (-) in the circuit and completes the circuit between the welder, the welding torch and the project.
- It should either be clipped directly to the piece of metal being welding or onto a metal welding table like the one pictured below.
- The earth clamp must be making good contact with the piece being welded for it to work so be sure to grind off any rust or paint that may be preventing it from making a connection with your work.



1. This is the spool of wire that feeds the welder. The wire comes off the spool, is pushed through the feeder and travels out to the welding torch.
2. These are the rollers that pull the wire off the spool and send it out to the welding torch



1.Wire being fed through the rollers
2. Tensioning Adjustment

Clamp the negative lead from the welder onto your project or, in this case, the welding table

13. SAFTEY GEAR

MIG welding can be a pretty safe thing to do so long as you follow a few important safety precautions. Because of MIG welding produces lots of heat and lots of harmful light, you need to take a few steps to protect yourself.

- The light that is generated by any form of arc welding is extremely bright. It will burn your eyes and your skin just like the sun will if you don't protect yourself. The first thing you will need to weld is a welding helmet. I am wearing an auto-darkening welding mask below. They are really helpful if you are going to do a lot of welding and make a great investment if you think you will be working with metal often. Manual masks require you to jerk your head dropping the mask into position or require to use a free hand to pull the mask down. This allows you to use both your hands to weld, and not worry about the mask. Think of protecting others from the light as well and use a welding screen if it's available to make a border around yourself. The light has a tendency to draw on lookers who might need to shielded from being burned too.
- Wear gloves and leathers to protect yourself from molten metal splattering off of your work piece. Some people like thin gloves for welding so you can have a lot of control. In TIG welding this is especially true; however for MIG welding you can wear whatever MIG welding gloves you feel comfortable with. The leathers will not only protect your skin from the heat produced by welding but they will also protect your skin from the UV light produced by welding. If you are going to be doing any amount of welding more than just a minute or two you will want to cover up because UV burns happen fast!
- If you are not going to wear leathers at least make sure that you are wearing clothing made from cotton.
- Do not wear open toed shoes or synthetic shoes that have mesh over the top of your toes. Hot metal often falls straight down and I have burned many holes through the tops of my shoes.
- Weld in a well-ventilated area. Welding produces hazardous fumes which you shouldn't breathe in if you can avoid it. Wear either a mask or a respirator if you are going to be welding for a prolonged amount of time.

14. IMPORTANT SAFETY WARNING

NB NB NB NB NB
DO NOT WELD GALVANIZED STEEL.

Galvanized steel contains a zinc coating that produces carcinogenic and poisonous gas when it is burned. Exposure to the stuff can result in heavy metal poisoning (welding shivers) - flu like symptoms that can persist for a few days, but that can also cause permanent damage

Fire Fire Fire

Molten metal can spit several feet from a weld. Grinding sparks are even worse. Any sawdust, paper or plastic bags in the area can smoulder and catch fire, so keep a tidy area for welding. Your attention will be focused on welding and it can be hard to see what's going on around you if something catches fire. Reduce the chance of that happening by clearing away all flammable objects from your weld area.

Keep a fire extinguisher beside the exit door from your workshop. CO2 is the best type for welding. Water extinguishers are not a good idea in a welding shop since you are standing next to a whole lot of electricity.

Gloves, auto-darkening helmet and a suitable cotton based jacket are essential to keep safe

15. PREPARING FOR THE WELD

Before you start welding make sure things are properly setup at both the welder and on the piece you are about to weld.

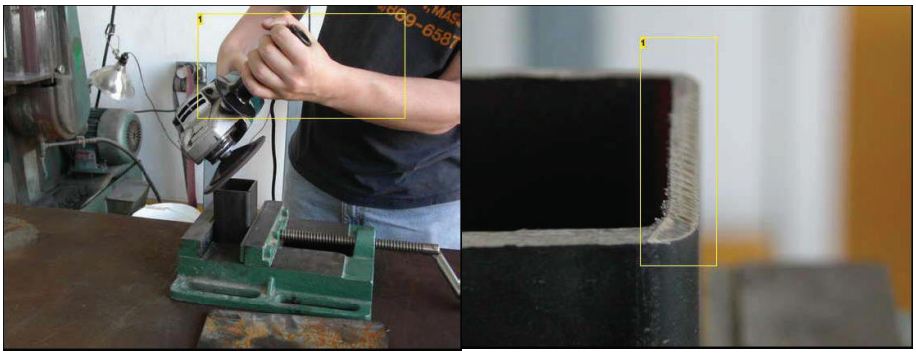
The Welder

- Check to make sure that the valve to the shielding gas is open and that you have around 14LPM flowing through the regulator.
- The welder needs to be turned on, ground earth clamp attached to your welding table or to the metal directly and you need to have the right combination of welding power and wire feed speed

The Metal

- While you can pretty much just take a MIG welder, squeeze the trigger and and touch it to your work piece to weld you won't get a great result.
- If you want the weld to be strong and clean, taking 5 minutes to clean your metal and grind down any edges that are being joined will really help your weld.
- In the picture below an angle grinder is being used to bevel the edges of some square tube before it gets welded onto another piece of square tubing.

- By creating two bevels on the joining edges it makes a little valley for the weld pool to form in.
- Doing this for butt welds (when two things are pushed together and joined) is a good idea.



Gloves should be worn but this is a staged picture on the left. The right hand picture shows a neat beveled edge which is required for your work prior to welding

16. LAYING A BEAD

- Once your welder is set up and you have prepped your piece of metal it's time to start focusing on the actual welding
- If it's your first time welding you might want to practice just running a bead before actually welding two pieces of metal together.
- You can do this by taking a piece of scrap metal and making a weld in a straight line on its surface.
- Do this a couple of times before you start actually welding so that you can get a feel for the process and figure out what wire speed and power settings you will want to use.
- Every welder is different so you will have to figure these settings out yourself.
- Too little power and you will have a splattered weld that won't penetrate through your work piece.
- Too much power and you might melt right through the metal entirely.
- The pictures below show a few different beads being laid down on some 1/4" plate.
- Some have too much power and some could use a little more. See the image notes for the details.
- The basic process of laying a bead is not too difficult.
- You are trying to make a small zigzag with the tip of the welder, or little concentric circles moving your way from the top of the weld downward.
- It is a "sewing" motion where I use the tip of the welding torch to weave the two pieces of metal together.
- First start laying beads about an inch or two long.
- If you make any one weld too long your work piece will heat up in that area and could become warped or compromised, so it's best to do a little welding in one spot, move to another, and then come back to finish up what's left in between.

17. What are the right settings?

- If you are experiencing holes in your work than your power is turned up too high and you are melting through your welds.
- If your welds are forming in spurts your wire speed or power settings are too low.
- You'll know when you have settings right because your welds will start looking nice and smooth.
- You can also tell a fair amount about the quality of the weld by the way it sounds.

- You want to hear continuous sparking.
- Some welders say it sounds like an egg frying!

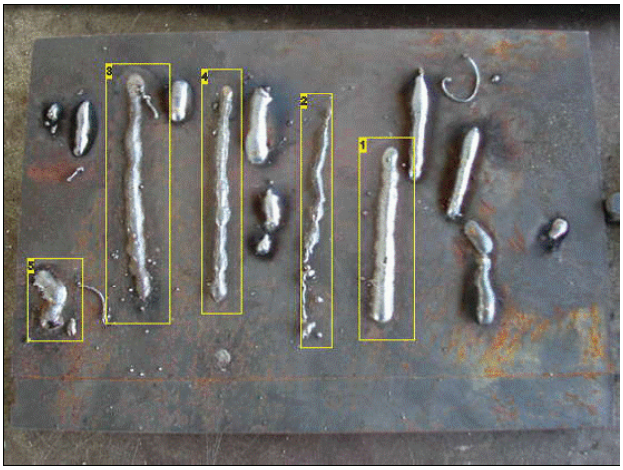


Image Notes

1. These settings are pretty good.
2. Not enough power, not enough wire feed.
3. Good wire feed, not enough power.
4. It takes a little while to get comfortable, don't be afraid to make some test welds to get a feel for it.

Image Notes

- *These are similar power and feed settings, but tested on a much thinner sheet of steel plate.*
- *As you can see the weld has penetrated very deeply and is starting to deform the piece.*

Image Notes

Too much power has created a burn hole in the metal.

18. WELDING METAL TOGETHER

- Once you've got your method tested out a bit on some scrap, it's time to do the actual weld.
- In this photo I am doing just a simple butt weld on some square stock.
- We've already ground down the edges of the surfaces that are going to be welded so that the seam where they meet makes a small "v".
- We are basically just taking the welder and making our sewing motion across the top of the seam.
- It's ideal to weld from the bottom of the stock up to the top, pushing the weld forward with the tip of the torch, however that isn't always comfortable or a good way to start learning.
- In the beginning it's perfectly fine to weld in whatever direction/position that is comfortable and that works for you.
- Once we finished welding the pipe we were left with a big bump where the filler came in.
- You can leave that if you like, or you can grind it flat depending on what you are using the metal for.
- Once we ground it down we found one side where the weld didn't penetrate properly. (See photo 3.)
- That means that we need to have more power and more wire to fill in the weld.
- We went back and redid the weld so that it was properly joined.

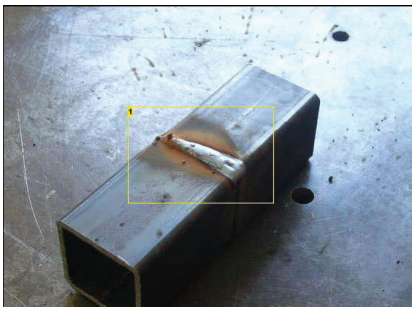


Image Notes

- *This was our first try.*
- *Not a bad weld, but we could probably use a little more gas and a little less power.*
- *This weld penetrated pretty deeply.*

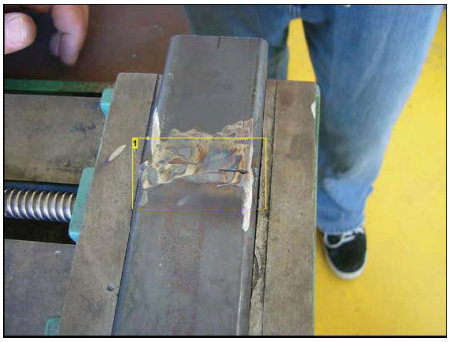


Image Notes

- *This side of the square stock wasn't welded with enough power because the weld didn't penetrate all the way through*
- *Notice the blue hue to the metal around the seam.*
- *That means that we were pushing too hard with the angle grinder when we were grinding down the weld.*
- *Remember to keep the disc moving and to resist the urge of trying to cut corners while grinding.*
- *It's sometimes a slow process that requires patience*

19. GRINDING DOWN THE WELD

- If your weld isn't on a piece of metal that will show, or if you don't care about how the weld looks, then you are done with your weld.
- However, if the weld is showing or you are welding something that you want to look nice then you will most likely want to grind down your weld and smooth it out.
- Put a grinding wheel onto an angle grinder and get started grinding on the weld.
- The neater your weld was the less grinding you will have to do, and after you have spent a whole day grinding, you will see why it's worth it to keep your welds neat in the first place.
- If you use a ton of wire and made a mess of things it's ok, it just means that you might be grinding for a while.
- If you had a neat simple weld though, then it shouldn't take too long to clean things up.
- Be careful as you approach the surface of the original stock.
- You don't want to grind through your nice new weld or gouge out a piece of the metal.
- Move the angle grinder around like you would a sander so as not to heat up, or grind away any one spot of the metal too much.
- If you see the metal get a blue tinge to it you are either pushing too hard with the grinder or not moving the grinding wheel around enough.
- This is can happen especially easily while grinding thin sheets of metal.
- Grinding welds can take a while to do depending on how much you have welded and can be a tedious process - take breaks while grinding and stay hydrated, (grinding rooms in shops or studios tend to heat up, especially if you are wearing leathers). Wear a full face mask when grinding, a mask or respirator, and ear protection.
- Make sure that all your clothing is neatly tucked in and that you don't have anything hanging down from your body that could get caught in the grinder - it spins fast and it can suck you in!
- When you have finished you should end up with something similar to the photo on the right hand side


20. COMMON PROBLEMS

It can take a good amount of practice to start welding reliably every time, so don't worry if you have some problems when you first stop. Some common problems are:

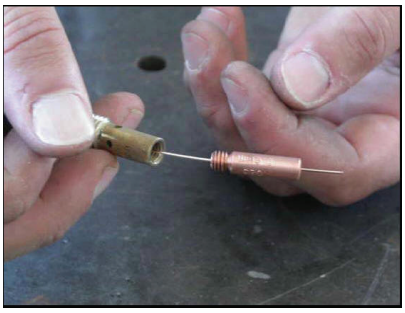
- No or not enough shielding gas from the torch is surrounding the weld. You can tell when this happens because the weld will start splattering little balls of metal, and will turn nasty colours of brown and green you can also see air bubbles on top of the weld (porosity). Turn up the pressure on the gas and see if that helps.
- Weld is not penetrating. This is easy to tell as your weld will be weak and won't be fully joining your two piece of metal. Try more power and wire speed.
- Weld burns a while right through your material. This is caused by welding with too much power. Simply turn down your welding power and it should go away.
- Too much metal in your weld pool or the weld is sloppy like porridge. This is caused by too much wire coming out of the torch and can be fixed by slowing down your wire speed.
- Poor weld penetration, erratic weld. Check condition of earth clamp and ensure where it fits to bench is clean and free from rust/paint. If earth clamp shows signs of overheating fit new clamp or complete lead assay
- Welding torch spits and does not maintain a constant weld. This could be caused because the torch is too far from the weld.
- You want to hold the tip of the torch about 1/4" to 1/2" away from the weld.

21. WELDING WIRE TO THE TIP/CHANGING THE TIP

- Sometimes if you are welding too close to your material or you are building up too much heat the tip of the wire can actually weld itself onto the tip of your welding torch.
- This looks like a little blob of metal at the tip of your torch and you'll know when you have this problem because the wire won't come out of the torch anymore.
- Fixing this is reasonably simple if you just pull on the blob with a set of pliers.
- See photos below.


If you really scorch the tip of your torch and fuse the hole closed with metal then you need to turn the welder off and replace the tip.

1. The tip is fused closed



2. Unscrew the welding shield cup.

3. Unscrew the bad welding tip

4. Slide a new tip into place

5. Screw the new tip on

6. Replace the welding cup

22. LISTED BELOW ARE SOME FEATURES FOUND ON ADVANCED MIG WELDERS WITH THEIR EXPLANATION.

Arc force

This controls the penetration of the weld via a control knob on machine
(On older machines this was known as choke, you may have 2-3 connectors for the earth cable).

Low setting = Less penetration and low splatter, used for thinner materials. This really helps when welding car bodywork!
High setting = High penetration and more splatter (harsher weld), used for thicker materials.

Spot Welding

This allows you to set an amount of time machine will weld when trigger is pressed. When you press the trigger a spot weld is carried out and then machine stops, release and press trigger again to produce another spot weld.

Stitch Welding

This is similar to spot welding but with the addition of stitch time which sets the interval between spots. So as you press the trigger a spot weld is done as set by spot welder control knob and then a delay set by the stitch control knob and then another spot weld is produced, this will carry on until the torch trigger is released.

Push Pull torch

This is a MIG torch used for aluminium welding. The torch head has a pair of rollers driven by a motor which pulls the wire as well as the MIG welder roller system pushing the wire. This ensures correct wire feed of the softer alloy wire and prevents snags and wire feed problems. Generally used for production alloy MIG welding.

Soft Start

When the trigger is pressed the wire comes out of the torch slowly (slower than set wire feed speed), when the wire touches the work the arc is started. The machine senses this and increases the wire feed to set speed. This can stop torch jerk when starting a weld and also produces a better start to the weld.

23. Roll Wire feed assembly

Smaller and DIY machines normally come with a 2-roll feed system, this comprises of a bottom roller with grooves in and a top pressure roller which is flat and puts pressure on wire as set by tensioners to drive wire when the rollers turn.

A 4-Roll system has two bottom rollers and two top rollers which give a more stable wire feed and is better at feeding softer alloy wires than a 2-roll system. Some MIG welders also have geared 4-roll systems which help to regulate wire flow speed with great accuracy resulting in exceptionally smooth welds. The pictures at the front of this guide show a 4-roll geared version – a common feature on most R-Tech MIG Welders.

24. SHORT QUESTIONS

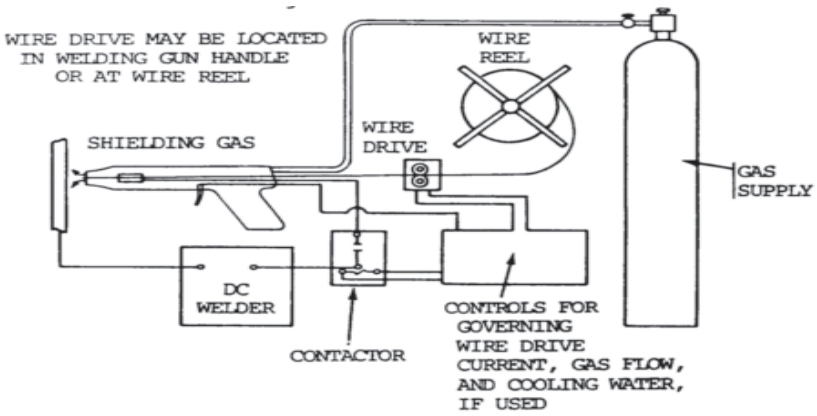


Figure 10-45. MIG welding process.

1. Describe shortly what MIG welding is about.

   It is an arc welding process in which individual consumable electrodes (standard welding rods) are replaced by continuously fed wire, and an insert gas shield replaces electrode flux.

2. Name the three types of gasses used in MIG welding?

Argon, helium and carbon dioxide CO_2.

CO_2 or a CO_2/argon mix can be used for welding mild steel.

3. What type of current does this process use?

Direct current DC.

4. Name the advantages of MAG welding above normal arc welding.

a) High welding speed / Faster

b) Important savings in materials and weight

c) High mechanical properties of welding joints.

d) Neat and smooth seam surface

e) Guaranteed welding strength for root and layer welding.

f) Safety against cold shuts and cracks.

g) Welding in all positions, vertical up, down and overhead.

h) Excellent fusion and penetration.

i) Operation requires less manual skills.

j) Welding area is easier to see.

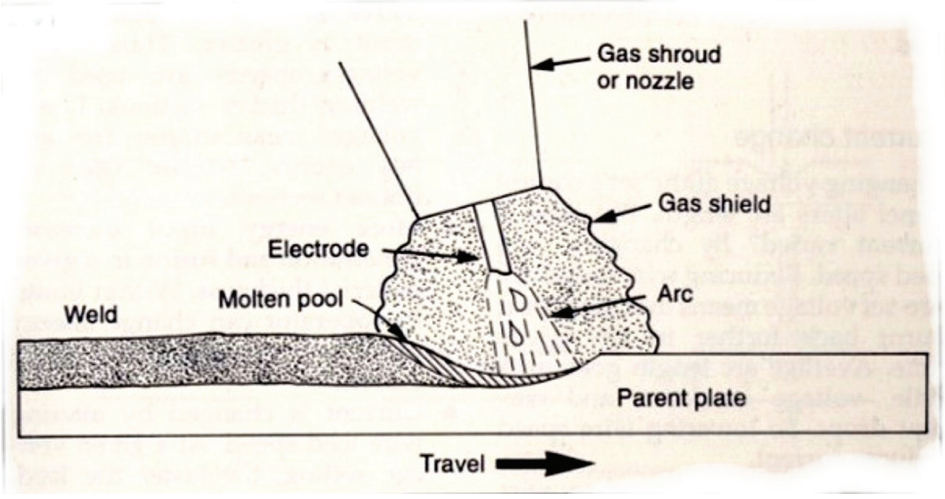
k) No heavy slag to control or to chip away, compressed gas seals the weld pool.

l) Potentially cheaper.

m) Welds a wider range of thickness.

n) Welding wire runs from a spool and need not to be replaced regularly.

5. Sketch of the MAG welding process.



6. In which direction must you work with MAG welding?

Push in the direction of travel with an 80° angle is the best but you can pull the gun also

7 The photo below shows the welding nozzle of a MIG welding machine.

7.1 Give the name of the part, labelled as A, and state its function.

Filler wire. This wire melts to form the joint between the two metals that you want to join.

72 What provides the shield, which prevents the welding bead to come into contact with oxygen during the welding process?

Shielding gas. CO2

7.3 Part A sometimes gets stuck to the part labelled as B.

State the cause of this and how it can be prevented.

The filler wires gets too short.

Use anti spatter or spatter release.

7.4 Provide the name of the part labelled as B.

MIG contact tip.

7.5 Name TWO safety rules when welding with the MIG welding machine.

a) Use a welding helmet.

b) Protect your body by wearing a leather apron and gloves.

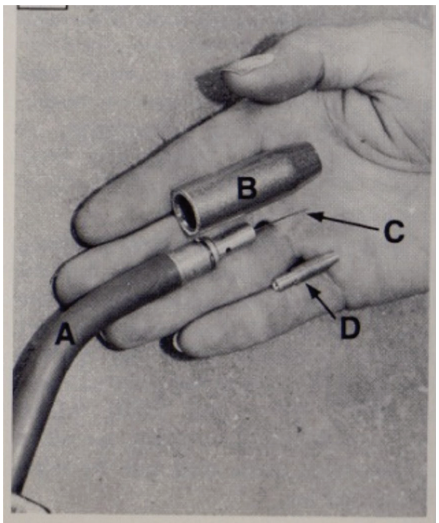
7.6 Identify the energy source for this welding process?

Electricity.

