Dc shunt motor pdf

OBJECTIVES • List of parts dc engine short circuit. • Draw connecting diagrams for serial short-circuit and composite motors. • Define the torque and tell you what factors influence the torque of the short-circuit motor dc. • describe the EMF counter and its effects on the current input. • describe the effects of increased load on the fitting current, torque and speed of the short-circuit motor dc. • a list of the characteristics of speed control, torque and engine displacement speed control dc. • establish DC connections. The production of electricity and its conversion into mechanical energy in electric motors of all types is the basis of our industrial structure. Dc engine principles can be found elsewhere on this page. THE DESIGN CHARACTERISTICS OF DC motors closely resemble DC generators in building elements. In fact, it is difficult to identify them only by appearance. The engine has the same two main parts as the generator - the field construction and fitting assembly consists of a core fitting, winding fitting, commutator, and brushes. Some of the general characteristics of the DC engine are shown in 1A and B. Field structure The field structure of the engine has at least two pairs of field poles, although engines with four pairs of field poles (2A) are also used. A strong magnetic field is a pro vided field blaming individual poles of the field. The magnetic polarity of the field system shall be so arranged that the polarity of any particular pole of the field is opposite to that of the poles adjacent to it. Engine fitting is a cylindrical iron structure mounted directly on the engine shaft (l-2B). In DC engines, the fitting is a rotating component of the engine. Fitting windings are inserted into the holes on the surface of the fitting and end up in commuting segments. The current is fed to these windings on the rotating fitting with carbon brushes that are pushed against the commute segments. This current in the fitting sets the magnetic field in the fitting, which acts with the magnetic field of the field poles. These magnetic effects are used to develop torque that causes the fitting to rotate (3). The commute changes the direction of the current in the fitting conductors as they pass through the poles of the opposite magnetic polarity. Continuous rotation in one direction results from these twists in the fitting current. Sick 4 is a cutaway view of the DC engine available with horsepower ratings ranging from 25.0 hp to 1,000 hp. Sick. 1 (A) dc motor fittings with commutator rods: CARBON BRUSH CONNECTIONS TO COMMUTATOR BARS; (B) Permanent magnet DC motor with rotor and carbon brush connecting poorly. 2 Engine field structure and fitting: (A) short-circuited coil, 50 hp, 850-r/min, 230-V engine; B Fitting coil windings, commuting, motor shaft, sick. 3 Torque or direction of force on current-carrying drivers in magnetic field: RESULTING MOVEMENT Types of DC MOTORS Shunt, Series, Compound and Permanent Magnet Motors are widely used. The diagram for each engine type is shown in 5. The choice of the type of engine to be used is based on the mechanical requirements of the applied load. The short-circuit engine has a field circuit connected to the displacement (parallel) to the fitting, while the series engine has an fitting and field circuits in series. The composite engine also has a short circuit and a series of windings in the field. The permanent magnet motor has only fitting connections. DC motors are rated according to their voltage, current, speed and horsepower. ill. 4 Prefabricated 25-hp dc motor: 1. Main shaft 2. Bearings 3. Lubricant meter 4. Fan 5. Fitting banding 6. Fitting coil assembly 7. Lifting eye 8. Frame 9. Control label 10. Main field coil 11. Commuting coils 12. Main field coil 13. Fitting 14. Commuting connection to the fitting turns 15. Commutator 16. Brush holder 17. Brushing saddle 18. Mounting legs 19. TORQUE terminal cap The rotational force in the engine shaft produced by the interaction of the magnetic fields of the fitting and the poles of the fields is called torque. The torque size increases with increasing shaft torque. Torque is defined as the force in pounds and the radius of the shaft or pulley in the legs. For example, an engine that produces a tangential force of 120 pounds on the surface of a shaft with a diameter of 2 inches or a radius of 1 inch, has a torque of 10 feet (ft-lb). Torque = force x radius = 120x 1/12 = 10 ft-lb Engine torque depends on the magnetic forces of the field and the fitting. Since the fitting array depends on the current fittings, the torque increases as the armature current, and subsequently the strength of the magnetic field fitting, increase. A distinction must be made between the torque developed by the engine when operating at its rated speed and the torque developed when the engine starts up. Some types of engines have high torque at rated speed, but low starting torque. Many types of load that can be applied to engines mean that torque characteristics must be considered when selecting an engine for a