

TUNNELWORKS AR APP

KS4 DESIGN & TECHNOLOGY

THE CUTTER HEAD & INDUCTION MOTORS

Specification

The Thames Tideway tunnel is being excavated by tunnel boring machines, huge tunnel sized machines specially equipped to grind away at the earth and remove excavated materials, whilst preventing tunnel collapse. The cutter head of the machine is dressed with cutting tools and rotated by 12 induction motors. Hydraulic rams push the cutter head through the ground, excavating the tunnel.

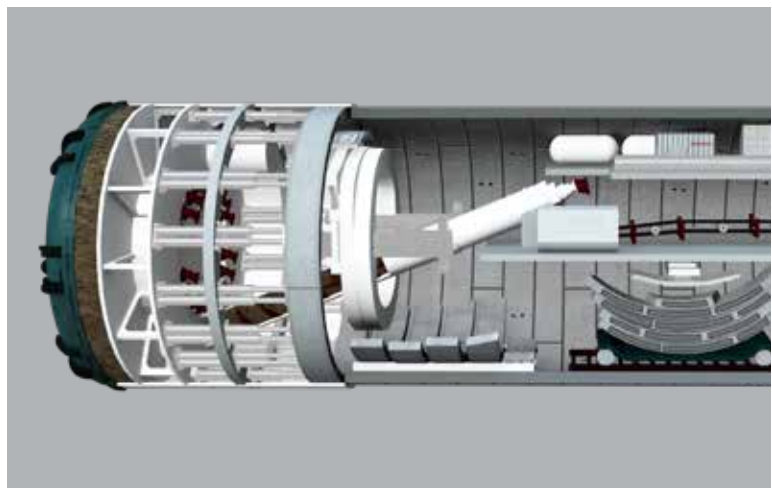
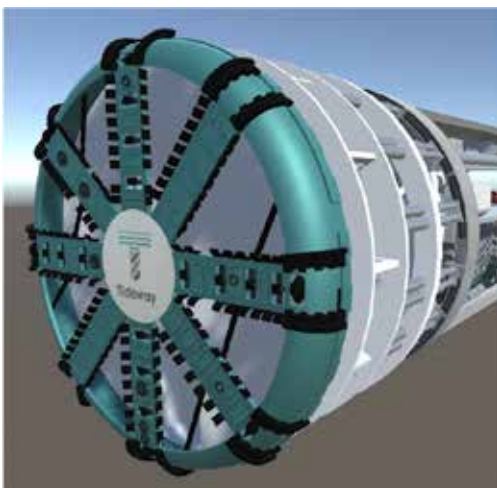
In this lesson, you will learn to:

- name the main features of the cutter head and describe their function
- name the features of an induction motor
- calculate the speed and torque of an induction motor.

Explore the Tunnelworks AR app or use your teacher's guidance to help complete the challenges below. You may also need to use your wider research skills.

Challenge 1: The Cutter Head

The tunnel boring machine excavates the tunnel using cutter head, a huge rotating disk. Using the Tunnelworks AR app, match the parts of the machine to the descriptions below, using the letters to label the diagrams.