7.7 Indicate THREE different metals that can successfully be welded with this welding machine.

- High alloy steel (stainless alloys)
- Aluminium
- Mild steel

8. Sketch of the tip of a MAG gun.



2.3 Shield gas flows from the gun (A) before passing through the nozzle (B), and then to the weld area. Filler wire (C) is fed to the weld pool mechanically via the torch liner, picking up electrical energy from a copper contact tip (D) as it leaves the gun.

Advanced welding techniques and their applications

1. **Describe the process of overhead welding**.

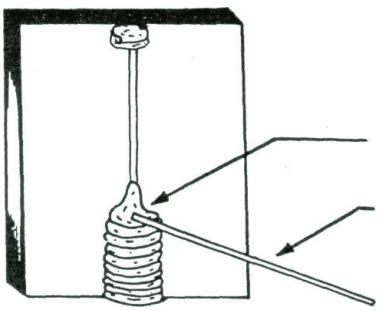
Gas welding

- Requires a reduced melting pool, big enough to create the wanted penetration
- Done by reducing the size of the flame
- Or using a slightly thicker welding rod
- Force of the flame will help to keep the molten metal positioned.

Arc welding

- Use an arc as short as possible.
- Weld a number of runs without any lateral movement.
- When molten metal starts dripping, the amperage should be reduced slightly.
- Move electrode slightly faster.
- Hold electrode in same position as in relation to base metal.

2. Describe the process of vertical up arc welding



- Welding upwards in a vertical position may prove a problem, because the molten metal of the puddle will tend to run down
- Special electrode is used for vertical welding with an arc welder, makes the process easier as it “freezes” more quickly.
- Amperage can be reduced slightly from the normal down hand setting.
- Tip of the electrode must be pointed upwards, so that the electrode forms an angle of up to 30° with the horizontal plane
- Arc must be kept short and the speed must be just sufficient to prevent the molten metal from the puddle to run down
- When welding up very little lateral movements of the electrode must be made.

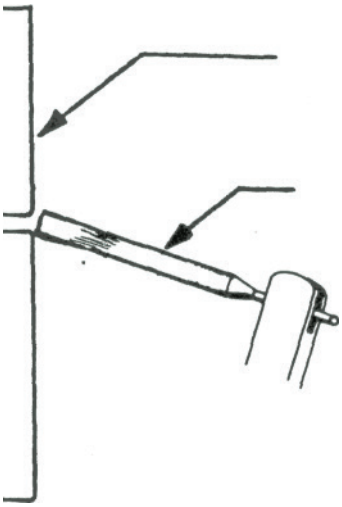
3. Name the different types of welding runs used for vertical welding.

- Figure 8 shape.
- U-shape.
- Zigzag shape.
- Triangle shape.

4. When is the horizontal square butt weld used?

The horizontal square butt weld is used when welding together two pieces of metal of less than 6mm in thickness that is in an upright position one above the other.

5. Describe the procedure of welding a horizontal square butt weld



- Tack the prepared work pieces together. Lean the electrode in the direction of travel and point it slightly upwards.
- Strike an arc and run a bead along the joint.
- If the force of the arc tends to undercut the work piece at the top of the bead, shorten the arc length and increase the upward angle of the electrode until a normal bead is formed.
- It may sometimes be necessary to lower the amperage setting to give better control of the flow of the metal.
- When the welds have been completed chip off the slag and inspect the bead.

6. What must be kept in mind when welding pipes?

When welding a pipe the welding plane continuously changes as the welder weld a run.

7. Name the three pipe welding positions.

- Horizontal fixed position.
- Horizontal movable position.
- Vertical position.

8. What must be remembered when welding galvanized metal?

The galvanizing makes welding difficult so it is recommended that the galvanizing is removed prior to welding.

9. Name the different pipe-welding joints.

- Closed butt join, roll position
- Open butt join, roll position
- Chamfered join, roll position
- Chamfered join, fixed position

10. Describe the procedure that you would follow to weld a cast iron pot/part.

- Use a pure nickel welding rod.
- Amperage must be as low as possible.
- Arc must be a little longer than when welding mild steel.
- Make sure that all rust, grease, dirt and/or any other substances, which can weaken the join has been removed, before starting with the process of joining.
- Remember to remove the surface layer of the metal where the join is to be made.
- Cover the suspect area with white chalk. Vaseline in the cracks will colour the chalk grey or show a wet line
- Mark the line by means of a prick-punch and hammer to prevent the line from disappearing when grinding out the V-groove
- It is very important that the casting is kept as cool as possible during the welding process
- Pre-heating of a casting to be welded can help to prevent it from forming new cracks
- Casting should be allowed to cool down slowly after welding
- A casting should never be submerged in water to cool it down
- While a run is allowed to cool down it can be lightly tapped with a small hammer. This action helps to relieve the tension around the weld.

11. Name a few points to consider when welding is done.

- Gravity can cause metal to drip or run down.
- Keep puddle small.
- Prevent over penetration, burning through.
- Electrode size plays a role in penetration.
- Current plays a dominant role in the welding process.

- Surface area must be cleaned thoroughly.

12. Describe what is meant by Hard-facing

- It is the process by means of which worn parts can be built up by padding with a wear resistant metal
- The type of hard-facing and type of electrode used, are determined by the service requirements of the parts concerned

13. Name the kinds of wear that parts can be subjected to.

- Metal against metal friction
- Serious jolts or shocks of metal against rock
- Scraping plus jolts and shocks
- Serious scraping

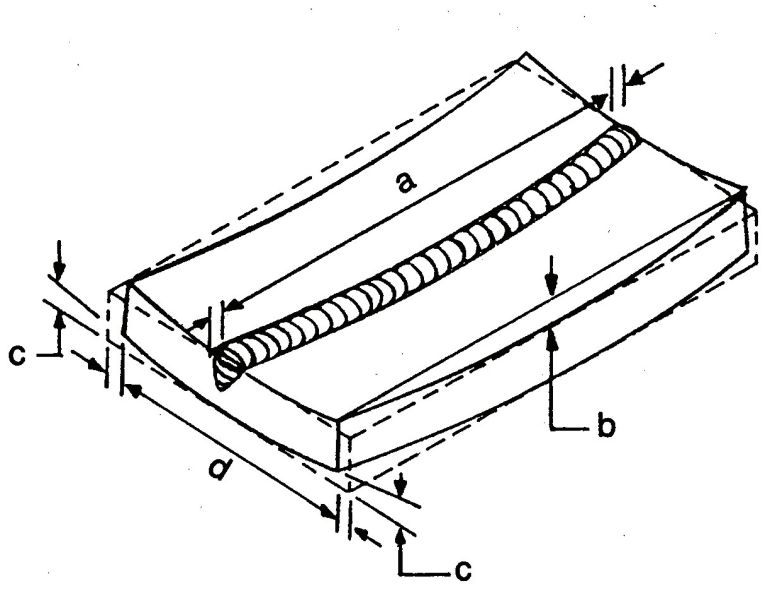
14. Describe the process of Hard-facing.

- Area to be covered must be free of corrosion, grease or foreign substances by grinding it away.
- Do not work at too high amperage.
- Use a longer arc.

15. Give the definition of shrinking of welding joins

When metal is heated it expands and when it cools down it shrinks. The shrinking of welded metal, as well as weld runs, causes distortion of sheets when they cool down. Shrinking takes place in all directions simultaneously and therefore causes various types of distortion.

16. Name and sketch the four types of shrinking



a) Longitudinal shrinking

b) Angular shrinking longitudinally

c) Angular shrinking

d) Lateral shrinking

17. **Name the factors that influence "shrinking" of welding joints**

a) Amount of welding

b) Number of welding runs

c) Degree of resistance

d) Original state or condition of parts that must be welded

e) Welding procedure

18. **Name four ways of controlling distortion of welding runs.**

- Pre-setting.
- Welding of patch work.
- Clamping.
- Spot welding.

OXY-ACETYLENE CUTTING AND HEATING

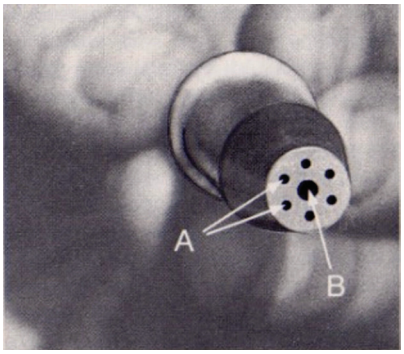
1. Describe the cutting process.

- First bring the material up to red hot.
- Oxygen is then fed with the lever on the cutting attachment.
- The steel actually ignites giving of more heat to keep the process going.
- The steel turns into a liquid.
- The iron liquid is cleared from the cut by pressure from the oxygen stream.

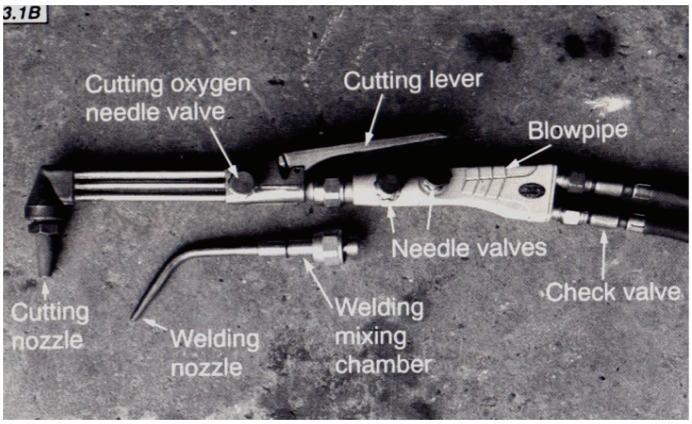
2. Name TWO types of metals that can be cut by using an oxy-acetylene welding set.

- Mild steel.
- Cast iron.
- Stainless steel

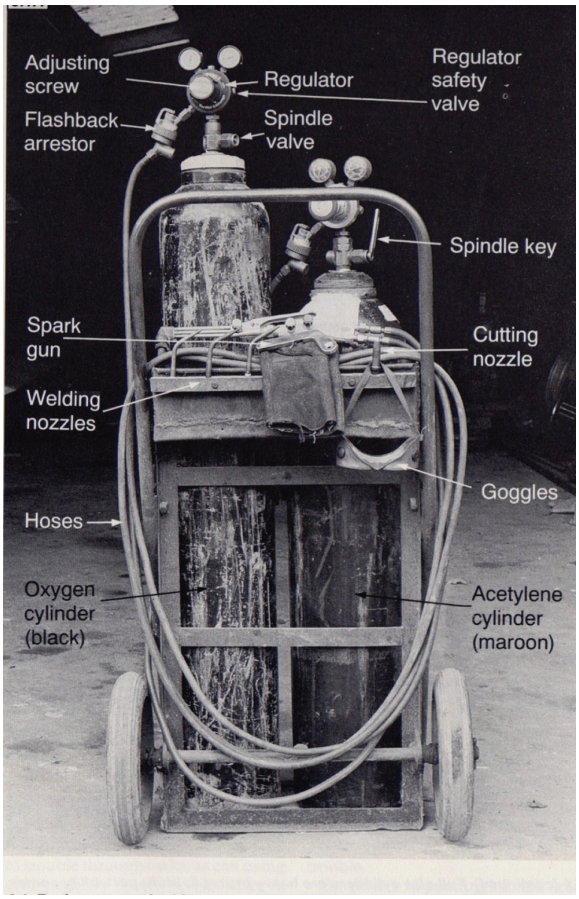
3. Sketch of a cutting tip.



4. Sketch of the cutting nozzle.



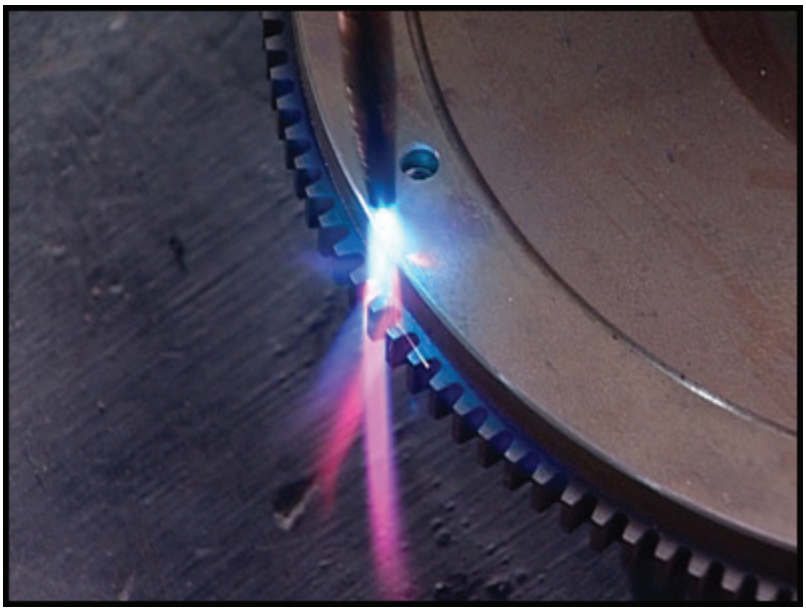
5. Sketch of the oxy acetylene cutting and welding apparatus.



USING AN OXYACETYLENE TORCH FOR HEATING

PART 1 Safety

The objective of this procedure is to show you how to use an oxyacetylene torch for heating. Wear a leather apron or similar protective clothing and welding gloves when using an oxyacetylene torch and always use proper welding goggles.



1. Personal safety

Whenever you perform a task in the workshop you must use personal protective clothing and equipment that is appropriate for the task and which conforms to your local safety regulations and policies. Among other items, this may include:

- Work clothing - such as coveralls and steel-capped footwear
- Eye protection - such as safety glasses and face masks
- Ear protection - such as earmuffs and earplugs
- Hand protection - such as rubber gloves and barrier cream
- Respiratory equipment - such as face masks and valve respirators

If you are not certain what is appropriate or required, ask your supervisor.

2. Safety check

- Oxygen and acetylene cylinders must be securely stored in an upright position.
- An oxyacetylene torch can produce a large amount of heat. Be aware that any objects you direct the flame towards will become hot.
- Always have a suitable fire extinguisher near your work area.
- Do not use an oxyacetylene torch near any flammable materials.
- Make sure that you understand and observe all legislative and personal safety procedures when carrying out the following tasks. If you are unsure of what these are, ask your supervisor.

3. Points to note

- If a cylinder falls over and breaks the main valve off, the cylinder will become a missile and cause extreme damage.
- Wear a leather apron or similar protective clothing and welding gloves when using an oxyacetylene torch. T-shirts, nylon and polyester blend clothing will not provide enough protection. Ultraviolet light and sparks of hot metal will pass through them.
- Always use proper welding goggles. Do not use sunglasses because they do not filter the extreme ultraviolet light as effectively. The plastic used in sunglass lenses will not protect your eyes from sparks.
- Never point the lighted flame toward another person or any flammable material.
- Always light the oxyacetylene torch with the striker. A cigarette lighter or match would put your hand too close to the igniting tip.
- Wherever possible, use a heat shield behind the component you are heating. This will prevent nearby objects from becoming hot.
- After heating a piece of metal, label it as “HOT” with a piece of chalk so that others will not attempt to pick it up.

Part 2: Step-by-step instruction

1. **Light the torch and adjust neutral flame**

   Light the torch and adjust the gas flow so that you have a neutral flame.

2. **Heat for 'Removal'**

   Place a flywheel and ring gear assembly on a set of insulating spacers, to elevate it from the working surface. Direct the flame onto the ring gear and apply the heat until smoke starts to appear. Stop applying the heat. At this stage, the ring gear is hot enough to remove by gently tapping with a hammer and drift. DO NOT TOUCH the metal with your hands. Use welding Gloves and tools that are designed for use in a hot environment.

3. **Heat to 'Red Hot'**

   Direct the flame to the component you wish to heat. If the component is made from thin metal it will heat quicker than one that is thicker. Apply the heat evenly, until you notice the object begin to glow red. Once the glow is uniform, the metal will now be hot enough to manipulate. Once again DO NOT TOUCH the metal with your hands. Use welding gloves and tools that are designed for use in a hot environment.

4. **Shut down**

   When you have finished the job, you will need to shut down the equipment. Turn off the acetylene valve on the torch handle. This will extinguish the flame. Turn off the oxygen valve on the torch handle. Next, remove your safety goggles or mask and your welding gloves. Turn the main cylinder valve clockwise on the top of both gas cylinders. Now open the two valves on the torch handle to "bleed" the system. Turn both the oxygen and acetylene regulator handles counter-clockwise until they are loose. Close both valves on the torch handle. Put the handle and tips away, and return the gas cylinders and their hoses to their proper storage area.

PLASMA CUTTING

1. About Plasma Cutting

- Plasma cutting, also known as plasma-arc cutting, is a technology that evolved from the WWII era plasma-arc welding technique.
- The process involves using a tungsten electrode and high pressure plasma (which is gas in an ionized state) to generate and carry an electrical arc between a copper nozzle and work piece.
- It is the electrical arc that performs the cutting, but the pressurized plasma helps to keep the cut cleared by removing the dross (metal impurities generated by the cutting).

2. Low Voltage, High Current

- The plasma cutter utilizes an electrical transformer and internal circuitry to transform the outlets power of 220 volts alternating current (VAC) with a current draw of 15 amperes, into a low voltage high current cutting stream.
- The typical voltage range of the plasma cutter can be in the area of 20 to 50 volts.
- The current on the other hand can have a high output of up to 100 amperes. It is this high current that creates the identifiable blue and white cutting stream of electrical plasma.
- Electricity is carried on the outside of all electrical wires.
- It is the free electrons of copper, the most common wire to conduct electricity that carries or moves the power from one point to another.
- The plasma cutter with its unique circuitry concentrates this electron flow into a stream of cutting power.
- The electrons form a plasma-like substance that can be seen when the trigger is pulled on the cutting torch handle.
- It is this intense plasma that heats and melts the metal into a small diameter puddle.

3. Compressed Air, the Final Force

- Once the molten puddle is made, another force is needed to “push” the puddle through the other side of the material being cut.
- Compressed air, in the range of 100 pounds per square inch (PSI) or 4.95 Bars, is conducted through the torch handle and released when the trigger is pulled.
- This plasma stream is now complete and creates the small diameter, but fine line for cutting metal.
- Generally the plasma stream is so intense that the torch handle can be moved along the surface of the material in speeds of 100 inches or more per minute.
- Comparing that to other types of cutting torches, which can only achieve a maximum speed of 30 inches per minute, makes the plasma cutter a high-speed cutting apparatus.

4. The Angle of Cut

- One minor draw back or physical characteristic of the plasma cutter is the angle of the final cut in relation to the material.
- The plasma arc will cut a 6 to 7 degree angle on the vertical face of the material.
- Thin metal stock will not have an appreciable face angle that has to be dealt with in as much with thicker material.
- Metal work pieces 5mm or greater may have to be dressed with an electric grinder in order to have a true perpendicular angle in relation to the horizontal surface.

5. Temperatures

The plasma used in plasma cutting is under such intense pressure that it can reach temperatures of over 36,000 degrees F during the cutting process.

6. Plasma Gases

Plasma cutting employs a number of gases to produce plasma, including argon, nitrogen, oxygen and regular air.

7. Electrodes

While tungsten electrodes are the standard, plasma cutting that uses regular air for plasma creation require the use of copper mounted hafnium or zirconium electrodes.

8. Electricity

Plasma cutting is a high-voltage process that can require up to 400 volts during initialization of the arc.

9. Calibration

- Calibration of the plasma torch is extremely important.
- An improperly calibrated plasma torch may generate a double arc, which can melt the torch nozzle.

10. Selecting the Correct Plasma Cutting Machine

- In order to select the correct handheld plasma cutting, an individual should analyze the normal and maximum thickness of the metal that will be cut.
- All handheld plasma cutting machines use high voltage and low amperage.
- When selecting a machine, the voltage must be high enough to emit the correct amount of power for the work that it must complete.

11. The Various Gases Available for Plasma Cutting

- Although all handheld plasma cutting machines are used to cut steel and metal, certain gases perform various tasks more efficiently than others.
- Air is the most versatile gas and works well for mild aluminum or stainless steel.
- Oxygen is the industry standard for cutting carbon steel because it cuts with the best quality considering its cutting rate.
- Nitrogen has a consistent cutting speed that is powerful and it also lengthens the life of the machine's parts.
- The final gas option is argon hydrogen.
- It is the best selection for cutting thick metal and steel because it is the hottest gas with the highest cutting capacity.
- Knowing the difference between the gases will increase the success of the plasma cutting machine that is being used.

12. Torch Size

- Power is determined by wattage, not amps or volts.
- Wattage equals amps multiplied by volts of direct current, or VCD. A 12-amp plasma torch rated at 210 VCD would have more cutting power than a 15-amp torch rated at 110 VDC.
- A plasma torch with a larger amp rating does not necessarily mean it has more cutting power, though many people make a purchase based on the number of amps.

13. Speed and Thickness

- If your plasma cutter has a quality-rated cut of 7/8 inch, you will be able to smoothly cut a piece of steel no thicker than 7/8 inch at a speed of 10 inches per minute, or IPM.
- The slowest rated cutting speed is 10 IPM. The same 7/8-inch quality-rated cutter will cut thicker pieces of steel but at a rate slower than 10 IPM, and the cuts will not be of good quality.

14. Plasma Cutting Safety

- One of the most important aspects of using a handheld plasma cutting machine is safety. Although the operation of the machine is relatively simple, the power of the machine and the level of voltage that it contains require that safety is a top priority.
- Fireproof gloves and a face shield must be worn at all times.
- All plasma cutting machines are potential fire hazards because they blow hot metal and sparks, so flame-resistant clothing should always be worn.
- Any flammable material should be a minimum of 35 feet away from the machine while it is being operated.
- Most important, plasma cutting machines contain a potentially lethal voltage reserve.
- If any live electrical parts are touched, fatal shocks or severe burns will occur.
- Although the handheld plasma cutting machine is simple to operate, certain mistakes can be deadly.