particular installation. ill. 5 Motor field connections: SERIES, SHORT CIRCUIT, COMPOSITE STARTING CURRENT AND ELECTROMOTIVE FORCE COUNTER The starting current dc of the engine is much higher than the running current while the engine is operating at its rated speed. With instantaneous supply, the fitting moves less and the fitting current is limited only by very low resistance to the fitting circuit. When the engine has built up its rated speed, the current input shall decrease until the engine reaches its rated speed. At this point, the fitting current stops falling and remains constant. Factors other than resistance to the fitting also limit the current. sick 6 a demonstration that shows the action of the generator in the engine, which represents a decrease in current with an increase in speed. In fgr6, dc motor and lamp (each with the same voltage) are connected in parallel to the dc source. A zero-centred ammeter connected in circumference indicates the quantity and direction of current to the engine. When the line switch is open (A), there is no current in any part of the circuit. When the switch is closed (B), the indicator light lights up immediately and the ampmeter registers a high current to the engine. The engine current shall decrease with increasing engine speed and shall remain constant when the engine reaches its rated speed. The moment the switch is opened, the ammeter will turn. The lamp continues to shine, but the dimmer grows as the engine speed drops. ill. 6 Emf counter demonstration Two conclusions can be drawn from this demonstration: 1. Dc engine develops induced voltage when rotating. 2. The direction of the induced voltage is opposite to that of the applied voltage and is therefore called the emf counter. As the torque, or twisting effort, rotates the fittings, the conductor coil fittings reduce the main field magnetic flow, as in the generator. This action induces tension into the winding fittings, which are against the tension of consciousness. The production of the EMF counter in the DC engine represents current changes to the motor fitting at different speeds. When there is no current in the circuit, the motor fitting is stationary and the EMF counter is zero. The initial current is very high, because only ohmic resistance of the fitting limits the current. As the fitting begins to rotate, the emf counter increases and the line current decreases. When the speed stops rising, the value of the emf counter is close to the value of the applied age of the volt, but never equals it. The value of the voltage actually forces the current through the engine equals the difference between the applied voltage and the emf counter. At rated speed, this voltage differential shall only maintain the engine at constant speed (7A). Under mechanical load, it is then applied to the motor shaft, both the speed and the emf counter decrease. However, the voltage differential increases and causes an increase in the input current to the engine. Any further increase in mechanical load causes a proportional increase in input current (7B). ill. 7A Effects of anti-mot force on the fitting current; ill. 7B Effects of the EMF and I counter (fitting) when the load increases. NEW VOLTAGE DIFFERENTIAL; NEW CURRENT OPERATION The increase in engine current due to the increase in mechanical load can also be explained in terms of torque. Since the torque depends on the strength of the armature's magnetic field, which in turn depends on the fitting current, any increase in mechanical load would require an increase in Fittings. As the initial current may be many times greater than the rated current under full load, large DC engines must not be connected directly to the power lines for starting. Heavy current surges produce excessive line voltage drops that can damage the motor. The maximum branch fuse size for each DC engine is based on the full engine operating current. Therefore, starters for DC engines generally limit the starting current to 150% dc operating current. FITTING REACTION The fitting reaction occurs in dc motors and is caused by a deformed or altered magnetic field of rest in response to the armature's magnetic field. The fitting reaction is actually bending the magnetic field of the motor so that the brushes are no longer aligned with the neutral magnetic plane of the motor. If the brushes do not comply with this magnetic plane, the current transferred to the fitting is not distributed evenly in the fitting wires and therefore causes a difference in the voltage on the brushes. This causes sparking where the brush meets the commute. In a constant load motor, brushes can be moved back to a neutral plane to reduce spark. The brushes are shifted in the opposite direction to the rotation. If the engine has different loads, the neutral plane shall be continuously moved. To combat the effects of field distortion, some engines are designed with interpols or commutation poles. These poles are connected in series with the circuit fitting. Any change in the fitting current that would tend to distort the