15. Fire Hazard

- Plasma cutters produce an intensely hot plasma jet that can exceed 45,000 degrees Fahrenheit. Contact with the plasma jet will cause severe burns and can easily cut through tissue.
- Under no circumstances should contact be made to the plasma torch with any part of your body while the machine is in operation.
- Never touch the work piece near the cutting area due to risk of burns.
- When used for cutting metal, plasma torches create large amounts of sparks and hot metal that can ignite clothing or other flammable items around your workspace.
- Wear fire-resistant, insulated clothing and be sure that the workspace is free of fire hazards

1. Vision Hazard

- As a secondary effect, a plasma jet creates strong amounts of visible and ultra-violet radiation that can be damaging to the eyes.
- Sparks and hot metal can cause eye injury.
- Wear proper face shields and eye protection while using a plasma torch.
- Appropriate eye protection will be detailed in your user manual.

2. Breathing Hazard

- Cutting metal with a plasma torch will generate hazardous gases.
- Wear proper respiration gear, and under no circumstances inhale these gases.
- If you must inspect a piece as you cut it, view the piece from the side, not from above. This will minimize your exposure to hazardous gas.
- Make sure the work area is well-ventilated as well.
- An exhaust hood or a space open to the outside is recommended when using a plasma torch. Respirators or other breathing apparatus may be required.
- Again, check your user manual for details.

3. Electrical Hazard

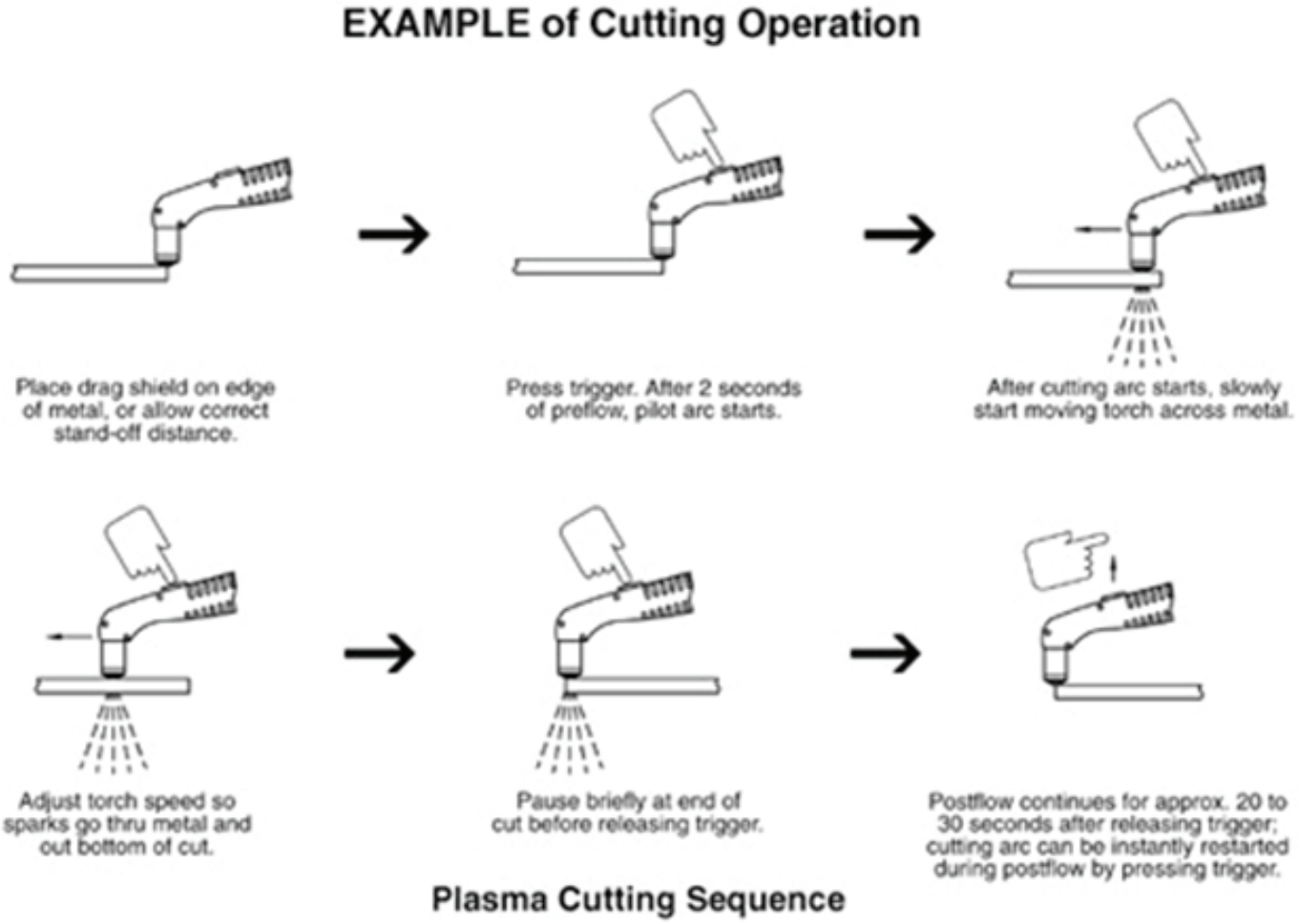
- A plasma torch operates using very high voltages.
- Torch components are “live” while power is being supplied.
- Contact with these live parts carries a high risk of fatal shock, so never touch any part of the plasma torch besides a handle or trigger while it is in operation.
- Even when the power switch has been turned off, do not touch any potentially live components. Be sure to wear insulated gloves and clothing, use electrically insulating dry mats, and be sure that the ground wire is securely fastened to the ground terminal.
- Make sure that the work piece itself is also properly grounded.
- Consult your user manual for instructions on electrical safety specific to your model of plasma cutter.

19. General Safety

Last, do not operate these machines if you are under the influence of any drugs or alcohol. If you do not have experience operating one of these devices, seek professional consultation and training before attempting to operate one yourself. These machines are extremely hazardous, and improper usage can injure or kill you.

20. Advantages

- **Rapid Cutting Speeds:** Plasma arc cutting is faster than oxyfuel for cutting steel up to 2 inches thick and is competitive for greater thickness. Plasma cutting achieves speeds greater than those of laser cutting systems for thickness over 1/8 inch. CNC controls allow speeds of up to 500 inches per minute (ipm) to be achieved on gauge thickness. These fast cutting speeds result in increased production, enabling systems to pay for themselves in as little as 6 months for smaller units.
- **Wide Range of Materials and Thickness**: Plasma cutting systems can yield quality cuts on both ferrous and nonferrous metals. Thickness from gauge to 3 inches can be cut effectively.
- **Easy to Use**: Plasma cutting requires only minimal operator training. The torch is easy to operate, and new operators can make excellent cuts almost immediately. Plasma cutting systems are rugged, are well suitable for production environments, and do not require the potentially complicated adjustments associated with laser cutting systems.
- **Economical**: Plasma cutting is more economical than oxyfuel for thickness under 1 inch, and comparable up to about 2 inches. For example, for ½ inch steel, plasma cutting costs are about half those of oxyfuel.



21. Troubleshooting and Maintenance

- If a machine produces an arc and then loses it, or if the arc fails to penetrate metal it once could, examine the consumables first. The electrode and tip wear a little bit with every start/stop cycle and need to be replaced when they are worn excessively.
- Some of the biggest problems relate to air pressure. Low air pressure leads to poor performance, notably at high amperages.
- To check for this condition, try increasing pressure at the machine. If the pressure gauge doesn't move much beyond the optimum setting, adjust pressure at the gas source, because minimum flow rate may not maintain enough pressure through several hundred feet of pipe or hose.
- To ensure sufficient pressure at the machine, set the source gauge 30 to 40 PSI higher than the pressure gauge on the machine.
- To ensure sufficient air pressure at a plasma machine, you must use a gas hose with at least a 3/8-inch internal diameter and hose fittings that match or exceed the rating recommended in the machine's owner's manual.
- Many plasma cutters have built-in regulators with air filters, but good practices call for additional filters and separators on the gas supply to remove water or other contaminants. Remember that water is highly conductive, and if water enters the torch, it can cause internal arcing that can damage the torch. Like the oil filter on your car, routinely change the air filters on a plasma setup; saturated filters do not remove moisture

CHAPTER 5

TOOLS, EQUIPMENT AND IMPLEMENTS

WORKSHOP EQUIPMENT AND TOOLS

1. What is the Most Common Farm Machinery?

- Farm machinery is the machinery that is used on farms to assist with farming work.
- Previously, hand-held implements and animal-drawn machinery were used. In modern times, mechanized farming is the norm.
- Electric or fuel-powered machinery carry out most of the tasks that were once carried out by men and animals.
- Using machinery is less time-consuming and more cost-effective than working by hand or using tools like scythes or animal drawn plough.
- Advances in farm machinery have revolutionized the farming industry.
- Whether it is a family farm, an organic farming enterprise or a commercial farming endeavour, a wide range of farm machinery is used.
- Commercial farming uses more sophisticated farming equipment than the other two.
- Not only is modern farming mechanized, it is also computerized.
- Farmers routinely use satellite imagery, GPS guidance and electric sensors in their farming work.
- Advanced farming machinery reduces waste and ensures a more profitable use of seeds, fertilizer, irrigation and fuel.
- It has improved the production and transport of farm produce.
- The most common and well-known farm machinery would be the tractor.
- Tractors are used to pull a variety of farm machines and equipments.
- Farm machinery used for soil cultivation includes the plough, the power tiller, the spike, drag and disk harrows, the chisel plough, the cultivator, the spading machine and the rock picker. These machines clear the land of stones and weeds, and loosen the soil in readiness for planting.
- The actual planting is done using mechanized planters, Trans planters, seed drill, broadcast seeders and mulch layers.
- Planters plant seeds in precise rows at precise intervals.
- Drills plant seeds much closer together than planters.
- Trans planters transplant seedlings into the field, and may be partially or fully automated.
- Mulch layer machines can lay natural or plastic mulch.
- The growing plants are helped along with fertilizer, manure and spray spreaders.
- Irrigation is made easier by specialized irrigation machinery.
- Quick and ready mechanized irrigation facilities have made it possible to cultivate high yields of crops in dry areas.
- Water can also be supplied over a wide range of land and in specific required quantities.
- Harvesting farm machinery includes the famous combine harvester and thresher.
- The combine, as it is usually called, saves farmers a lot of time and effort.
- It cuts, threshes and separates grain as it works its way through crop fields.
- Other harvesting farm machines are the cane, corn and bean harvesters and the cotton pickers.

- Rakes, mowers, balers and bale movers are used to make hay bales.
- Backhoe and front end loaders are used for loading purposes.
- Vehicles like trucks, planes and helicopters are used for transportation purposes.
- Planes and helicopters may also be used for spraying crops and tracking animal herds.

2. What Are the Different Types of Agricultural Machinery?

- The growing world population means that the world's food demands are also growing.
- To meet those demands, production needs to be faster and more efficient than it was in the past.
- Agricultural machinery, such as tractors, combine harvesters, and crop dusters, help to achieve those goals.
- A tractor is typically one of the most recognized pieces of agricultural machinery.
- What may not be as widely recognized are the capabilities these machines have and the technology they are equipped with.
- A tractor's primary purpose is to haul or pull something as part of the agricultural process.
- With older models, this could be a very tough job.
- Tractors were once simple motorized machines with two large wheels in the back and two smaller wheels in the front.
- Tractors have evolved into sophisticated pieces of agricultural machinery that may not even have wheels.
- Some models are equipped with tracks instead, and modernized tractors may also have cabs accessorized with heated seats, automatic temperature controls, and dashboard computers.
- Broadcast seeders are machines that can be attached to tractors to distribute seeds.
- These machines come in different sizes, but the larger models are generally connected so that they can draw operational power from the tractor.
- Seeds are placed inside the hopper, which is a funnel-type barrel that may have multiple vanes inside.
- There are usually rotating disks at the bottom of the machine that can be adjusted for various spread patterns.
- A combine harvester is a large machine that is used to gather grains, such as wheat, barley, and corn.
- This piece of agricultural machinery is significant because it performs what were traditionally three separate jobs.
- A combine harvester chops the plants; removes the edible portion, which is the grain; and then cleans the debris from the grain.
- Once the combine harvester has a significant supply in it storage tank, it can easily be loaded into a truck and transported elsewhere.
- The discarded portion of the plants that the combine harvester leaves behind can often be used for hay.
- The remnants of those plants are typically converted into neat bales with another piece of agricultural machinery.
- There are machines that produce square bales and others that produce round ones.
- Both types of baling machines typically employ a system of gathering and forced

3. CUTTING MACHINES

Lawn and rotary mowers

Objective: To promote safe use of lawn mowers

1. Background

- Rotary mowers are useful but dangerous equipment with the potential to cause serious injuries. Their blades rotate at a high-speed in the range of 2,000 or 4,000 rpm. The speed at the blade tip may vary from 100 to 200 mph. For improved safety, he operator should know how to quickly disengage the blade and stop the engine.

2. Safety Tips for Operating a Rotary Mower

- Read and understand the operator's manual and become familiar with the machine.
- Remove all debris from lawns before mowing.
- Use recommended PPE including close-fitting clothing when operating a lawn mower.
- Disengage the blade before starting.
- Keep all guards and safety shields in place.
- Never disengage any safety interlock switches.
- Never refuel the mower when the engine is hot or running.
- Store gasoline in an approved container with proper label.
- Turn off the motor before cleaning the area under the deck.
- Disconnect the spark or electric plug before trouble-shooting or repairing the mower.
- Perform routine maintenance according to the schedule recommended by the manufacturer.
- Keep a running mower away from bystanders and pets.

3. Safety Tips for Push Mowers

- Start push mowers from a firm stance with feet in a safe position.

4. Safety Tips for Electric Mowers

- Never use an electric mower on wet grass.

5. Safety Tips for Riding Mowers

- Keep both feet on the foot rests of a riding 2 mower.
- No extra riders on any mowers.
- Be aware of power-take-offs (PTO's)
- Turn off the motor before dismounting

6. Be Aware of Mowing Hazards

- A mower can tip over easily.
- Push the mower away from the operator during a fall.
- Never leave a running mower unattended.
- Foreign objects in the mowing area can be thrown by the mower.
- Make sure area is free of loose items.

7. Proper Mowing Directions

- When mowing on a slope with a riding mower, mow down the slope.
- When mowing on a slope with a push mower, mow across the slope.

8. Proper PPE for Mowing

- Sturdy steel-toed work boots are highly recommended during mowing.
- Long pants and long-sleeve shirts protect from flying debris, grass clippings, and the sun.
- Use safety glasses or goggles, especially when mowing near solid objects like gravel driveways.
- Ear protection is highly recommended during mowing.

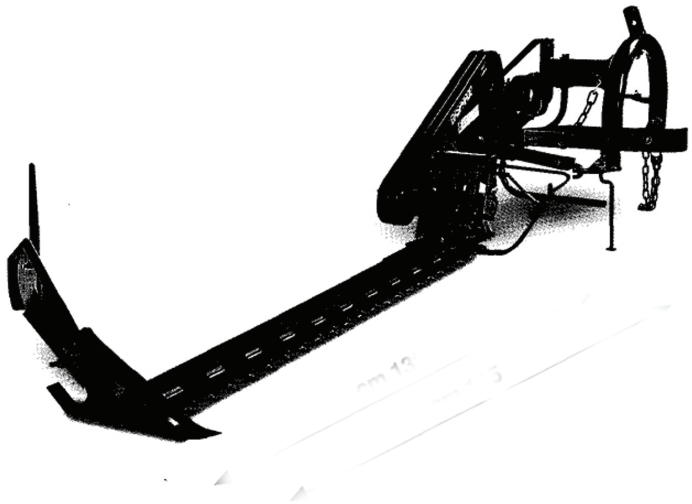
9. Review

- A rotary blade turns at 2,000 and 4,000 rpm, and the blade tip speed may reach 200 mph.
- Wear PPE, snug clothing when mowing.
- Keep guards and safety shields in place.
- Never disengage any safety interlock switch.
- Turn off the mower before removing any foreign objects.
- Know how to disengage the clutch and stop the engine.
- Never leave a running mower unattended.

CUTTING MACHINE

QUESTIONS AND ANSWERS

1. The illustration below shows a machine used on a farm for cutting plants for various purposes.



1.1 Briefly describe how this machine is connected to the tractor.

a) Connected to the three-point mechanism of the tractor.

b) Two lifting arms

c) Top link.

d) Two stabilizing chains

1.2 Describe shortly how you will maintain this machine.

- Lubricate regularly
- Sharpen all blades
- See that all screens are in working order and in place
- Replace worn V-belts
- Make sure all V-belts are tight
- Repair damaged or broken parts immediately.

BAILING MACHINES

1. **Name the two types of baling machines.**

a) Ram or piston type makes oblong rectangular bales.

b) Roller type makes cylindrical bales.

2. **Describe the working of the ram type of baler**.

- The baler is driven from a power take-off.
- When the flywheel rotates, the crankshaft also rotates causing the ram to move backwards and forwards.
- At the same time the packing arms move in and out of the baling chamber and the auger continuously rotates.

- The pick-up wheel, which is spring, toothed picks up the hay as the baler moves foreword and puts it onto the combine plates where it comes into contact with the feeding auger.
- The auger, that is floating, constantly rotates and feeds the hay to the packing arms.
- The packing arms that move up and down to the hay feed the hay to the baling chamber, where it comes into contact with the ram.
- The hay is compressed in the baling chamber by the ram with a forward backward movement. This movement is synchronized with the packer arms. It allows hay to be fed into the baling chamber by the packing arms when it is withdrawn to its maximum.
- The baler is fitted with a blade on the side of the ram in order to separate the hay in the baling chamber from the rest.
- Two needles are used to push the ropes through the bale where the knotting mechanism catches it and binds it.
- Measuring wheel that slowly rotates as the bale move through the baling chamber measures the bale and activates the needles and knotting mechanism as soon as the desired bale length is acquired.

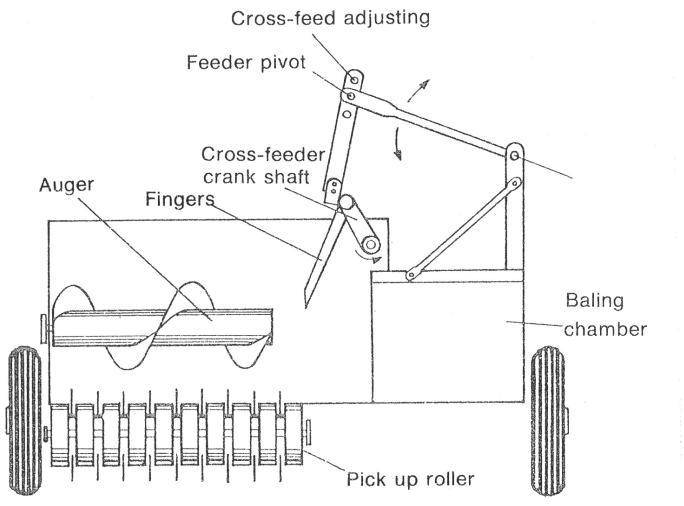
3. **How is bale density changed in the ram type baler?**

   By increasing or decreasing the resistance to the hay moving through the baling chamber.

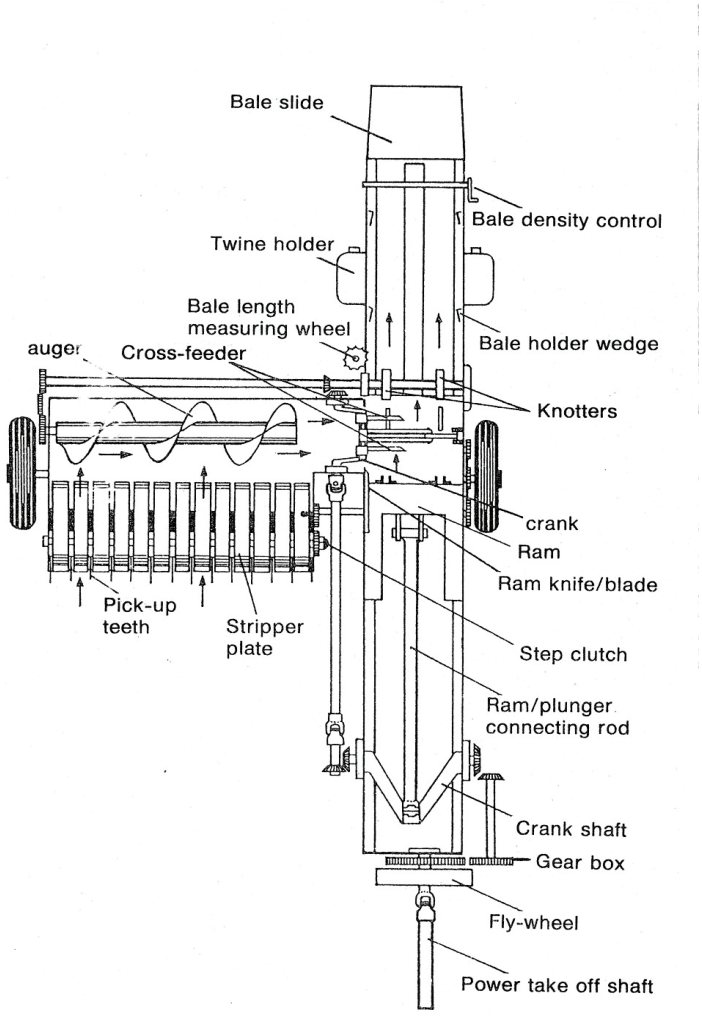
4. **What is the function of the slip clutch? (Ratchet plate)**

- Prevent heavy objects from being taken into the baler.
- Protect the pick-up if it is impeded by anything.
- Protect the auger if it becomes overloaded.

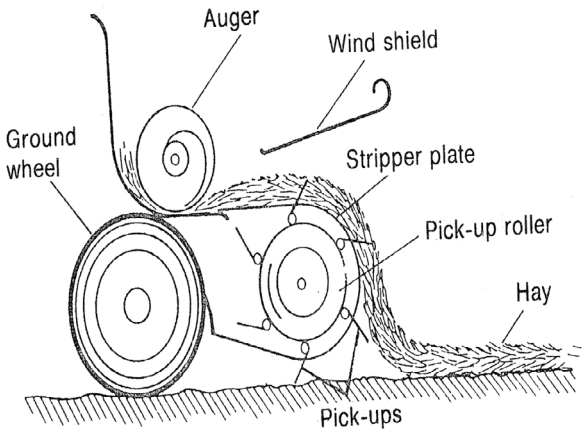
5. **The position of the packer arms**



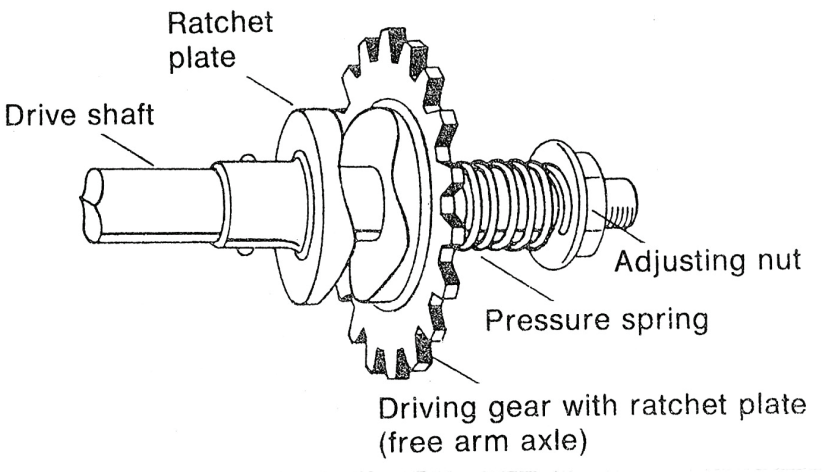
6. **A top view of the layout of the main working parts of the pick-up baler.**



7. **Side view of the baler picking up hay.**



8. **The ratchet slip clutch**.



9. **How is the bale density of round bales changed?**

By increasing or decreasing the tempo of baling. (Groundspeed of the baler)

10. **Compare the advantages of the Rectangular baler to that of the Roller baler.**

a) Storage space optimally utilized.	a) One man operation.
b) Bales handled manually.	b) Low rope consumption.
c) Continuous baling process.	c) Simplistic working.
d) Bales stored easily.	d) Can bale until rain starts.
e) Transport space optimally utilized.	e) Roofed storage not necessary.

11. **Compare the disadvantages of the Rectangular baler to that of the Roller baler.**

a)	Higher labour needs.	a) Not easily transported.
b)	Bales must be stored under cover.	b) Must be handled mechanically.
c)	Higher maintenance requirements.	c) No automatic packing machine.
d)	Working more complicated.	d) Relatively vast storage area required.
e)	Higher repair requirements	e) Use of bales for feeding problematic.

12. **Describe the procedure to follow when a baler is prepared for use**.

a) All grease points must be well greased.

b) The correct tension must be set for all belts or chains.

c) Check that all parts are functioning correctly by operating it slowly.

d) Replace all worn parts immediately.

e) Service according to manufacturers specifications.

f) Lift up all dust release guards.

g) Check that binding timing is set correctly.

h) Check that machines magazine has sufficient rope.

13. **Describe what is meant with timing of a ram type baler**.

Exact moment when the needles lift the binding rope so that the compressed hay can be bound.

14. **Name the safety mechanisms of the baling machine.**

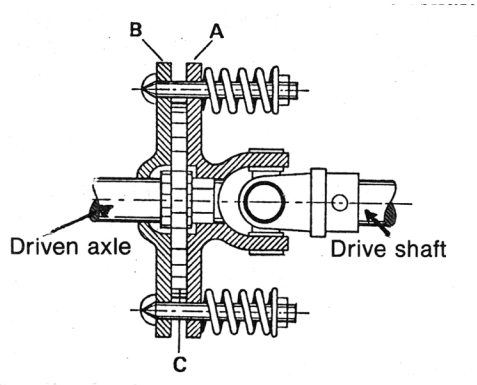
a) Slip clutch.

b) Screens.

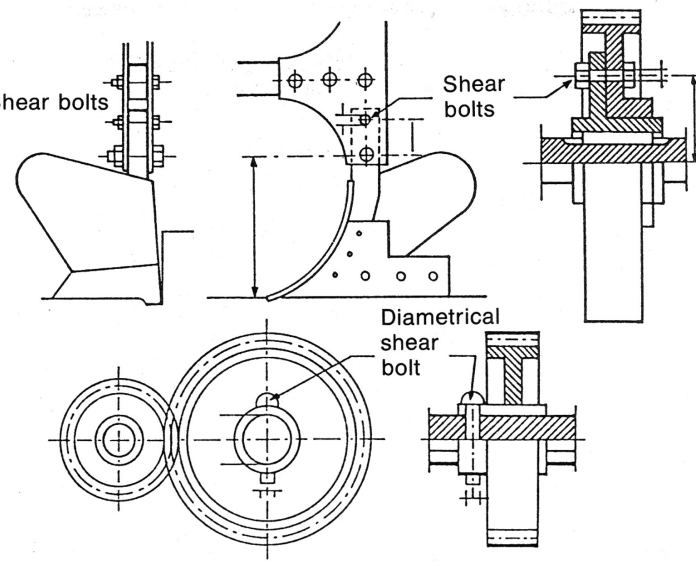
c) Shear bolts.

d) Ram stop safety mechanism.

15. **Sketch of the slip clutch**.



16. **Sketch of the shear bolt.**



17. **Name the tasks that a person should perform when maintaining a baler.**

a) Lubrication.

b) Check all bearings, chains and gears.

c) Check all safety clutches.

d) Sharpen all blades.

e) Check tires pressure.

f) Check bolt tension.

g) Inspect chassis and tires for damage.

18. **Name the procedure to follow when the baler are to be stored for a long period.**

a) Remove all bales from baling chamber.

b) Clean the baler properly.

c) Drain and replace all oil.

d) Releases the tension on all drive belts.

e) Remove all chains, clean and oil them, and replace them.

f) Dismantle all slip clutches, clean them and reassemble them but do not put the springs under tension.

g) Totally reduce bale chamber tension.

h) Cover all unpainted areas with a thin layer of grease.

i) Grease all grease nipples.

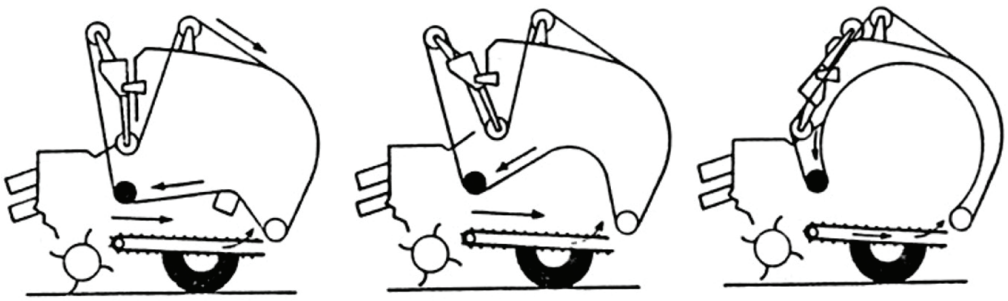
j) Store baler in a dry place under cover.

19. **Name two types of roller balers systems**.

a) Welger system.

b) Vermeer system.

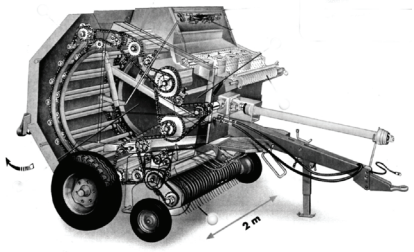
VERMEER-TYPE ROUND BALER.

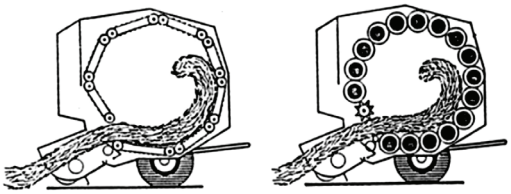


20. **Explain the working of the round baler VERMEER SYSTEM.**

- It has a bale shaping mechanism that tightly rolls the hay into a round bale.
- Baling chamber is initially small but enlarges gradually as the hay is fed into the chamber.
- A tensioning system of pulleys belts and chains keeps the tension of the bale constant while it is turning around.
- The baling chamber enlarges with the expanding bale.
- If the bale is large enough ropes are bounded around the bale.
- The bale is then ejected at the back of the baler and a new bale is formed.

WELGER-TYPE ROUND BALER.





A B

21. What is the difference between baler A and baler B?

Baler A has belts and baler B has rollers.

22. Describe the process of bale formation in this type of baler up to the point before binding takes place.

- As soon as a bale reaches maximum size, rope is released to bind it and the forward movement is stopped.
- The bale continuous to rotate and a special arm, which operates
- mechanically, moves forward over the bale putting the rope around it.
- This movement results in the rope being wound around the entire width of the bale.

23. Large Round Bale Safety

- Safety aspects of equipment used in large round bale packages such as: balers, front-end loaders, bale handling and transport devices.
- The key to safe and efficient systems for handling large round bales is an operator who knows the hazards involved and who follows safety practices that can prevent accidents.
- Operators must be constantly alert for situations that may cause injuries to themselves or others.
- Besides pain and suffering, accidents contribute to higher costs in terms of unnecessary downtime or costly machine repairs.
- Alertness and safety consciousness can result in more efficient and profitable baling and handling.

24. Baler Machinery Safety

- Developing safety awareness begins with the operator's manual.
- Take time to read the manual and become reacquainted with the machine at the beginning of each season.
- Insist that all operators be trained and acquainted with all the safety precautions in the manual.
- This precaution is particular important for youth, whose training should be reinforced periodically.
- Large round baling creates unique safety problems for farmers and ranchers.
- Large round balers have many moving parts that can cause injury or death if a person becomes entangled.
- Never leave the tractor seat until the PTO (power take-off) has been disengaged and all moving parts have stopped.
- Balers and bale handling equipment should carry warning signs or labels (Figure 1).
- Read and heed all safety warnings (see Table 1 for additional safety tips).

Table 1. Round Baler Safety Tips.

- A round baler is bulky and reduces operator vision to the rear.
- Be watchful when backing the baler.
- Assure no one is near the rear gate when it is being raised and lowered.
- Keep everyone clear of the rear of the baler during unloading.
- Large round bales can roll after discharge when on hilly terrain.
- Before servicing, cleaning, or adjusting a round baler, disengage the tractor PTO and shut off the engine. Never attempt to pull hay or twine from an operating baler.
- Block the gate before working under it. Use the safety lock system for the baler gate or the safety stops for the gate lift cylinders.
- Keep the PTO properly shielded.
- Shift the tractor transmission into park and lock the brakes, or block the baler wheels if the baler is not hitched to a tractor, before working on or under the baler.
- During operation, remain seated on the tractor seat to reduce the chance of falling into the path of the baler. Never allow passengers to ride on the baler during operation or transport.
- Be extremely cautious when operating a baler on uneven or hilly terrain. Round balers are top heavy (high center of gravity) and could tip sideways if one wheel drops in a hole, ditch or other irregularity, especially if carrying a near-completed bale.
- Raise the pickup to clear humps and obstacles when passing over uneven terrain.
- Avoid sharp turns; with the tractor wheels set wide to straddle windrows, rear tires could strike the baler tongue on sharp turns.
- Never be in a hurry about anything connected with the baling operation.
- Keep safety signs clean, readable and free from obstructing material. Replace damaged or missing safety emblems with new ones. Instruct all operators on the meaning of the hazard signs.

Figure 2. Be sure no one is near the rear gate when it is being raised or lowered.

25. Bale Handling on Hillsides

- Operating large round balers on a slope is a greater concern than almost any other machinery operation.
- Bales on a slope have the potential to roll down the hill, break through fences and cross highways, leading to bodily harm and potential property damage.
- Always orient the bale correctly before ejecting the bale from the bale chamber.
- Sometimes this just means backing the baler at the right angle to eject the bale perpendicular to the slope.
- The objective is to make certain that the bale will come to rest securely on the hillside.
- Steep slopes may require that the bale be hauled to a flat location before ejection.

26. Handling Large Round Bales

- Whereas small square bales, weighing 35 to 85 pounds, are traditionally handled and stacked manually or with a bale loader,
- large round bales usually weigh between 500 and 2,500 pounds and must be handled mechanically.
- Because of their weight, these bales can cause significant injury if they roll into or fall on an individual.
- Many farmers use hauling equipment designed for small square bales to handle these larger packages (sometimes with minor modifications).
- When done improperly, this can lead to injury or death due to overturning or crushing.

BALE HANDLING DEVICES

FRONT-END LOADERS

- Many people use front-end loaders to move and stack large round bales.
- Use caution when hauling large round bales or any heavy load on a front-end loader so that you avoid side overturns and being crushed from a bale rolling down upon the tractor.
- It is extremely important that the size of the tractor and loader are matched properly to the size and weight of the bales being handled.
- Side overturns result from the change in the tractor's centre of gravity due to the additional weight of the bale.
- Figure 3 shows what happens to the centre of gravity.

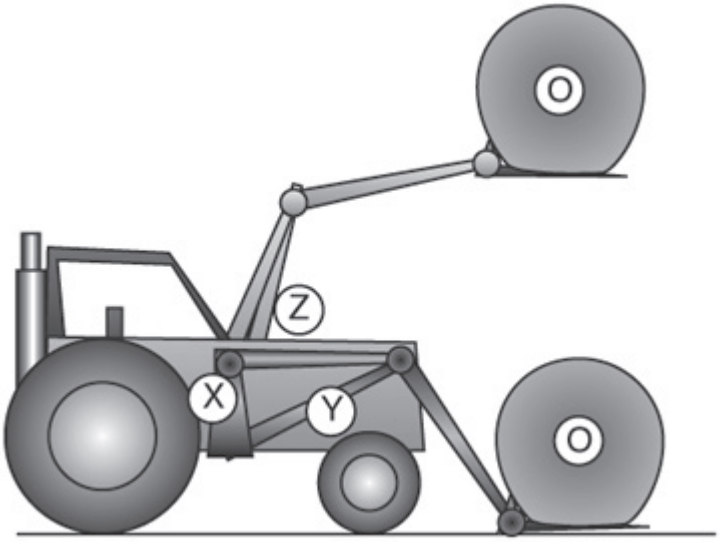


Figure 3. The point marked "X" is the normal centre of gravity with a front-end loader. As a large bale is added, the centre of gravity moves to a point marked "Z". When the load is raised, the shift in centre of gravity increases the chance of overturning. The point marked "O" is the centre of gravity for the round bale.

- The normal centre of gravity with a front-end loader is at the point marked “X.”
- When a large round bale is carried on the front-end loader close to the ground, the centre of gravity moves forward, represented by point “Y.”
- The point marked “O,” or half the diameter or length of the bale, is the bale’s centre of gravity.
- Some operators will carry the load high for improved visibility while driving.
- However, when the loader is raised as shown, the centre of gravity moves to the point marked “Z,” which is both forward and higher than the original centre of gravity, “X.”
- In the raised position, the tractor is less stable and the potential for side overturn increases.
- Now visualize this tractor on a slope with two wheels on the downhill side and two wheels on uphill side.
- As the bale is lifted, the centre of gravity gets higher and the potential for the tractor to roll down the hill increases.
- The same phenomena is observed with a dump truck. Have you noticed that no dump truck operator will dump the truck on a side slope?
- The chance of side overturns increases when carrying a load on the front-end loader, especially on slightly rough ground.
- Moving the centre of gravity forward causes a transfer of weight from the rear wheels to the front, making it much easier to bounce a rear tire off the ground when passing over bumps or holes.
- Plus, the additional weight on the front tires may exceed the axle and tire load-carrying capacity.
- A loss of traction occurs when weight is transferred from the rear tires during bale handling. This can be a problem when moving bales up a slope or on wet soil.
- Loss of traction can result in a braking loss on all surfaces.
- Mounted front-end loaders (see Table 2 for additional safety tips) should be used when the load is properly counter-balanced by adding weight to the rear of the tractor.
- This additional weight will bring the centre of gravity back to the original centre.

Table 2. Front-End Loader Safety Tips.

- Never walk or work under a raised loader.
- Raise and lower loader arms slowly and steadily.
- Allow for the extra length of the loader when making turns.
- Be careful when handling loose or movable loads.
- Never move or swing a load as long as people are in the work area.
- Stay away from the outer edge when working along high banks and slopes.
- Watch for overhead wires and obstacles when you raise the loader.
- Carry the load low to the ground and watch for obstructions on the ground.
- Always use the recommended amount of counterweight to ensure good stability. Add recommended wheel ballast or rear weight.
- Operate the loader from the operator's seat only.
- Move the wheels to the widest recommended settings to increase stability.
- Do not lift or carry anyone on the loader, bucket or attachments.
- Lower the loader when parking or servicing.
- Assure all parked loaders are on a firm, level surface and all safety devices are engaged.
- Visually check for hydraulic leaks and broken, missing or malfunctioning parts, then make necessary repairs.
- Under pressure, escaping hydraulic oil can have sufficient force to penetrate the skin, causing serious personal injury. Injuries resulting from oil penetrating the skin are very difficult to treat. Use a piece of cardboard or paper to check for pinhole leaks.
- Before disconnecting hydraulic lines, relieve all hydraulic pressure.
- Be certain anyone operating the loader is aware of safe operating practices and potential hazards.
- Extending the tines of a loader may look like a good way to solve the loading problem, but when this is done the tractor's center of gravity is moved forward. Extra stress is placed on the loader, the hydraulic system and tractor front end.
- All tractors used to move bales should have roll-over protective structures (ROPS). ROPS can either be a protective enclosed cab or a roll bar with a canopy.
- Tractor operators should utilize the tractor seat belt at all times when operating the tractor, regardless of the task that is being done.

THREE-POINT HITCH SPEARS

Three-point hitch spears that are pushed through the bale and fingers that grasp the edges of the bale are available. Know where the centre of gravity is when using this handling equipment, especially if the load extends far to the rear of the tractor. This can overload the tractor hydraulic system; the relief valve will open but the lifting actuators will not come up.

Avoid lifting bales with a 3-point lift on the rear to a height where the front tractor wheels are barely in contact with the ground. This causes steering and stability problems. At least 30 percent of the front weight of the tractor should remain on the front wheels.

It is better to handle bales with rear attachments rather than with the front-end loader. Rear tires are better suited to carry the extra weight, and there is less chance of side overturns because the bale is not lifted as high.

There is some increased possibility for rear overturns. However, the bale or carrying attachment may help prevent the tractor from having a rear overturn. Some operators use both a rear-mounted handler and front-end loaders (Figure 4). This will reduce the stability problems, but make sure the bale loads do not exceed the tire-carrying capacity of either the front or rear tires.

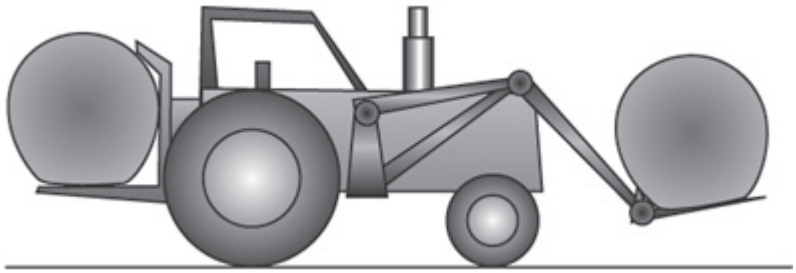


Figure 4. Rear and front-end bale-handling devices.

If possible, try to operate bale handling devices on fairly level ground. When picking up a bale with a front- end loader, drive up the slope in order to spear the bale. Care must be exercised when driving across the slope to pick up a bale. The operator may need to transport bales, in the baler, to a safer location before ejection.

When using a front-end loader to load round bales on a trailer, drive the trailer across the slope and load from the uphill or downhill side. Never try to place a second-layer of bales on a trailer up or down the slope. To accomplish this the tractor must travel across the slope and will increase the potential for overturn.

TRANSPORT

Special low clearance trailers that carry 4 to 10 bales and also load bales directly from the ground are available. These units are preferred for moving bales because they reduce or eliminate problems of overloading the hydraulic system and reduce potential overturn. They also handle more than one or two bales at a time.

Since these trailers can carry 4 to 10 bales, there can be a problem with stopping the load. At 1,500 pounds per bale, load size is between 3 to 7 tons. Add the weight of the bale trailer to this and the total transport weight approaches 9 tons. The tractor must be the proper size and weight to safely stop the entire bale and trailer weight.

Use a lower gear when going downhill, since the tractor brakes alone may not be able to stop the load. When going uphill, also use a low gear, so that you will not have to hold the load with the tractor brakes while changing gears up the slope. Do not attempt to change gears during descent, begin descent in a low gear.

Install brakes on any transport trailers carrying heavy loads. Never operate a hay trailer on the highway that is not equipped with brakes. This accessory makes stopping easier and safer. Trailers can be equipped with electric, hydraulic, or surge brakes. Most models can be equipped with a breakaway device that will lock the brakes if the trailer breaks loose from the towing vehicle.

Keep people out of the area between the trailer and tractor during hitching. Hand signals should be used and understood by both the operator and those assisting (see Table 3 for safety tips). Hitch the trailer only to the drawbar; never attach to any other point on the tractor (Figure 5). Assure the tractor drawbar is in the lowest, most centred and stationary position. This will keep the tractor's front wheels moving straight and provide extra steering control. Use a safety locking hitch-pin and secure the trailer with chains.

Table 3. Tractor Operations Safety Tips.