magnetic field is counter-terrorism by Interpol's magnetic field. See 3. ROTATION The direction of rotation of the dc motor fitting depends on the direction of the field circuit and the fitting circuit (8A). To reverse the direction of rotation, the current direction must be reversed either in the field or in the fitting. Reversing the supply line does not reverse the direction of rotation of the fitting, as this situation will cause both field and fitting currents to reverse, as shown in 8B. To determine the direction of movement of the driver, use the right rule for engines. Use your right hand as shown in 8C. The first finger indicates the direction of flow (from north to south), the centre finger indicates the direction of the jet stream (negative to positive), and the thumb indicates the direction of the resulting stroke. SPEED CONTROL AND SPEED CONTROL The terms speed control and speed control should not be used interchangeably. The meaning of each one is completely different. Speed control refers to the ability of the engine to maintain a certain speed under different mechanical loads from no load to full load. It shall be expressed as a percentage. The formula used is: % speed control = [(No load speed - full load speed) / Full load speed] x 100 Use formula, we can determine that the engine that holds a constant speed between no load and full load has 0% speed control. The speed control refers to the deliberate change of engine speed by means of external controls. This is done in different ways and is not the result of the design of the engine. Speed Control DC motors are operated at normal speed by reducing the voltage applied to the fitting circuit. Resistances associated with the serial arm can be used to reduce voltage. When the armature voltage is reduced while maintaining the array current constant, the emf counter is too high. Therefore, the engine slows down to reduce the counter emf (9A). The dc engine speed may also be lower than its rated speed by changing the voltage to the entire engine. However, this method is not used because there is a loss of torque along with a decrease in speed. The dc motor can be operated over the rated speed by reducing the strength of the field flow. Rheostat located in the field circuit changes the resistance of the perimeter of the field, the current of the field and , in turn, the flow of the field. While it seems reasonable that reducing the flow of the field reduces the speed, the speed actually increases because the flow reduction reduces the EMF counter and allows the applied voltage to increase the current fitting. The speed continues to increase until the increased torque is applied to the opposite torque of the mechanical load. When the field flow is reduced while keeping the fitting voltage constant, the counter-emf in the fitting decreases. As a result, there is a larger voltage differential, which causes an increase in the fitting current. It develops more torque to increase engine speed (9B). Note: As the engine speed increases with a reduction in off-road flow, the engine circuit should never open when the engine is in use, especially if it operates freely without load. An open field can cause the engine to rotate at speeds that are dangerous both for the machine and for the personnel operating it. For this reason, some engines are protected against excessive speed by field rheostats, which have no field release function. This device disconnects the engine from the power supply when the field circuit is opened. ill. 8A Standard connections for short-circuit motors: counterclockwise rotation, sick clockwise rotation. 8B Reversing either the fitting connections or the connection of the field will cause a change in the direction of rotation of the fitting;. changing both connections will result in the same direction of rotation: The original connections give the polarity of the field as shown in the figure. The fitting current, as shown, would produce anti-rotation clockwise. The fitting connection changed to the opposite direction of the current in the fitting while maintaining the direction of the field leading to rotation clockwise. Rub array polarity and armature polarity from the center will result in the same direction of rotation clockwise. ill. 8C Orthodox rule for engines using electron flow: direction of flow from north to south, resulting thrust of movement, current flow in the drivers. ill. 9A To reduce the speed, reduce the tension of the fitting while maintaining a constant field current. ill. 9B To increase the speed, reduce the current of the field while maintaining the voltage constant of the SKRAT MOTOR Two factors are important when selecting the engine for a particular application: (1) a change in speed with a change of load and (2) a change in torque with a change in load. A short-circuit motor is basically a constant speed device. If a load is applied, the engine tends to decelerate. A slight loss of speed reduces the emf counter and leads to an increase in the current fitting. This action continues until the increased current has sufficient torque to meet the demands of the increased load. As a result, the short-circuit engine is in a stable balance state because the change in load always produces a reaction that adjusts the power to the load change. The basic circumference of the short-circuit motor is shown in 10A. Note that only the offset field of the reeds is displayed. 