- Most baler injuries and fatalities occur from bales rolling out of the loading forks or bucket onto the operator.
- Know the tractor, the implements and how they work. Be thoroughly familiar with both the operator's manual and the tractor before starting.
- Know the controls, where they're located and how they work. Practice stopping the tractor and PTO quickly in the event of an emergency.
- Use roll-over protective structure (ROPS) and seat belts. Most tractor fatalities are caused by overturns.
- Be familiar with the terrain and drive safely. Use caution on slopes, slow down for all turns.
- While on the highway, use appropriate lighting and follow all rules of the road.
- Never operate an engine in a closed shed or garage. Carbon monoxide is colorless and deadly.
- Keep the PTO properly shielded.
- Keep hitches low and always tow or pull from the drawbar. The tractor is designed so that it will not overturn backwards if the load is hitched properly to the drawbar.
- Never chain the rear wheels with a piece of wood to prevent slipping. The tractor can be "torqued-over." The torque supplied by the transmission will lift the tractor (rather than turning the wheels) and flip it over backwards.
- Never jump off a moving tractor or leave it with the engine running. Never try to jump onto a runaway tractor; it is extremely dangerous.
- Never refuel while the engine is running. Never refuel an overheated engine. Do not add coolant or water to a radiator while the engine is hot; radiator coolant can erupt and scald.
- Keep children off and away from the tractor, implements and attachments at all times.
- Never be in a hurry. Take your time, take a break and do it right.
- Keep safety signs clean, readable and free from obstructing material. Replace damaged or missing safety emblems with new ones. Instruct all operators on the meaning of the hazard signs.
- Do not transport wide loads after daylight hours, in poor visibility or bad weather.

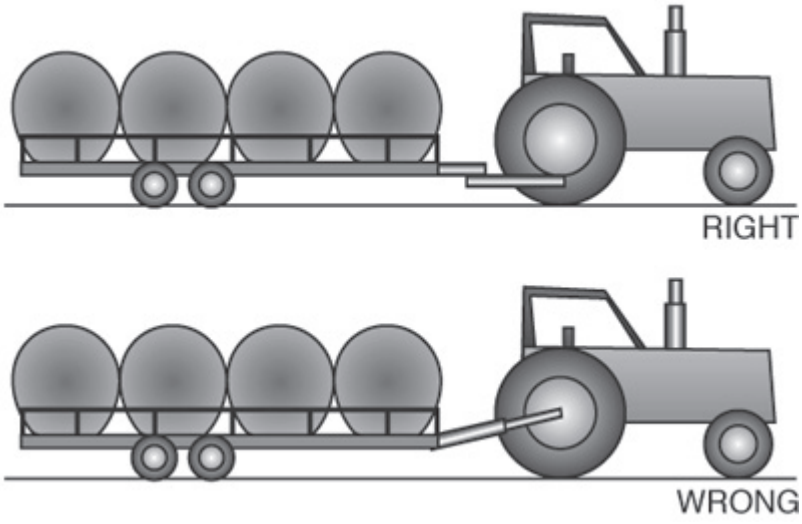


Figure 5. Hitch only to the tractor drawbar. Hitching anywhere else increases the chances of tractor overturn.

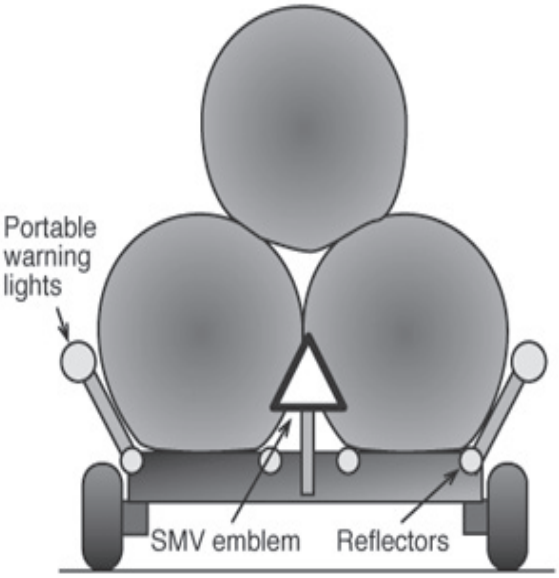


Figure 6. The trailer equipped with SMV, reflectors and warning lights.

- Do not allow bales to rest against the trailer tires.
- At transport speeds, the friction of the hay against the rotating tire can generate enough heat to ignite the hay.
- Remember that trailers pulled by a pickup have faster transport speeds than tractors and heat sufficient to cause a fire can occur in a short distance (1 km).
- Trailer fires are difficult to control and can lead to loss of hay, trailer and tractor (or pickup).
- While driving on the highway with any vehicle, assure that the driver can see and be seen. Use flashing lights and have an SMV emblem properly mounted.
- Allow time to pull into and across traffic.
- Avoid sudden, erratic, or unexpected manoeuvres.
- Keep to the left, pull over at a safe place to let traffic pass. Never wave vehicles to pass; let drivers pass at their own discretion.
- Signal all turns well in advance and make sure no one is passing when turning right.
- Pull completely off the road if something goes wrong.

Awareness

- Fatigue often is an operator's most common physical problem.
- Long workdays and the pressure associated with baling and forage harvesting can be tiring.
- Fatigue can slow reaction time, impair memory, and even cause hallucinations.
- Safety breaks, which include stretching, breathing deeply, and periodically walking around, can help prevent the effects of fatigue or boredom.
- If you feel drowsy, stop and have a cup of coffee, soda or soup. If you still feel drowsy, discontinue operations that need your full attention.
- Large round baling is a good method of harvesting, storing and moving hay crops but keep safety in mind.
- Safety, in the final analysis, is largely a matter of common sense and patience.
- Most manufacturers have designed and built equipment with your safety in mind.
- The ultimate responsibility for its safe and proper operation lies with the operator.

SILLAGE CUTTER

1. The picture below shows a silage cutting machine that can be used on a farm to cut silage:

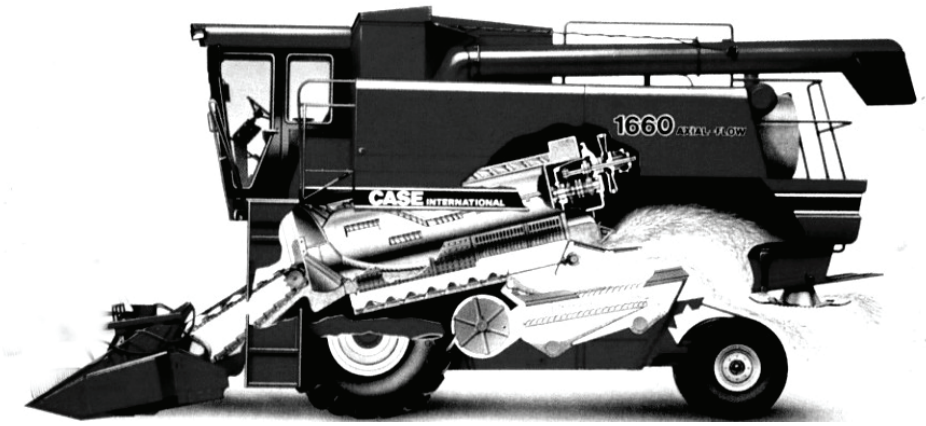
1.1 Explain THREE safety precautions that should be followed when working with this machine.

- Do not let people or animals come near the blades or working parts of the machine while working.
- Make sure that all safety devices are in place and in working order.
- No person other than the driver may ride or climb on top of the machine.

1.2 Describe the procedure to follow when this machine is prepared for use.

- All grease points must be well greased.
- The correct tension must be set for all belts or chains.
- Check that all parts are functioning correctly by operating it slowly.
- Replace all worn parts immediately especially the cutter blades.
- Service according to manufacturers specifications.
- Lift up all dust release guards.
- Check that there is no damage to the blades and that they are sharp.

HARVESTERS



1 Describe the role of computers and satellite positioning systems in modern combine harvesters.

a) Computers help you to determine the yield on each specific spot on your land.

b) Computers help you to spot problems in the mechanics of the harvester that prevents lost of maize kernels.

c) Helps you to identify nutrient deficiencies in your land.

d) Helps to identify problem areas in your maize land.

2 Describe the harvesting process of maize with the combine harvesting machine

- The machine cut the whole plant and feed it to the thresher.
- The hammers, blowers and sieves strip the grain and separate the
- chaff.
- Kernels are collected in a bin inside the harvester.
- When full the kernels are poured into a lorry and taken to the maize
- agent or buyer.
- Chaff can be collected for animal feed.

3 Name a few problems that can occur when using the combine harvester.

a) Lost of maize kernels due to blowers that are set incorrectly.

b) Thresher that breaks the kernels.

c) Too much foreign particles.

d) Mechanical problems.

e) Cannot use harvester when it has rained.

4 Name the advantages of using the combine harvesting machine

- Very quick way of getting your crop from the land.
- Very reliable method of harvesting.
- Economical.
- Labour saving.
- Accurate record keeping.
- Computers do the whole harvesting proses with little input from the driver.
- Single operation.

5. Name another way of harvesting maize. And describe it shortly.

HANDPICKING

i) The cobs are picked by hand. and put into bags.

ii) It is then transport to a central spot -where the threshing machine removes the kernels from the cobs.

iii) Put into bags not exceeding a net mass of 70kg.

6. Why is it important to set a combine correctly?

a) If not set correctly, kernel loss may occur because of:

* Kernels not remove from the stalks or

* It is blown out by the blower of the machine.

b) If the drum speed is not set correctly combines may also break the kernels,

HAMMER MILL

1. Name the factors that have to be considered when a hammer mill is build/bought.

a) Sturdy construction.

b) Replaceable wearing parts.

c) Rotor housing should close tightly.

d) Size of the hopper feed aperture.

2. Name the parts of the hammer mill and the uses of each part.

a) Framework.	House the guard plates and wearing plates.
b) Hopper.	Facilitate the proses of feeding.
c) Rotor and hammers.	Pulverize the fodder.
d) Screens.	Determine the size of the final grounded product.
e) Fan.	Blow the grounded material through the screens.
f) Cyclone.	Separate the grounded material effectively from the air.
	Dust release.

3. Name FOUR points to consider when installing a hammer mill.

a) It must be installed in such a way that it can be handled with ease.

b) Placed in a well ventilated area.

c) Fodder must be offloaded next to the hopper.

d) Mill should be placed near the feed mixer.

4. What are the advantages in installing the hammer mill on a level surface?

a) The mass of moving parts is spread equally over bearings.

b) Cyclone hang level on the blower pipe.

c) Looks neat.

5. What is the major cause of metal fatigue on a hammer mill?

   a) Vibration.

   b) Wear.

   c) Rust.

6. How can you prevent vibration on a hammer mill?

   a) Machines that vibrate excessively should be send back to the manufacturer.

   b) New sets of hammers should be checked to ensure that their mass is the same.

   c) All hammers should be reversed or replaced at the same time.

   d) Hammers that are reversed should be replaced in its original place.

   e) Nothing should be added or removed from the rotor.

   f) Run at the correct speed.

   g) Proper anchored.

7. Name the safety measures that have to be taken into account when working with the hammer mill.

   a) Do not work on the machine while it is still in motion.

   b) Ensure that there are no loose objects lying inside the machine when starting it.

   c) Wear safety goggles.

   d) Do not use the machine when the rotor is out of balance.

   e) Driving mechanism must be screened off.

   f) Use in a well ventilated area.

   g) Small pieces of scrap metal must be kept away from fodder. It can cause a spark, which can cause an explosion.

8. Name six aspects that must receive special attention when maintenance is carried out on the hammer mill.

   a) Regular lubrication.

   b) Hammers should be replaced with the correct type.

   c) Hammer mill must be correctly anchored.

   d) PTO coupling done correctly.

   e) Clean after each job.

   f) Sieves and screens inspected on a regular base.

9. Name four points to consider when attaching the hammer mill to the PTO shaft of the tractor.

a) Check if the anchor bolts of the static machine are tight.

b) Check that the universal joints are well lubricated.

c) Check that the driving shaft guard is present and without cracks.

d) Ensure that the driving shaft is as straight as possible.

TRACTOR HYDRAULIC POWER LIFT SYSTEMS

1. Name the advantages of the use of transmission oil in tractor hydraulic systems.

a) Not compressible.

b) Good lubrication qualities.

c) Remains liquid over a large temperature range.

d) Not volatile.

e) Relatively cheap.

f) Easily conductible in pipes.

g) Flows through filters, pipes, oil pumps and cylinders with ease.

h) Contains detergents that keeps parts clean.

2. What activates the control valve of a tractor?

The operators control lever.

3. Name the two types of hydraulic cylinders.

a) Single action hydraulic cylinders.

b) Double action hydraulic cylinders.

4. Describe the working of the single action hydraulic cylinder.

a) The piston-type pump is driven off the tractor's engine and creates a high oil pressure in that part of the system between the pump and the control valve.

b) The moment the operator moves the control valve plunger to the right, the oil under pressure flows via the non-return valve to the cylinder and the piston and shaft are forced in the out direction.

c) When the control valve is moved into the opposite direction, a small hole in the control valve is exposed, allowing the oil to return to the oil tank through the same pipe.

d) The weight of the implement forces the piston to return to its original position.

5. Describe the working of the double action cylinder.

a) When the control lever is in neutral position, the oil is pumped to the control valve and back to the oil container via the oil filter.

b) The moment the control lever is shifted to the lift position, the control valve directs the pressurized oil to the piston end of the hydraulic cylinder causing the piston to move to the right, and the implement is lifted.

c) In order to force the implement into the soil, the operator moves the control lever to the "lower" position and now the control valve will direct the pressurized oil along the second pipe into the shaft-end of the cylinder (where the shaft is connected to the piston), causing the piston to move to the left.

d) In this way the operator controls the implement positively in two directions.

6. Which side of the double action hydraulic cylinder is the strongest?

The thrust direction is stronger than the pull direction because of the area that is subjected to the oil pressure in the cylinder.

The part of the cylinder, which contains the shaft, is weaker than the other side.

7. Who designed the three-point mechanism?

Harry Ferguson.

8. What is the function of the levelling box?

To adjust the cross-angle of the implement in relation to the tractor.

9. What is the function of the top link?

To adjust the angle of the implement in relation to the tractors movement.

10. The photo beneath shows a power take off shaft that is used as a drive linkbetween the tractor and implement.

10.1 Name the device that facilitates the PTO shaft to operate at an angle.

Universal joint.

10.2 Give the function of the grease nipples installed on this device.

To grease the joints regularly.

10.3 The PTO shaft must always be screened off to prevent injuries to people. Mention TWO requirements for these screens.

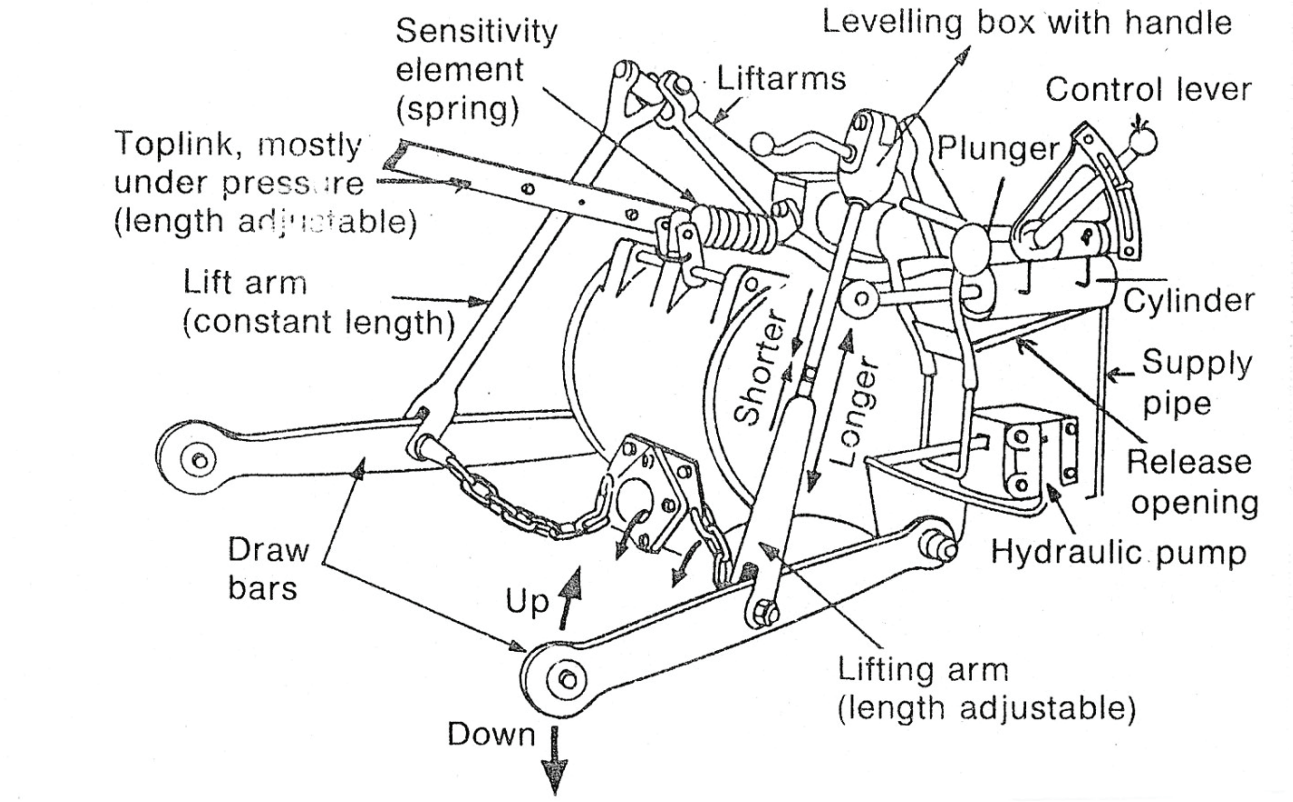
a) Strong.

b) Not become loose.

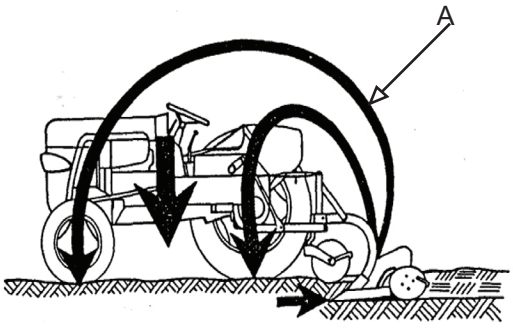
c) Weight saving.

d) Must provide adequate/efficient protection.

11. A sketch of the typical three-point mechanism.



12. The illustration below shows a tractor pulling a plough.



12.1 Analyze the illustration and describe shortly what arrow A illustrates. Give a reason for your answer.

The illustration shows how the plough tends to push down the front wheels when a top link is fitted between the plough and tractor.

12.2 What will happen if the top link between the tractor and plough are removed?

The back of the plough will tend to lift up out of the soil or the nose of the tractor will tend to lift up.

12.3 Name THREE ways to change a tractors mass displacement positively.

a) Decrease the tow bar pulling force.

b) Lower the tow bar.

c) Increase the wheelbase.

13. Name the three ways in which a tractors mass displacement can be changed positively or negatively.

a) Increasing or decreasing the tow bar pulling force.

b) Lifting or lowering the tow bar.

c) Decrease or increase the wheel base of the tractor.

14. Name the three factors that have an influence on the depth control system of a tractor.

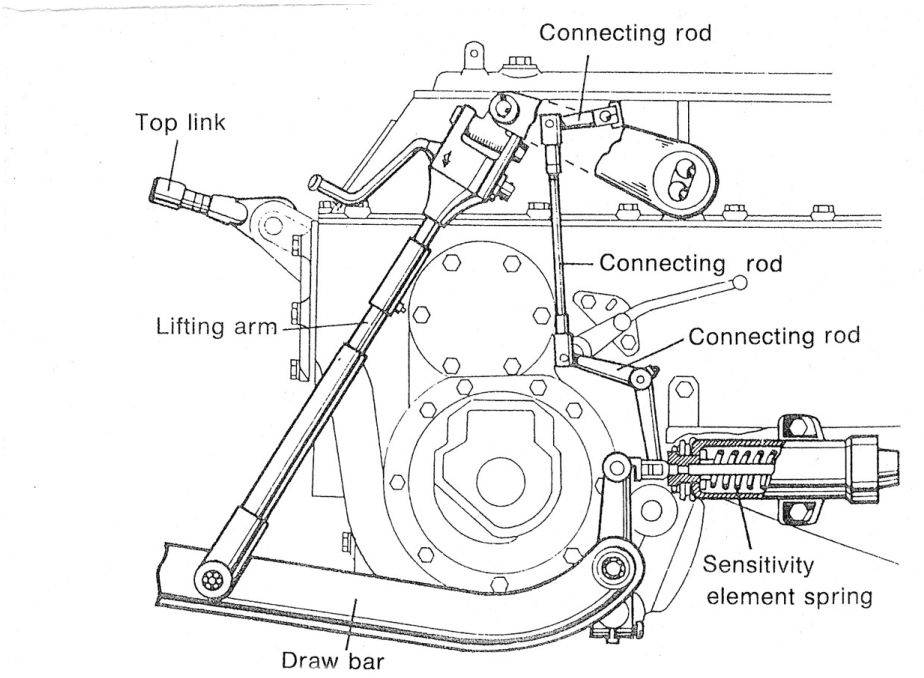
a) Ploughing depth.

b) Soil resistance.

c) Forward speed of the tractor.

15. What is the function of the sensitivity element?

Its function is to excite the hydraulic system at a given moment e.g. when the plough penetrates too deeply or when it hits hard soil, so the hydraulic system can make the necessary correction to overcome the difficulty.



18. What is the sensitivity element also called?

Automatic depth control mechanism.

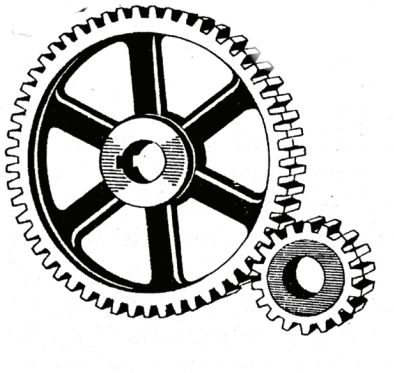
GEARBOXES

1. Name the three types of gears usually used in gearboxes sketch each and describe each shortly.

a) Straight-cut gear (Spur gear)

The teeth of this gear run laterally across the outer circumference of the gear.

Disadvantage - Noisy.



b) Helical gear

Gear runs at an angle across the outer circumference of the gear.

Advantage – Gears last long.

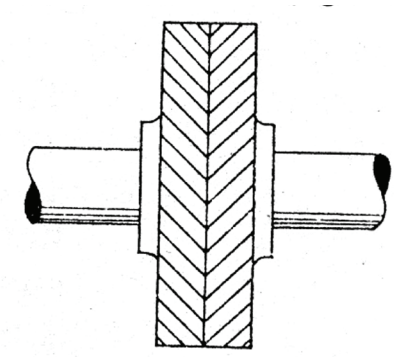
Disadvantage – Subjected to side thrust under load.

c) Double-helical gear. (Herringbone gear)

The teeth are angled in both directions.

Advantage - Very few wear.

Disadvantage - Cannot be used in gearboxes of cars because it cannot be meshed from the side.



2. Name the three types of gearboxes.

a) Sliding gearbox.

b) Constant mesh gearbox.

c) Synchronized gearbox.

3. Name the three shafts that are found in the gearbox of a car.

a) Main shaft.

b) Countershaft.

c) Drive shaft.

4. Determine the speed ratio if the large drive gear has 50 teeth and the small driven gear has 25 teeth? (Show all calculations)

Ratio = Drive gear

Driven gear

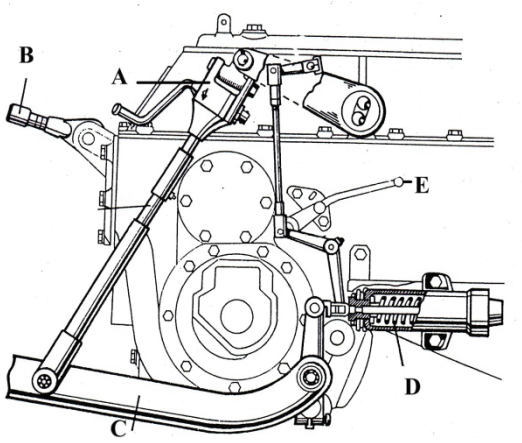
= 50

25

= 2

Ratio = 1:2

5. Study the illustration of the mechanical system of the tractor and answer the questions that follow:



5.1 What is the name of this mechanism?

Three point mechanism.

5.2 Name the parts labelled from B to E.

B. Top link.

C. Lifting arm.

D. Sensitivity element.

E. Lift control lever.

5.3 Describe the function of A.

To adjust the cross-angle of the implement in relation to the tractor.

5.4 Explain what will happen to the implement if the part labelled as B is removed.

The back of the implement will not lift if the plough is lifted up.

5.5 What is the function of D.

Lowers the implement so that the ploughing depth stays constant while ploughing

DRIVES

1. Name the advantages of flat belts:

a) Easily installed or taken off.

b) Used over a long distance.

c) Easily lengthened or shortened.

d) Easily joined.

e) Used with ease to run over a pulley situated between two bearings without removing the bearings.

2. Name the disadvantages of flat belts:

a) If the pulleys over which they run are not aligned accurately the belt is thrown off.

b) If they are not lubricated regularly, they tend to slip on pulleys.

c) They have to be lubricated regularly.

d) When flat belts are put under extreme tension, they easily slip off a pulley or break.

e) This type of belt is subject to stretching and/or shrinking.

3. Name the advantages V-belts:

a) V-belts do not easily slip off pulleys.

b) V-belts draw tighter round pulleys when tension increases.

c) Lubrication is never necessary.

d) V-belts are relatively strong, and under normal circumstances do not easily break.

e) Cold, moist conditions, age or use do not cause V-belts to stretch or shrink

f) V-belts last longer than flat belts.

4. Name the disadvantages of V-belts:

a) V-belts are more difficult to install than flat belts.

b) V-belts are not normally manufactured in very long lengths.

c) V-belts cannot be joined.

d) When the pulley over which a V-belt runs is situated between two bearings, one of them needs to be removed before the V-belt can be put over the pulley.

e) V-belts are much more dangerous than flat belts.

5. Name the six requirements for the screens used for safeguarding implements.

a) Must appear neat.

b) Safeguard the equipment.

c) Removed and replaced easily.

d) Don't become loose.

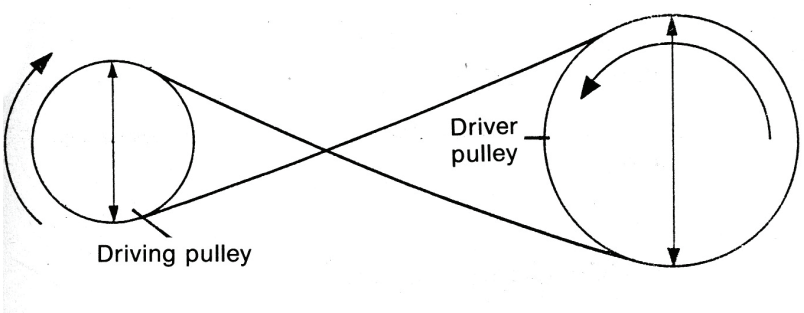
e) Weight saving.

f) Keep out all undesired matter.

6. Give the formula for calculating speed ratios of pulleys.

Na X Da = Ng X Dg.

Na = Speed of driving pulley



7. In which direction does the PTO shaft turns

Clockwise

8. Name the four types of power take-of drive shafts.

a) Common type PTO shaft.

b) Live PTO shaft.

c) Ground wheel driven PTO shaft.

d) Independent PTO shaft.

9. Which type of power take-off enables the operator to stop forward movement without stopping the PTO drive?

Live power take-off drive.

10. Name the two types of tow bars.

a) Fixed tow bar.

b) Swinging tow bar.

CLUTCHES

1. Name the reasons for equipping a tractor with a clutch.

a) Engine drive needs to be disengaged when gears are changed.

b) Drive should be disengaged when the tractor is started.

c) The clutch is disengaged to allow engine speed to increased and then engaged to give greater torque.

d) Allows the operator to stop the tractor, belt pulley or PTO shaft without stopping the engine.

2. Properties of a good clutch:

a) It should engage smoothly and not jam, slip or shudder.

b) It should be capable of transferring the maximum load of the engine without slip.

c) When the clutch is disengaged, it should do so completely and not tend to drag.

d) The clutch should be of such a nature that it could be engaged or disengaged comfortably by hand or foot.

e) The friction material used on the clutch plate should not only be highly wear and temperature resistant.

3. Name the four types of clutches.

a) Single plate clutch.

b) Multi-plate clutch.

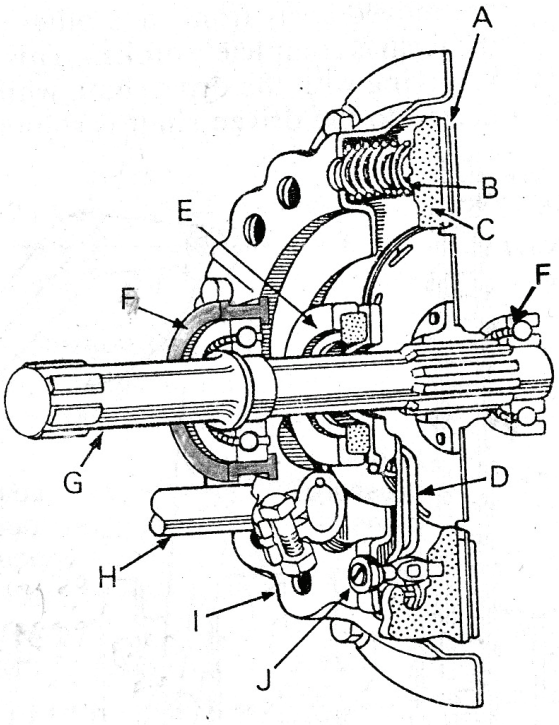
c) Claw type clutch.

d) Hydraulic clutch.

4. What are clutch linings made of?

Asbestos.

5. Sketch of the clutch.



A – Friction plate
B – Pressure rings
C – Pressure plate
D – Lever
E – Thrust bearing
F – Pilot bearing
G – Shaft
H – Shaft connected to clutch pedal
I – Back plate
J – Adjustable nut for withdrawal lever (D)

DIFFERENTIAL

1. Name three reasons for why differentials are built into the rear axles of tractors.

- Changing direction of rotation.
- Speed reduction.
- Dividing rotation equal between the rear wheels.

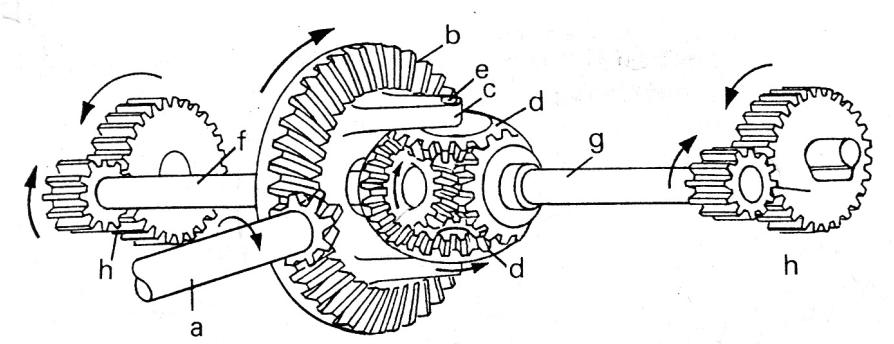
2. Describe the working of the conventional differential when the tractor negotiates a bend.

- When the tractor negotiates a bend all the wheels are momentarily turning about a common centre.
- The outer wheel on the curve consequently tends to rotate faster than the inner wheel.
- This means that the half axle shaft of the outer wheel revolves faster than that of the inner wheel.
- The difference in speed between these two axle shafts causes the differential pinions to rotate round their individual shafts.
- As these little shafts are mounted in the casing which in turn is connected to the crown wheel gear, they revolve with it, but in the same time still drive the rear wheels, in spite of the fact that they do not revolve at the same speed.

3. What is the function of the final drive?

- Further reduction in speed.
- More torque.

4. Sketch of the differential.



DIFF LOCK

A locking differential, differential lock, diff lock or locker is a variation on the standard automotive differential.

A locking differential may provide increased traction compared to a standard or “open” differential by restricting each of the two wheels on an axle to the same rotational speed without regard to available traction or differences in resistance seen at each wheel.

A locking differential is designed to overcome the chief limitation of a standard open differential by essentially “locking” both wheels on an axle together as if on a common shaft.

This forces both wheels to turn in unison, regardless of the traction (or lack thereof) available to either wheel individually.

When the differential is unlocked (open differential), it allows each wheel to rotate at different speeds (such as when negotiating a turn), thus avoiding tire scuffing.

An open (or unlocked) differential always provides the same torque (rotational force) to each of the two wheels, on that axle.

So although the wheels can rotate at different speeds, they apply the same rotational force, even if one is entirely stationary, and the other spinning. (Equal torque, unequal rotational speed).

By contrast, a locked differential forces both left and right wheels on the same axle to rotate at the same speed under nearly all circumstances, without regard to traction differences seen at either wheel.

Therefore, each wheel can apply as much rotational force as the traction under it will allow, and the torques on each side-shaft will be unequal. (Unequal torque, equal rotational speeds).

A locked differential can provide a significant traction advantage over an open differential, but only when the traction under each wheel differs significantly.

Applications

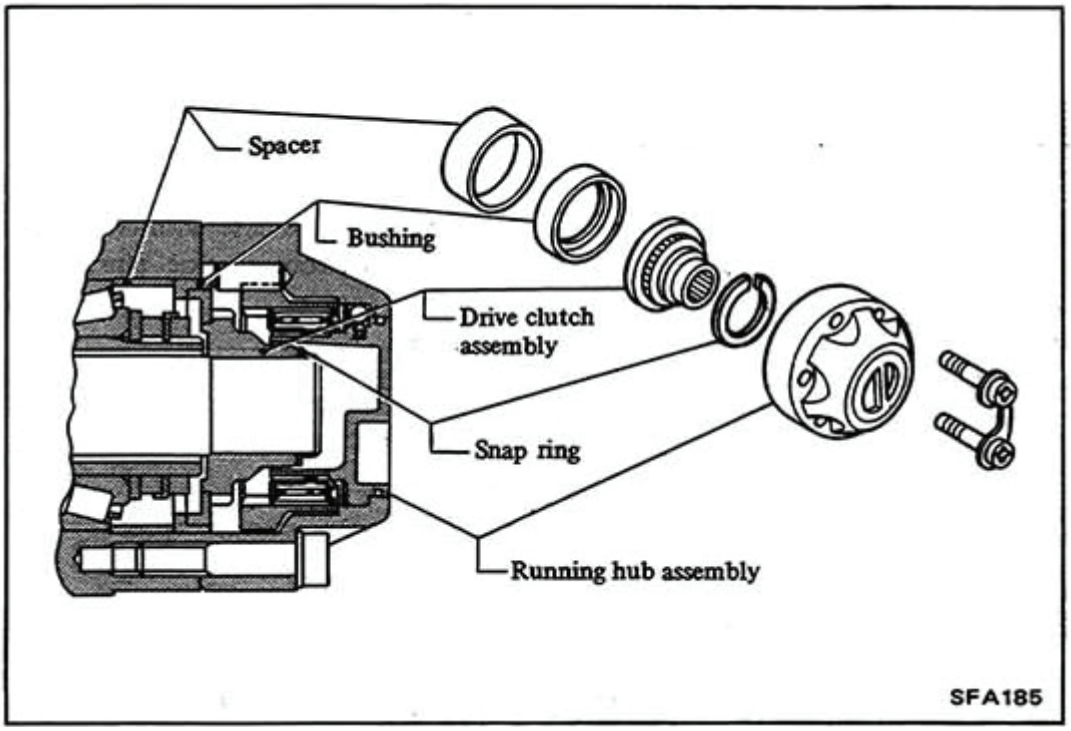
- Race cars often use locking differentials in order to maintain traction during high speed maneuvers or when accelerating at extreme rates. Additionally, vehicle dynamics are made more predictable when there is a loss of traction, as the driver knows that neither wheel will suddenly sap power if it encounters a low-friction surface.
- Some utility vehicles such as tow trucks, forklifts, tractors, and heavy equipment use locking differentials to maintain traction, especially when driving on soft, muddy, or uneven surfaces. Lockers are common in agricultural equipment and military trucks. On some farm tractors, there is a pedal that can be stepped on with the operator's heel to lock the differential as needed.
- Four-wheel drive vehicles that drive off-road often use a locking differential to keep from getting stuck when driving on loose, muddy, or rocky terrain. Locking differentials are considered essential equipment for serious off-road driving. Many such vehicles have a locking differential on the central differential (between the front and rear axles), rear differential and front differential; or any combination of any of the three.

Disadvantages

- Because they do not operate as smoothly as standard differentials, automatic locking differentials are often responsible for increased tire wear.
- Some older automatic locking differentials are known for making a clicking or banging noise when locking and unlocking as the vehicle negotiates turns. This is annoying to many drivers
- Also, automatic locking differentials will affect the ability of a vehicle to steer, particularly if a locker is located in the front axle.
- Aside from tire scuffing while turning any degree on high friction (low slip) surfaces, locked axles provoke under steer and, if used on the front axle, will increase steering forces required to turn the vehicle.
- Furthermore, automatically locking differentials can cause a loss of control on ice where an open differential would allow one wheel to spin and the other to hold, while not transferring power.

4X4 WHEEL HUB LOCK

FREE-RUNNING HUB



Where are the Locking hubs located?

- Locking hubs are located at the front of your 4-wheel-drive vehicle.
- They may look like innocent little dials in the middle of your two front wheels, but there is slightly more to them.
- The hubs are, essentially, an axle split in half (right and left).
- They work separately, spinning free of each other and allowing the drive from the rear axle to push them wherever you steer them. This is two-wheel-drive mode, just like a rear-wheel-drive car.
- When they are unlocked, you do not have the ability to put your vehicle into 4WD.

Modern vehicles have **automatic locking hubs** that require little to no manual operation from the user. However, some of these newer vehicles still allow for manual operation as a backup in case the automatic locking hubs fail.

Older 4WD vehicles had **manual locking hubs** and were referred to as “part-time” 4x4 because the half axles moved freely of each other like a 2WD car. On these models you had to exit your vehicle to turn a dial on the hub of each front wheel from “free” to “lock” and then get back in and set your transmission into the “neutral” position before engaging

4x4. It is not uncommon to “lock in” the hubs during winter snowfall and drive around until you need to put the vehicle into 4x4 mode.

Some models were made as “**full-time” 4x4**. On these models the front axle turned freely as one unit until the 4x4 was engaged, but you still had to put your vehicle into the “neutral” position to engage 4x4.

UNIVERSAL JOINTS

A universal joint, universal coupling, U-joint is a joint or coupling in a rigid rod that allows the rod to ‘bend’ in any direction, and is commonly used in shafts that transmit rotary motion. It consists of a pair of hinges located close together, oriented at 90° to each other, connected by a cross shaft.

A configuration known as a double Cardan joint drive shaft partially overcomes the problem of jerky rotation. This configuration uses two U-joints joined by an intermediate shaft, with the second U-joint phased in relation to the first U-joint to cancel the changing angular velocity. In this configuration, the angular velocity of the driven shaft will match that of the driving shaft, provided that both the driving shaft and the driven shaft are at equal angles with respect to the intermediate shaft (but not necessarily in the same plane) and that the two universal joints are 90 degrees out of phase. This assembly is commonly employed in rear wheel drive vehicles, where it is known as a drive shaft or propeller (prop) shaft.

General

A universal joint is a positive, mechanical connection between rotating shafts, which are usually not parallel, but intersecting. They are used to transmit motion, power, or both.

The simplest and most common type is called the Cardan joint or Hooke joint. It is shown in Figure 1. It consists of two yokes, one on each shaft, connected by a cross-shaped intermediate member called the spider. The angle between the two shafts is called the operating angle.

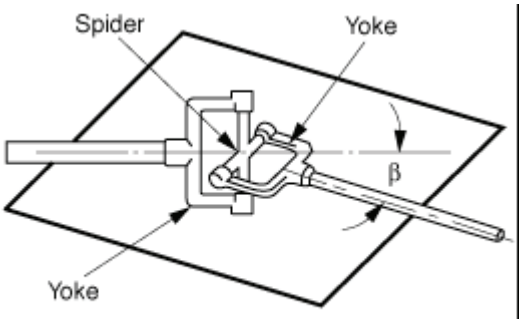


Figure 1 - Single Universal Joint

Applications

Typical applications of universal joints include drive shafts, aircraft, appliances, control mechanisms, electronics, Instrumentation, medical and optical devices, ordnance, radio, sewing machines, textile machinery and tool drives.

Universal joints are available in steel or in thermoplastic body members. Universal joints made of steel have maximum load-carrying capacity for a given size. Universal joints with thermoplastic body members are used in light industrial

applications in which their self-lubricating feature, light weight, negligible backlash, corrosion resistance and capability for high-speed operation are significant advantages.

Universal joints of special construction, such as ball-jointed universals are also available. These are used for high-speed operation and for carrying large torques. They are available both in miniature and standard sizes.

Single joints have the following advantages:

- Low side thrust on bearings.
- Large angular displacements are possible.
- High torsional stiffness.
- High torque capacity.

They have the following disadvantages:

- Velocity and acceleration fluctuation increases with operating angle.
- Lubrication is required to reduce wear.
- Shafts must lie in precisely the same plane.
- Backlash difficult to control.

GREASE NIPPLES

A grease fitting or grease nipple is a metal fitting used in mechanical systems to feed lubricants, usually lubricating grease, into a bearing under moderate to high pressure using a grease gun.

Grease fittings are rarely found on today's consumer goods, appliances, or cars, because maintenance-free products have more sales appeal to the general public. They are still commonly used on industrial, agricultural, and mining equipment

Since the 1920s, the ever-growing dissemination of sealed bearings throughout the manufacturing industries has made the use of grease fittings less common.

Sealed bearings are lubricated for life at the factory, and are sealed such that the lubricant is not lost or dirtied. However, grease fittings are far from obsolete, and much new machinery is built with them every year (e.g., tractors, lawnmowers, automatic pool covers, industrial plant, and still a few car and truck parts), because as long as maintenance is even minimally attended to (via occasional lube jobs where new grease is pumped into the bearing), this type of bearing and lubrication setup is cost-effective, simple, and long-lasting. However, total neglect of maintenance shortens lifespan.

GREASE GUN for applying grease to a grease nipple

BEARINGS

- **A bearing** is a machine element that constrains relative motion between moving parts to only the desired motion.
- The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts.
- Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the loads (forces) applied to the parts.
- The term "bearing" is derived from the verb "to bear";[1] a bearing being a machine element that allows one part to bear (i.e., to support) another.
- The simplest bearings are bearing surfaces, cut or formed into a part, with varying degrees of control over the form, size, roughness and location of the surface.
- Other bearings are separate devices installed into a machine or machine part.
- Bearings saw use for holding wheel and axles

Purpose of a bearing

Reducing friction in bearings is often important for efficiency, to reduce wear and to facilitate extended use at high speeds and to avoid overheating and premature failure of the bearing.