10B shows the addition of a series of windings against the effects of the fitting reaction. In terms of scheme, the 10B is a composite engine. However, this type of engine is not considered com pound engine because commuting winding is not a blow on the same pole as the winding field and the series field has only a few wire turns in series with a circuit fitting. As a result, they are the operational characteristics of the short-circuit engine. This is thus stated on the engine label under conditions compensated by engine short circuit or stabilized engine short circuit. Speed control The dc short-circuit engine has excellent speed control. A field rheostat shall be used to operate the engine above rated speed to reduce field current and field flow. To operate at rated speed, reduce the voltage applied to the fitting circuit. More modem speed control method is an electronic speed control system. The control policies are the same as manual drivers. Speeds above normal are achieved by electronic reduction of field voltage and speed below normal reduce the voltage applied to the fitting. Rotation The direction of rotation of the fitting may be changed by reversing the direction of curvature either in the field circuit or in the fitting circuit. For an engine with a simple short-circuit circuit, it may be easier to reverse the field circumference. If the engine has a serial winding or interpolated winding against the reaction of the fitting, the same relative direction of curvature must be maintained in short-circuit and serial windings. For this reason, it is always easier to reverse the direction of the current fitting. Sick. 10 Short-circuit motor connections: (A) Without Poles; (B) With the commute of poles, the torque A dc short-circuit engine has high torque at all speeds. At start-up, the dc short-circuit engine develops 150 per cent of its rated torque if the resistives used in the start-up mechanism are capable of withstanding the heating effects of the current. For a very short period of time, the engine can develop 350 percent of the full load of torque, if necessary. Speed control The speed control of the short-circuit engine decreases from 5 per cent to 10 per cent from a state without full load. As a result, the short circuit engine is better than the DC series engine, but is lower than the compound-blow dc engine. sick 1 1A shows dc engine with a horsepower rating ranging from 1 hp to 5 hp. PERMANENT MAGNET MOTORS A variation on the dc motor short circuit principle is the PM (Permanent Magnet) motor. There are two varieties. One style PM motor uses permanently magnetized material such as Alnico or ceramic magnets mounted in the stator to provide a constant magnetic field. The rotor comes with dc via brush and commutator system. The result is similar to a short circuit dc-type engine, but has a very linear speed/torque curve. Another type of PM motor uses permanent magnets mounted in the rotor. As DC is still supplied to the engine, a commutation must be available to properly magnetise the stator in relation to the rotor to provide rotational torque. The commutator segments are actually connected to the stator coke and the rotor sliding contact set ensures the correct electrical connection from the dc source to the correct stator commute segments. This type of PM engine can be made in larger-horse models such as PM stator types. PM engines are generally smaller than 5 hp. sick 11B compares the physical size of pm to the short circuit of the engine. If the engines don't provide hp or torque, the problem could be that the magnets have lost some of their original magnetic power. Another problem that may occur is the demagnetization of permanent magnetic material. This can happen when the engines are running in one direction and then quickly turned in power. Some control circuits provide protection against rapid reversals; others compensate for this problem by using a small voltage when reversing. Sick. 11A Direct current engine, hp up to 5-hp; ill. 11B Compare dc permanent motor magnet and reel field engine. HEADLESS DC MOTORS Instead of mechanical commuting to power the array and rotor power supply, the use of electronics can be used to switch the stator field. The rotor uses a permanent magnet so that the rotor is not powered by any direct power. In order to switch the power supply to the reeling box, the sensors must be used to determine the movement of the rotor. When the rotor speed increases or decreases, the sensor transmits information to the electronic switch. Electronic power supply is constantly adapting Voltage level to the correct stator poles to maintain speed and direction. See 12. ill. 12 BrushlessDC motor control schematic