Maintenance and lubrication

- Many bearings require periodic maintenance to prevent premature failure, although some such as fluid or magnetic bearings may require little maintenance.
- Most bearings in high cycle operations need periodic lubrication and cleaning, and may require adjustment to minimize the effects of wear.
- Bearing life is often much better when the bearing is kept clean and well-lubricated.

Uses for ball bearings

1. Hard drives
2. Roller skates
3. Advanced flywheel energy storage systems
4. Guitars
5. The Cape Hattera Lighthouse
6. Earthquake-proof buildings in San Francisco
7. Wheel bearings
8. Engines
9. Fishing Reels

ECONOMICS ASSOSIATED WITH AGRICULTURAL TECHNOLOGY

1. Name the THREE types of capital costs associated with the determination of tractor costs.

Fixed capital

(Land, buildings, improvements such as kraals, boreholes, pumps)

Movable capital

(Implements, equipment and machinery)

Working or floating capital

(Spare parts, fuel, wages, repairs, contract work and transport)

2. Name the two types of tractor expenses and give examples of each.

A) Fixed expenses.

a) Depreciation.

b) Interest on invested capital.

c) Incidental expenses.

d) Financing cost.

B) Running expenses.

a) Repairs.

b) Oil.

c) Fuel.

d) Grease.

e) labour.

f) Supervising expenses.

CHOISE OF TRACTOR AND TRACTOR EXPENCES

1. Name the factors that have to be considered before buying a new tractor.

- Driving power.
- Local availability of parts and service.
- Rigidity of construction.
- Simplicity of control mechanisms.
- Driver comfort.
- Versatility.
- Proven reliability and durability.

1.1. Name the factors that have to be considered in terms of drive when a suitable tractor are to be purchased

- Type of use
- Maximum drive requirements
- Texture of the soil
- Type of tractor

2. **If a tractor's price appears to be reasonable the following information should be gained from the seller:**

- The reason why the tractor is being sold.
- The kind of work for which the tractor was primarily used.
- The year of manufacture and the model.
- The real number of hours the tractor has worked.
- What repairs, if any, have been done to the tractor.
- Who was its driver?

3. Points to consider before purchasing a used tractor:

- How well established and reliable is the agent?
- Are spares easily available?
- Is the tractor a well-proven model in your area?
- What period of guarantee and service facilities are offered by the agent?

- Collect all information regarding the tractor.
- Examine the mechanics of the tractor.
- Do a field test of the tractor.
- What is the reading of the hour gauge and is it still working?
- After a price has been agreed upon, a decision should be made as to whether it will be more economical to buy a new tractor or a used one.

4. Name the parts that should receive special attention when examining the tractor.

- Engine.
- Gearbox.
- Final drive.
- Cooling system.
- Fuel system.
- Steering mechanism.
- Instruments.
- Battery.
- Field testing the tractor.

5. What is wrong with the tractor if the following symptoms occur?

a) Black smoke.

Diesel mixture too rich.

b) White smoke.

Dysfunctional fuel distribution line.

Water leaks into combustion chamber.

c) Blue smoke.

Engine uses oil.

Piston rings are worn.

Cylinder walls are worn.

6. What is meant with standardization of farm implements?

All farm implements and tractor spares should comply with certain requirements like being interchangeable and easier to handle.

7. Name the advantages of standardization:

- Any implement can be used on any tractor.
- The same engine and spares can be used on a variety of tractors.
- Spares can be purchased from any agent instead of a specific one.

- Spares can be offered to the farmer relatively cheaply, because of mass production.
- A reduced quantity of spares needs to be kept in stock for maintenance and service purposes.
- When a farmer decides to purchase a new tractor, he will not have to take a special course on how to maintain it.

8. Devine mechanization in Agriculture?

Provides technology and advancement to agriculture above the use of animal drawn implements to increase productivity, quality and yield.

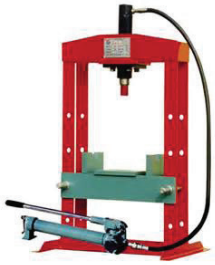
9. What is the aim of mechanization?

To help the farmer to produce better, quicker, cheaper and more effectively.

PNEUMATIC AND HYDRAULIC TOOLS: IDENTIFICATION

- **Compressor**

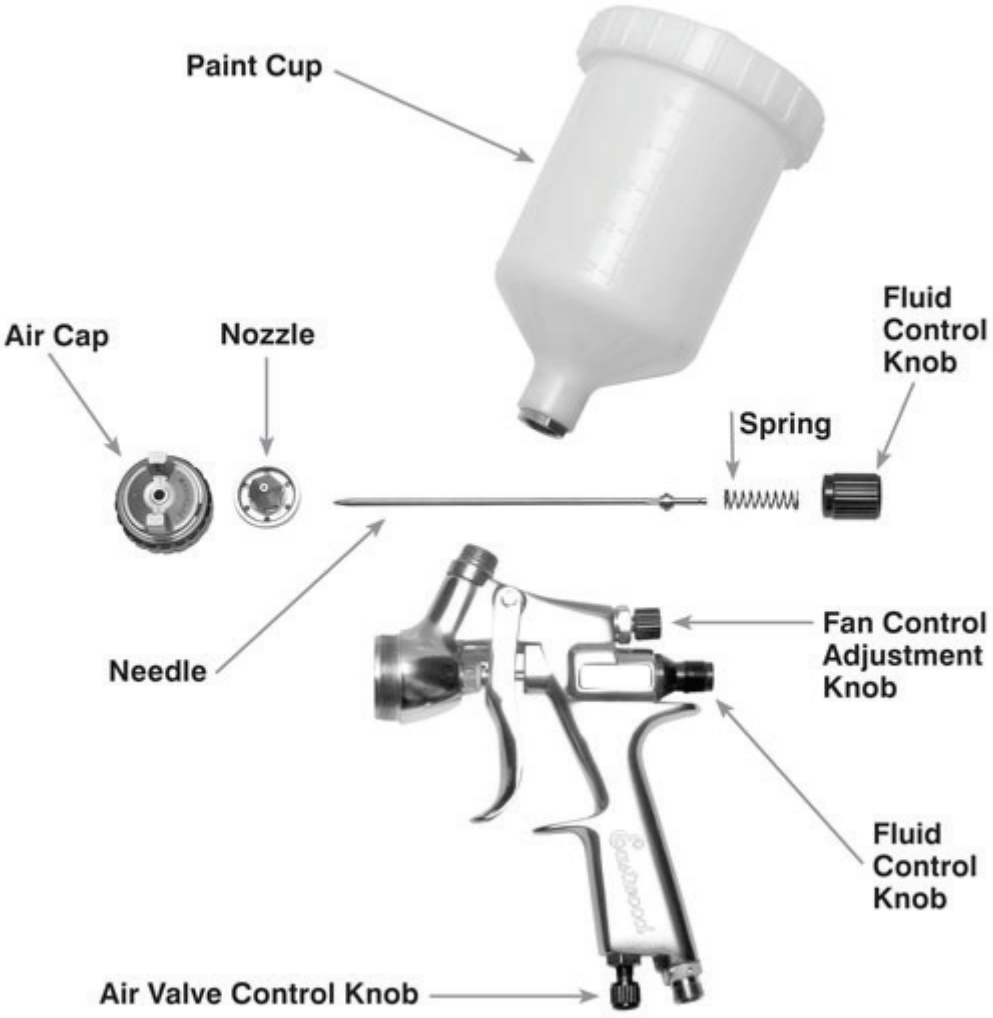
- **Hydraulic press**



- **Air wrench**

- **Hydraulic jacks**

Spray paint gun



CHAPTER 6

IRRIGATION AND WATER SUPPLY

IRRIGATION

1. Problems in irrigation

- Competition for surface water rights.
- Depletion of underground aquifers.
- Ground subsidence
- Under irrigation or irrigation giving only just enough water for the plant (e.g. in drip line irrigation) gives poor soil salinity control which leads to increased soil salinity with consequent build up of toxic salts on soil surface in areas with high evaporation. This requires either leaching to remove these salts and a method of drainage to carry the salts away. When using drip lines, the leaching is best done regularly at certain intervals (with only a slight excess of water), so that the salt is flushed back under the plant's roots.[22][23]
- Over irrigation because of poor distribution uniformity or management wastes water, chemicals, and may lead to water pollution.
- Deep drainage (from over-irrigation) may result in rising water tables which in some instances will lead to problems of irrigation salinity.
- Irrigation with saline or high-sodium water may damage soil structure.

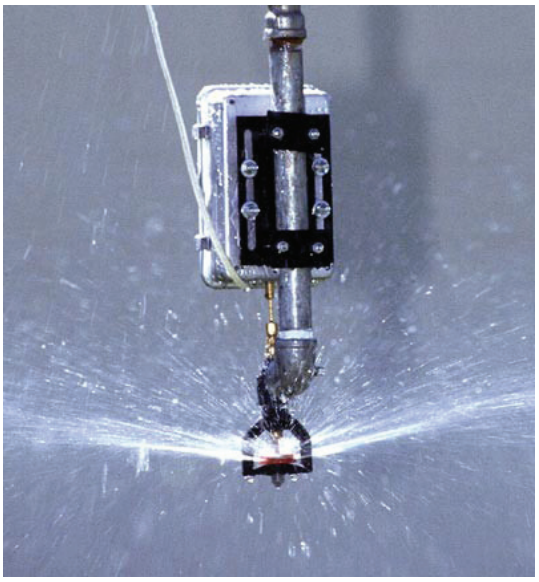
2. For a New Irrigation System:

Here's the basic procedure to follow if you're selecting a pump for a new irrigation system.

- Decide on the type of pump that best fits your needs, rotary, centrifugal, submersible, turbine, jet pump, etc.
- Estimate your flow (LPM) and pressure requirements.
- Research the available pump models and select a preliminary pump model that meets the requirements you established above.
- Create a first draft irrigation design. The irrigation should be designed for the flow and pressure the pump will produce.
- Once you have a first draft of your irrigation you may be able to fine tune your pump selection based on that design. Would a different pump lower your irrigation costs or better fit your irrigation system design? Return to the pump selection process and re-evaluate your pump selection. Make your final pump selection.
- Return once again to your irrigation design. Can it be fine tuned to better match your final pump selection? Make any necessary adjustments.

3. Overhead Irrigation

Water is pumped in under **pressure** and sprayed down onto the plants from flat spray nozzles.



Variable-flow irrigation sprinkler head

These may be mounted on an overhead network of aluminum pipes or even simply mounted on the top of a stake.

Pivot irrigation system watering a field of cotton

- Because it can be difficult to produce an even coverage, some more expensive systems may feature a **moving overhead boom**.
- This mechanism, which moves across the length of the whole crop, can then disperse the water in a much more even manner. Another overhead irrigation device is the **water gun**, which, as its name suggests, shoots water into the air and out over a field.
- A large water gun can cover several acres of land without needing to be moved.
- Overhead systems are particularly useful when covering large areas of land, and some can even be dismantled and moved from field to field with little trouble.

4. Centre pivot irrigation

Rotator style pivot applicator sprinkler.

- Centre pivot irrigation is a form of sprinkler irrigation consisting of several segments of pipe (usually galvanized steel or aluminium) joined together and supported by trusses, mounted on wheeled towers with sprinklers positioned along its length.
- The system moves in a circular pattern and is fed with water from the pivot point at the centre of the arc.
- These systems are common in parts where terrain is flat.
- Newer irrigations have drops as shown in the image that follows.

Centre pivot with drop sprinklers.

Most centre pivot systems now have drops hanging from a u-shaped pipe called a gooseneck attached at the top of the pipe with sprinkler heads that are positioned a few feet (at most) above the crop, thus limiting evaporative losses.

"Hand Move" portable sprinkler system

5. Sprinkler irrigation

Sprinkler irrigation

- In sprinkler or overhead irrigation, water is piped to one or more central locations within the field and distributed by overhead high-pressure sprinklers or guns.
- A system utilizing sprinklers, sprays, or guns mounted overhead on permanently installed risers is often referred to as a solid-set irrigation system.

6. A traveling sprinkler

- Sprinklers may also be mounted on moving platforms connected to the water source by a hose.
- Automatically moving wheeled systems known as traveling sprinklers may irrigate areas such as small farms, sports fields, parks, pastures, and cemeteries unattended.
- Most of these utilize a length of polyethylene tubing wound on a steel drum.
- As the tubing is wound on the drum powered by the irrigation water or a small gas engine, the sprinkler is pulled across the field.
- When the sprinkler arrives back at the reel the system shuts off. This type of system is known to most people as a "water reel"

Wheel line irrigation system.

7. Lateral move (side roll, wheel line) irrigation

- A series of pipes, each with a wheel of about 1.5 m diameter permanently affixed to its midpoint and sprinklers along its length, are coupled together at one edge of a field.
- Water is supplied at one end using a large hose.
- After sufficient water has been applied, the hose is removed and the remaining assembly rotated either by hand or with a purpose-built mechanism, so that the sprinklers move 10 m across the field. The hose is reconnected.
- The process is repeated until the opposite edge of the field is reached.
- This system is less expensive to install than a centre pivot, but much more labour intensive to operate, and it is limited in the amount of water it can carry.

- Most systems utilize 4 or 5-inch (130 mm) diameter aluminium pipe.
- One feature of a lateral move system is that it consists of sections that can be easily disconnected. They are most often used for small or oddly-shaped fields, such as those found in hilly or mountainous regions, or in regions where labour is inexpensive.

8. Controllers, zones, and valves

Most Irrigation systems are divided into zones. A zone is a single Irrigation Valve and one or a group of sprinklers that are connected by pipes. Irrigation Systems are divided into zones because there is usually not enough pressure and available flow to run sprinklers for an entire yard or sports field at once. Each zone has a solenoid valve on it that is controlled via wire by an Irrigation Controller. The Irrigation Controller is either a mechanical (now the "dinosaur" type) or electrical device that signals a zone to turn on at a specific time and keeps it on for a specified amount of time. "Smart Controller" is a recent term used to describe a controller that is capable of adjusting the watering time by itself in response to current environmental conditions. The smart controller determines current conditions by means of historic weather data for the local area, a soil moisture sensors (water potential or water content), Rain sensor, or in more sophisticated systems satellite feed weather station, or a combination of these.

9. What Is an Irrigation Valve?

An irrigation valve regulates the one-directional flow of water in an irrigation system. These valves are often found in sprinkler systems used for parks, golf courses and home lawns. They help control water flow in above-ground systems as well as in-ground systems that have been buried well beneath the surface to present a less cluttered, more attractive landscape.

10. What Is an Irrigation Sprinkler?

- An irrigation sprinkler drops water onto the land, mimicking the effects of rain.
- Most sprinkler irrigation systems use a pipe or hose with water travelling under pressure, which then escapes through sprinkler heads and is thrown or dropped onto the ground.
- This is a basic means of delivering water, but the forms an irrigation sprinkler can take are highly varied.
- Anyone considering an irrigation sprinkler should consider how big an area needs to be irrigated, as well as what shape that land is.
- Obstructions, such as trees or rocks, may require extra work to water around.
- How deep the soil needs to be watered should also be considered, along with how much time and effort is available to use the system.
- A sprinkler head is a distribution device attached to the end of a water pipe or hose.
- The head is the device through which the water of a sprinter system is discharged.
- There are different types of sprinkler heads available, depending on where the sprinkler will be used, with a special design for fire suppression sprinkler heads.
- The sprinkler head is fairly small in size and is attached to a sprinkler mount with a central ring for water flow.
- The top of the sprinkler head is a circular shape with a series of fins or thin blades arranged in a circular pattern.
- When the sprinkler is activated, the water passes through the sprinkler head and changes the water flow from a steady stream to a circular arc shape.
- The water dispersion is designed to maximum the surface area that is reached by the water.
- There are two common applications for sprinkler heads: lawn sprinkler systems and fire suppression systems.
- In both uses, the requirements are the same; the water needs to be distributed without any human intervention or adjustment.

- Through careful planning and design, it is possible to ensure that the total required area is covered.
- Lawn sprinkler heads can be recessed into the ground and forced up by the pressure of the water when the system is activated or they can be fixed in place above ground. In a lawn sprinkler system, there are two types of sprinkler heads: spray and rotor.
- A spray sprinkler head is designed to distribute a heavy discharge rate in a short period of time.
- The sprinkler head is often designed with an intermittent directional arm that forces the water to follow a circular path.
- This type of sprinkler head is most commonly found on flat ground.

A rotor sprinkler head discharges water at a slower rate and covers a wider area over a longer period of time. This type of system is most commonly found in large areas that require frequent watering due to soil and climate conditions. The selection of the type of sprinkler head requires some thought to the conditions over a long period of time and the amount of maintenance that will be required.

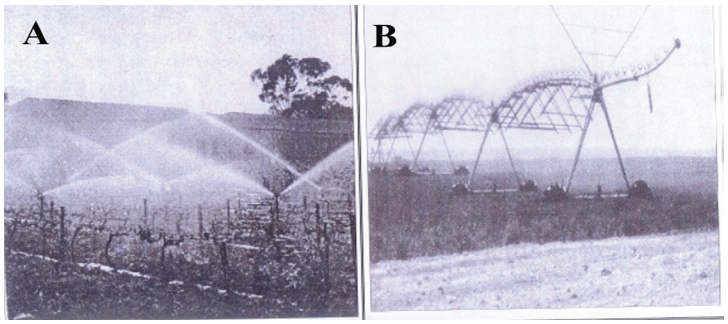
In a **fire suppression system,** the sprinkler head is attached to the ceiling, with the top of the head facing down. Built into the sprinkler head is a heat-sensitive bulb or a two part metal link that is held together with an alloy. The bulb or metal lies across the top of the head and acts as a plug to keep the opening closed.

Sprinkler maintenance is a fairly straightforward process that involves replacement and repair as necessary. Any sprinkler system owners who are uncomfortable handling these fixes can hire a professional to take care of them. Many sprinkler companies offer a yearly maintenance routine for a fee that makes events like the springtime start-up a hassle-free event for the owners.

11. General questions

1. When will sprinkler irrigation be preferred above flood irrigation?
    - When water supply is weak.
    - Surface gradient (steep) leads to erosion.
    - Infiltration tempo not constant.
    - Drainage problems.
    - No high costs of levelling of land.
2. Sprinkler irrigation consists of four primary parts. List these primary parts.
    - Engine/ electrical motor.
    - Pump.
    - Pipes.
    - Sprinklers.

3. Two types of sprinkler irrigation systems are illustrated below:



3.1 Write the name of the irrigation method shown in B.

Centre pivot.

3.2 Under what conditions will the system, numbered as B, be a better option than the system numbered as A.?

- Time saving.
- Bigger surfaces/larger land.
- Not enough labour.

3.3 If macro irrigation systems are not managed effectively it will have a negative effect on the environment. Name THREE of these negative effects.

- Waste water- over utilization of natural resources.
- Soil erosion.
- Increase salinity in soil.

3.4 Name FIVE advantages of the irrigation system shown above.

- Minimum labour cost.
- Low pump cost.
- Low maintenance cost.
- Durable.
- High second hand value.

3.5 Name a way of protecting the metal parts of the irrigation system against corrosion (rust).

Galvanising.

3.6 How can theft of electrical cable be prevented?

By installing the cable inside the water pipe.

3.7 Identify the device installed at the pump station, to prevent blockages of sprayers.

Sand filter.

4. The use of self-driven irrigation systems simplifies the labour intensive task of providing water to crops.

Study the photo below of one of these types of irrigation systems and answer the questions that follows:

4.1 Explain why this irrigation system is called a labour saving system?

- No labourers needed to shift the pipes/system.
- One-man operation.
- Automated watering system/scheduling.
- Pesticides/fertilizers are applied through the system.

4.2 Give a reason for keeping the water pressure constant from the centre of the pivot to the end of the pivot?

So that the quantity of water that is administered to the crop can be equal from the centre of the land to the outer edge.

4.3 The centre pivot works on the basis that irrigation line turns around a centre pivot on wheels. The outer wheels of the system will turn much faster than the inner wheels.

How is the quantity of water applied along the length of the pivot been regulated when you take this unequal wheel speed into account?

Inner nozzles smaller and further apart than outer nozzles.

4.4 Name TWO substances, used in crop production that must never be applied through a centre pivot irrigation system. Provide a reason for each answer.

- Fertilizers/pesticides with a high acid content.
- Acid will corrode the galvanized pipes
- Fertilizers with a large particle size.
- Large particles will block the nozzles

4.5 Name an easy method for the farmer to communicate with the centre pivot, to start or stop the irrigation system over long distances.
Cell phone.

4.6 Describe briefly the preventative measures that must be put in place to prevent the system from falling down when one of the wheels get stuck or the electrical motor that drives the wheel breaks down.

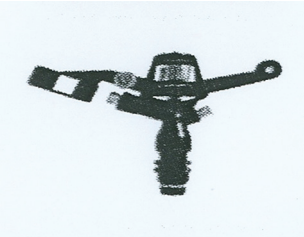
When the system gets out of line a safety switch cuts the electricity to the wheels preventing the other wheels from moving forward.

4.7 The sprayers in this system can easily be blocked by dirt/rust in the pipes. How can this dirt in the pipes be removed effectively without dismantling the whole system?

The tap at the end of the system is opened and all impurities in the pipe are flushed out.

The tap is then closed and the irrigation system can function effectively.

5. Sprinklers forms part of the irrigation system.



5.1 What is the function of the sprinkler head in the photo?

Distribute water evenly in this case over large areas

5.2 Name two effective materials used to manufacture the sprinkler head indicated in the picture.

- Metal: Brass; galvanised iron
- Plastic

5.3 Name an advantage of each material used in the previous question that makes it suitable for the sprinkler head.

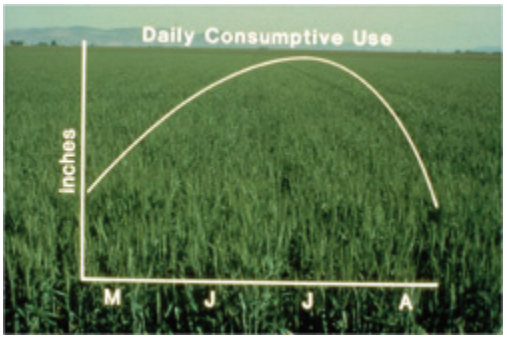
- Metal does not wear out easily,
- plastic and choice of metals is not corrosive.

12. IRRIGATION SCHEDULING

Irrigation scheduling is the process used by irrigation system managers to determine the correct frequency and duration of watering.

The goal in irrigation scheduling is to apply enough water to fully wet the plant's root zone while minimizing overwatering and then allow the soil to dry out in between waterings, to allow air to enter the soil, but not so much that the plant is stressed beyond what is allowable.

Efficient Irrigation Scheduling



1. Introduction

Irrigation scheduling consists of applying the right amount of water at the right time. With potatoes, growers have incentives to make irrigation scheduling work well.

Incentives to growers for precise irrigation scheduling include the following:

- Under-irrigation leads to a loss in market grade, tuber quality, and contract price.
- Over-irrigation leads to a loss in water, electricity for pumping, leaching of nitrogen, and wastes time. Over-irrigation increases crop N needs, fertilizer costs, and nitrogen losses to groundwater. Soil losses can be aggravated.
- Under-irrigation and over-irrigation can occur during the same season in a given field.

2. Scheduling Methods

Growers irrigate using one of several criteria:

a. intuition,

b. calendar days since the last rainfall or irrigation,

c. crop evapotranspiration,

d. soil water.

Measurements of soil water or crop evapotranspiration provide objective criteria for irrigation management.

3. Crop Evapotranspiration

Crop evapotranspiration is a fancy word for the consumptive use of water. Consumptive water use is composed of evaporation of water off of the soil surface and transpiration of water through plant tissue to the air. Crop evapotranspiration is calculated using a weather station or an atmometer.

4. Soil Moisture Measuring Techniques

Soil water can be measured by the methods that determine the soil water content or the soil water potential. Soil water content is the amount of water per volume of soil or weight of dry soil. Soil water potential is the force necessary to remove the next increment of water from the soil.

Different measurement methods have particular strengths and weaknesses. For example the gravimetric method is very accurate, but it is very slow and many samples are needed for each field and site specific interpretations are necessary. Strengths and weaknesses of several methods will be discussed.

5. Water Content

- Feel method
- Gravimetric
- Neutron probe

6. Measuring Soil Water Tension

Tensiometers

The use of soil water potential measurements with tensiometers or granular matrix sensors is provides a measurement analogous to the force (suction) necessary to extract water from the soil. The force is transmitted from the atmosphere through the plant to the roots.

7. GENERAL QUESTIONS

1. Define water scheduling shortly and give the reason for using water scheduling.

Is the process used by irrigation system managers to determine the correct frequency and duration of watering and also the quantity of water.

- To save water
- To prevent over irrigation
- To prevent under irrigation

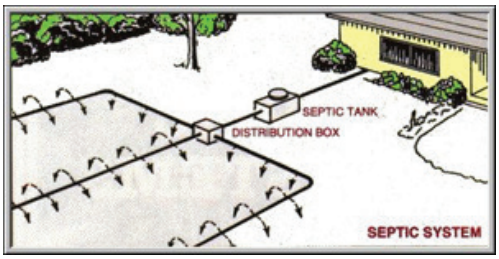
2. Name any TWO pieces of equipment that can be used to determine the evaporation in a specific field.

- Tensio meter
- Evaporation pan

UNDERSTANDING SEPTIC TANKS

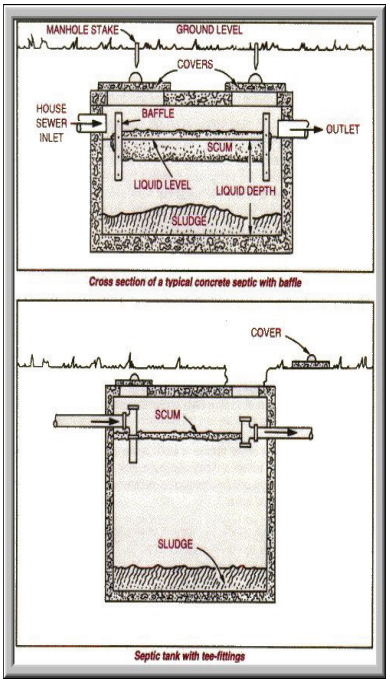
8. What are septic tanks?

- The septic tank serves as a settling basin where solids accumulate and gradually get broken down by bacterial action.
- Some of the solid waste is actually liquefied by this 'natural bacterial decomposition," however the rest of the waste accumulates in the bottom as a layer of sludge.
- Additionally, a small percentage of this, waste (mostly fats and oils) float to the top of the tank to form a layer of semi-solid scum.



9. How do septic tanks work?

- The population living in metropolitan areas (who have never had the pleasure of maintaining a septic system, or even had the experience of pumping out their systems) simply flush their toilets.
- Those of us living in more rural areas have been forced to learn about the maintenance and working of the sewerage treatment facility attached to our home, "the septic system."
- Usually a septic tank is connected to a drainage field or seepage pit of some kind. If properly maintained, a well-designed system will last almost indefinitely.
- However, if it is neglected for too long a time, it can back up and clog the drainage field.
- This neglect can result in an expensive excavation and even a replacement of the drainpipes that could cost thousands of dollars.



10. Design of the septic tank

- Although designs vary, most septic tanks consist of a watertight, below ground, tank that has one or two manhole covers (buried a few inches below ground) to provide access for cleaning and inspection.
- Effluent from the house flows into the tank through an inlet pipe near the top on one side. It flows out through a discharge or overflow pipe at the other side.
- The pipe may end in a large tee fitting or into a baffle (wall) preventing the effluent from flowing straight across from one pipe to the other.
- The incoming effluent will be diverted downward with a minimum of splashing, allowing the solids to sink to the bottom.
- Outgoing effluent is drawn from several feet below the top layer of the floating waste (grease, oil, scum) so that only liquid waste or solids that have been liquefied by the BACTERIAL ACTION going on at the bottom of the septic tank (which we will come back to this point later) are discharged out into the drainage field.

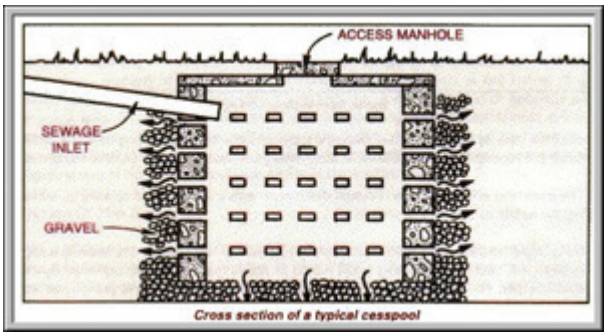
11. Components of sewage treatment systems

A typical household sewage treatment system consists of a house sewer, septic tank, distribution box and absorption field or seepage pit.

- **House Sewer** - The pipeline connecting the house and drain and the septic tank.
- **Septic Tank** - Untreated liquid household wastes (sewage) will quickly clog your absorption field if not properly treated. The septic tank provides this needed treatment. When sewage enters the septic tank, the heavy solids settle to the bottom of the tank; the lighter solids, fats and greases partially decompose and rise to the surface and form a layer of scum. The solids that have settled to the bottom are attacked by bacteria and form sludge. Septic tanks do not remove bacteria and, therefore, what is discharged cannot be considered safe.
- **Distribution Box** - Serves to distribute the flow from the septic tank evenly to the absorption field or seepage pits. It is important that each trench or pit receive an equal amount of flow. This prevents overloading of one part of the system.
- **Absorption Field** - A system of narrow trenches partially filled with a bed of washed gravel or crushed stone into which perforated or open joint pipe is placed. The discharge from the septic tank is distributed through these pipes into trenches and surrounding soil. The subsurface absorption field must be properly sized and constructed. While

seepage pits normally require less land area to install, they should be used only where absorption fields are not suitable and well-water supplies are not endangered.

- **Cesspools** - Work in a similar manner to septic systems. Sewage water usually seeps through the open bottom and portholes in the sides of the walls. These can also clog up with overuse and the introduction of detergents and other material which slow up the bacterial action.



Cross section of a typical cesspool

12. Maintenance of septic tanks

- Since solids will continue to build up at the bottom of the tank, it is imperative that the "septic tank be pumped out periodically." Remember, sludge is not biodegradable, if it's not pumped out, sludge will accumulate until it overflows.
- The frequency of pumping out will depend primarily on the amount of wastewater that goes through the system each day.
- The frequency also depends on how careful you are about not throwing excess fats, rinds and other similar garbage down the drains.
- The more solid waste thrown in the system, the quicker the tank will fill up.
- Heavy flows of water also tend to make the tank fill up more quickly.
- That is why it is best not to use a garbage disposal in the system when you have a septic tank, and why water should not be left running indiscriminately in sinks or toilets.

13. Treatment of septic tanks

- It is important to get the septic tank cleaned before the sludge level gets high enough so that any of the solid material at the bottom or the semi-solid scum at the top can flow out into the drainage field. This will quickly clog the drainage pipes and the soil into which they drain.
- Make certain there are live bacteria in your system at all times.
- The bacteria's job is to digest all organic waste matter in the system.
- If there are no bacteria in your system it will simply act as a holding tank for your waste. It becomes full, and natural digestion will not occur. That is when the system backs up.

14. Bacteria are killed off or overrun because of:

- excessive quantities of detergents, laundry waste, bleach, household chemicals, and caustic drain openers.
- garbage disposal grinds which substantially increase the accumulation of solids.
- disposal of items not biodegradable in the system (plastics etc.).
- disposal of excessive amounts of grease and fats, which are biodegradable but need particular types of bacteria to digest them.
- disposal of cigarette butts, sanitary napkins which are also biodegradable but are not readily decomposable.

- too many people using a smaller/inadequate or failing system.
- If you have no bacteria in your system and you add enzymes to the system, it simply will not help and your system will still not work. Enzymes are simply a catalyst for bacteria. If there are no bacteria in your system, why use enzymes?
- Solids left in a septic tank mostly break down through the digestion of anaerobic processes.
- Not all the solids will work their way out, however, and occasionally a septic tank must be drained before it reaches capacity.
- The speed at which this filling occurs depends on the size of the septic tank, the amount of waste being pumped into it, the temperature the tank is kept at, and whether a large amount of non-biodegradable solids have been added to the tank.
- The truck that comes to remove solid waste from a septic tank is commonly referred to as a honey truck or honey wagon.
- Most rural areas have only one septic truck working their region, as the rate of removal tends to be fairly low.
- In some high-density areas, a number of septic companies may be needed, but it tends to be the case that as populations grow to levels where multiple trucks would be required, environmental factors force the transition to a centralized waste treatment system anyway.

15. What Are the Different Types of Home Drainage?

- **Home drainage** is the system by which water is drained away from the home. The most common types of home drainage systems are French drains, channel drains, downspouts, slope drains, and a drainage ditch. Regardless of how the water arrived, all drainage systems are meant to divert water so there are not leaks into the house, standing water that attracts pests, or erosion around the foundation.
- **French drain** is basically a ditch dug around the foundation's perimeter to let the water flow away from the structure. Many French drains also contain perforated pipes that are buried under gravel or pebbles. The water drains through the surface gravel and seeps into the pipe's perforations before traveling out the end of the pipe into an area that can accommodate extra water.
- **Channel drain** is a long, narrow ditch used to quickly move large amounts of water. Also called a trench drain, channel drains are typically constructed of concrete. In addition to draining water, channel drains can also be used to hold buried utility lines and cables. Though not often used in rural areas, channel drains are seen in larger suburban areas where homes are built relatively close together.
- **Downspouts** are a traditional home drainage system and work by diverting water from a home's foundation. As part of a gutter system, downspouts are attached at the bottom of the gutter and tilted at an angle so the water flows away. Downspouts are usually constructed of zinc coated plate, aluminium or vinyl and are also available in longer flexible pieces that can divert water several feet away.
- **Slope drain**. This type of drain employs gravity to work. When your home is on a hill or has even a slight slope, the water can be directed away from the foundation using the principle of negative slope. This type of system typically involves a flexible hose of PVC or plastic laid into a tunnel. The tunnel is dug from the home's foundation to a more suitable spot such as a flower bed or drainage ditch where the water can be reused.
- **Drainage ditch** is a type of home drainage usually meant to drain excess water from lawns and yards. The ditch is dug along the street and water runs from the lawn into the ditch, then flows into the waste water system. This prevents standing water or erosion from ruining a home's landscaping.

16. GENERAL QUESTIONS

1. Calculate the flow rate of water in a pipe delivery system by using the data below:

   (Show all calculations)

- The liquid content of the tank is 5000 litres.
- It took 5 minutes to fill the tank to the top.

Flow rate = Content

Time

= 5000

5

= 1000 ℓ / minute

2. Supply reasons why it is sometimes necessary for the farmer to determine the flow rate in a pipe delivery system.

- For correct calibrating of the sprayers.
- Effective scheduling of irrigation.
- To prevent the over utilisation of the water source.

3. Describe shortly how a septic tank functions.

- Sewage is broken down by anaerobic bacteria in the first tank.
- Very little solids remain when the watery sewerage flows to the second tank.
- Only liquid sewage remains and drains away through the outlet pipe or stone trench

4. Name the important measures that must be remembered by the users of a septic tank system for the system to function properly,

- Use only toilet paper.
- No plastics or non-degradable materials
- No cigarette buds, rags etc. should get into the tank
- No disinfectants should be used.
- No bleaches, oils

5. Where should a septic tank not be build?

- Do not build near boreholes, drinking water installations.
- A suitable distance away from the house
- Not near traffic.
- Not near where people eat, wash or work regularly.

COMMUNICATION SYSTEMS

GPS

1. What is GPS?

- GPS stands for the **Global Positioning System**.
- It refers to a system of satellites and receivers that allow people and devices to pinpoint their precise location on the earth.
- The heart of the system relies on 24 satellites that orbit the earth twice per day.
- Devices that are equipped with GPS equipment receive transmissions from at least a few of the satellites and are able to discern very precise positioning data.
- The first GPS satellite was launched in 1974 and the 24th was launched in 1994.
- The system is operated by the United States Department of Defence and use of the system is free for anyone.
- New satellites are periodically launched to replace aging ones.
- As the technology has improved, the cost of GPS devices has plummeted while the accuracy has increased.
- Small portable GPS receivers have become very affordable, and the accuracy is amazing.
- Accuracy varies based on various factors, but it can be as good as a few meters! Land-based supplemental devices can be used to improve accuracy if higher precision is required.
- The application of the GPS is very broad, and as the prices come down the number of uses is increasing.
- Portable GPS devices are used by farmers to help them determining specific positions on their farms.
- Many new cars are being equipped with GPS systems to help drivers with navigation.
- The military uses GPS to guide cruise missiles to pre-specified targets.

2. What is an irrigation timer?

- An irrigation timer is a device that controls when a watering system turns on and off.
- It ranges in design from a simple unit that can be used by the home gardener to complicated automated systems used by professional landscapers and farmers.

The three basic types of irrigation timers include mechanical timers, battery powered timers, and electric timers.

Mechanical timer

- A mechanical timer is the simplest and least expensive kind of irrigation timer.
- It doesn't require power or batteries and attaches to a garden hose or tap.
- It works like a kitchen timer, so a user turns the water on manually and the timer shuts it off based on a pre-designated time or volume of water used.
- It is usually set by rotating geared wheels, and is very reliable because it doesn't need external power.

Battery powered timer

- As its name indicates, a battery powered timer runs on a battery that generally lasts for a full season.
- It also attaches to a garden hose or tap and has both automatic on and off features, so users can schedule when watering should begin.
- Some models feature LED screens and can handle multiple programs, making them a popular and convenient choice for vacationing gardeners.
- If the battery dies, however, these timers will usually lose their programming.

Electronic timer

- An electric or **electronic timer** can be complicated and more expensive, but it usually has significantly more functionality.
- It connects to the main water supply and runs on external power, often with a backup battery. Depending upon the model, an electronic irrigation timer may be able to control multiple valves, allowing users to schedule different times and programs for each valve independently.
- It usually has a key pad and an LED display screen for programming.
- Users can designate a start time and the duration for which the system should run, and can schedule supplemental watering or bypass watering altogether with additional features.
- Many of these timers can be operated by remote control or from a computer through a telephone line.

3. What Is Irrigation Software?

Irrigation software is software which is used to manage an irrigation system.

- Software products for irrigation purposes vary widely, from very simple freeware programs which people can use at home to complex systems used in irrigation design in commercial agriculture.
- Consumers who pay for software also usually receive support and updates as part of the package price, which can include consultation with people who can provide irrigation advice and recommendations.
- There are a number of reasons to choose to use irrigation software to manage an irrigation system.
- For a big system, software may be the only way to control the system.
- Software can be used to control when water is turned on and off, how frequently watering occurs, and how much water is delivered at any given time.
- On a huge farm or large landscaped estate, managing water needs manually or with a restrictive timer system may not be feasible, making software critically important.
- Such programs typically include tracking utilities, which keep track of how much water is used, monitor average rain fall, and collect other useful data.
- This data can be used to adjust the programming, to determine whether or not water efficiency goals are being met, and to identify patterns which may be important to know about.
- The irrigation software can also be programmed to manage the delivery of liquid fertilizer products.
- Irrigation companies which specialize in installing irrigation systems can set up a system which is controllable with software.
- The software can be installed on a computer system dedicated specifically to management of irrigation, or on the computer core of a smart house which controls a number of functions electronically, creating a single workstation for all tasks related to the house and garden.
- People can also design and install their own systems and program software independently, if they have irrigation experience.
- When browsing irrigation software choices, people may want to think about how the software will be used.
- A program which can respond to ongoing weather conditions with automatic reprogramming, for example, may be useful.
- Programs which keep statistics and data can also be valuable, as can programs which interface with moisture sensors and other devices in the field to provide continuous feedback.
- People may also want to investigate the support options.

- While software support may not seem critical when an irrigation software product is new, it can help to have people to call if problems emerge.

4. What is a Water Purification System?

- Water purification systems have become a necessity in many parts of the world due to pollution and other contaminants in drinking water supplies.
- A water filter removes impurities from the water.

Different types of water purification systems

Distillers

- **Distillers** are one kind of water purification system.
- They work by heating the water up until turns into a vapour.
- When the steam cools, in a different area of the filter, it condenses back into water.
- This is one of the best ways to get very pure water.
- Distilling cannot remove chemicals that have the same boiling point as water, such as ammonia. They are a very slow type of filter, often only able to clean around three litres of water an hour.

Reverse osmosis.

- Water purification systems may also work through **reverse osmosis**.
- This is one of the most widely used methods of water filtering.
- The water is sent through two different liquids, separated by a permeable film which only allows water to pass through on a molecular level.
- The water then finishes passing through the system, leaving all impurities behind.
- However, this system is also slow, and requires professionals to change the filters on a regular basis.

Whole house water purification systems

- These systems use a cartridge to filter the water, and work much faster than other filtering models.
- This type of filter also usually contains a **water softener**.
- They get hooked to incoming water pipes, and provide clean water for the entire house.

Faucet water filters

- These filters are screwed right into a kitchen faucet, and clean the water as it comes out.
- Most can be switched on and off, and some even allow for different types of sprays, such as stream or shower.
- Cartridges are fairly inexpensive and easy to change.

Jug or pitcher that filters water

- In most of these, the water is poured in through the top of the filter. It then works its way downward, being filtered, until it is released into the reservoir.
- Water purification systems are available to fit almost any budget.
- They can be used to filter the water for an entire home, or just for a single cup of water.
- Water filters are even available for water bottles, allowing people to enjoy clean water no matter where they go.

- Water filters remove many of the dangerous contaminants in water supplies, providing people with clean and fresh water for both drinking and cooking.

5. Data Integrated Through a Geographical Information System

- Yield monitors are crop yield measuring devices installed on harvesting equipment.
- The yield data from the monitor is recorded and stored at regular intervals along with positional data received from the GPS unit.
- GIS software takes the yield data and produces yield maps.

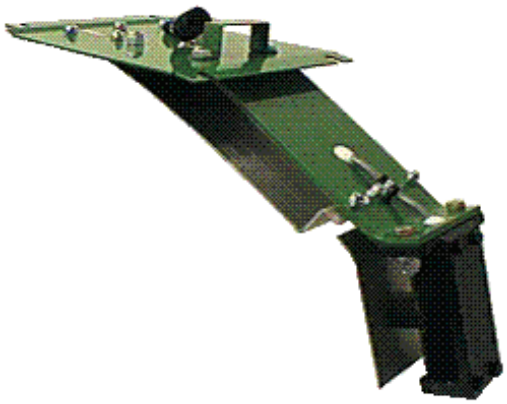
GPS – **Global Positioning System** Pinpoint exact position up to one meter

GIS **- Geographical Information System** Shows areas of under growth

VRT - **Variable Rate Technology** consists of farm field equipment with the ability to precisely control the rate of application

It is the use of these advanced technologies that has generated enormous amounts of data to process with computers.

Combine Yield Monitor

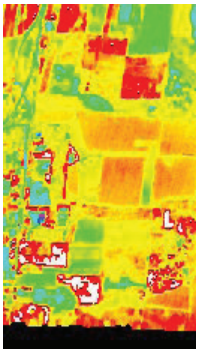


Combine Grain Tank Flow Sensor

VRT Spreader

Remote sensing image data from the soil and crops is processed and then added to the GIS database.

Normalized Vegetation Index Image of Farm Field



Research

Precision farming is an integration of several technologies. U.S. and foreign governments originally paid for the development and support of technologies such as GPS, Remote Sensing, and GIS. This amazing technology is commonly used for precision farming over the whole world.

Notes

Notes

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