STEPPING MOTORS Another type of motor that can use a permanent magnet on the rotor is called a step ping motor, Instead of continuous power supply and continuous rotation, the rotor moves in increments as the stator is energized. The advantage of this type of engine is that movement can be monitored and precise degrees of rotation can be obtained from entering the engine. These engines do not melt high torque, so they are often used in small devices that need incremental movement or movement in incremental steps. The concept of the engine is to encourage the stator array and allow the rotor poles to move to the desired position, which provides magnetic alignment. Instead of a rotating magnetic field or dc field with commutation, the fields are more stationary. As seen in 13, the stator can be energized by moving switches 1 and 2 either to position A or B. The first sequence of switches shown in 13 will result in clockwise rotation; the second sequence creates a counterclockwise rotation. ill. 13 Diagram illustrating how the switching sequence creates motion steps in the treadmed motor The simple concept stepper motor is explained by a permanent magnet on the rotor with only two sets of poles on the stator. Actually the rotor consists of many magnetic poles consistent with the teeth on the rotor. These teeth are spaced so that only one set of teeth are perfectly aligned with the stator poles at once. Taking the number of times that stator power must be used to move one tooth through a 360° rotation, we can calculate the angle of step. For example, if the tooth moves 360° with 200 power steps (using stator power), the step angle is calculated by splitting 360° 200; this gives us 1.8° movement per step. The angle of step determines how fine the motion steps are for a given engine. Other types of stepper motors use a high throughput rotor instead of a permanent magnet rotor. The rotor magnetic fields align and retain magnetism during operation. These stepper engines are called variable-reluctance to tread engines. Most staged engines use instructions or commands that are produced by computer processors. Step commands are generated to produce the desired movement and fed on an electronic controller board, then the power is applied to the engine leads. (sick 14). 14 Stepper motor and related controller board. Note the small size of the engine (only 65 oz. - in. torque) SUMMARY Short circuit motor uses the short circuit field as the main magnetic field in the stator. The short-circuit field consists of many corners of a small wire and is connected or displaced through the fitting. The short-circuit field may have a rheostat attached to the series to control the amount of current into the field. the principle of dc engine relies on the concept of commutation. This commute and brush connection always keeps the direction of the current and the direction of the magnetic field consistent. The speed and current to the rotor are indirectly proportional. If the rotor spins faster, more EMF (CEMF) counters are produced and less voltage differential, and therefore less current. DC motors are used in different styles for different purposes. There are many variants of short circuit engine used for specialized purposes. QUIZ A. Select the correct answer for each of the following statements. 1. DC motors shall be dimensioned at: a. voltage, frequency, current and speeds. b. Voltage, current, speed and torque. c. voltage, current and horsepower. d. Voltage, current, speed and horsepower. 2. The effect of the generator in the engine creates: a. high power factor. b. High durability. c. against electromotor forces. d. reduced wiring voltage. 3. The Dc motor draws more current with the mechanical load applied to its shaft because: a. the EMF counter is reduced with speed. b. the voltage differential decreases. c. the applied voltage decreases. d. torque depends on magnetic force. 4. The direction of rotation of the composite between the pole motor may be reversed by reversing the direction of the jet stream through: a. the fitting. b. fitting or field circuit. c. fitting, interpols and batch field. d. short circuit field. 5. The DC engine speed may be reduced below the rated speed without loss of torque by reducing the voltage to: a. the engine. b. Series field. c. fitting. d. fitting and field. 6. The advantages of dc engines are: a. simplicity in construction. b. Speed control above and below the base speed. c. Excellent torque and speed control. d. horsepower for size. B. Complete the following declarations. 7. The torque force applied to the motor shaft is called _______and caused by the interaction of the magnetic field _________ and _______ 8. Field interpols connected in series to the engine fitting circuit help to counteract the effects of of___________ 9. As the DC engine comes to its rated speed, its fitting current (decreases, remains the same, increases). (Underline the answer.) 10. The main factor controlling the fitting current of the short-circuit motor operating at rated speed is _______________ __________