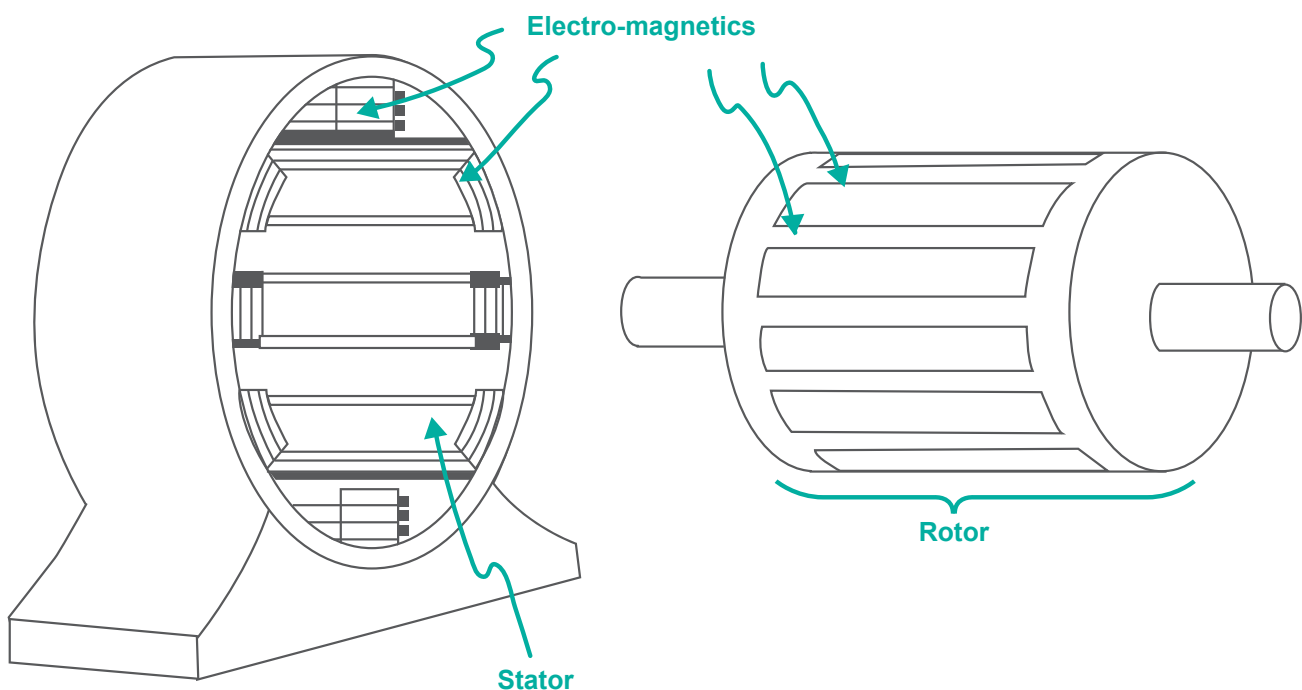


A	The cutter head is an 8130mm diameter cutting disc which grinds away the earth.
B	12 induction motors drive the cutting disc from behind the excavation chamber, with a combined power of 1920kW.
C	The cutting tools consist of cutters, rippers and knives which can be replaced to excavate different rock types.
D	The excavation chamber contains pressurised excavated materials prevent the tunnel face from collapsing.
E	The screw conveyor removes materials from the excavation chamber and can be slowed to ensure pressure is maintained.
F	The tunnel face is the front of the tunnel, pushing on the front of the tunnel boring machine with the weight of the rocks above.

Challenge 2: Induction Motor Diagram

The cutter head of the Tunnel Boring Machine (TBM) is driven by a ring of 12 induction motors, with a combined power of 1920 kW. Combined with pressure from the hydraulic rams, the cutter head uses this rotary force to scrape away the earth with its cutting tools. This rotary force is known as torque, and is a measurement of how much pushing power a rotating object has.

- a) Using the Tunnelworks AR app, label the diagram of the induction motor, and add an arrow to show the type of motion produced at the driveshaft.



- b) Using the Tunnelworks AR app, explain how an induction motor works.

Induction motors work using _____ force. The _____ or stationary part of the motor is lined with electromagnets, which switch _____ as the AC current supply to the motor _____. The corresponding electromagnets of the freely spinning _____ are repelled and by those of the stator, forcing the rotor and its driveshaft to rotate. This rotary pushing force is called _____.

attracted **stator** **alternates** **poles**
rotor **torque** **electromagnetic**

Challenge 4: Talking About Torque

Torque is the rotary or twisting force produced by a motor, measured by newton metres (N m). We can also measure the speed of the rotations in revolutions per minutes (rpm). We can use both measurements to calculate the power of the motor in kilowatts (kW) with the following equation:

$$\text{Power (kW)} = \frac{\text{Torque (N m)} \times \text{Speed (rpm)}}{9.5488}$$

Using this equation, fill in the table.

Motor	Torque (N m)	Speed (rpm)	Power (kW)
A	7936	3	
B		70	3000
C	2000	13	
D	1200		5060

Which motor is the most powerful? _____

EXTENSION:

Tunnelling operatives & PPE

Specification

Being a Tunnelling Operative can be an exciting job. Working underground at the tunnel face, Tunnelling Operative (s) get hands-on experience with cutting-edge civil engineering technology. Like all construction works, Tunnelling Operative (s) must be kept safe with specialist personal protective equipment, or PPE.

In this extension, you will learn to:

- Describe the personal protective equipment used by Tunnelling Operative (s) and understand their use
- Assess the product specifications of a high visibility jacket
- Evaluate the skills and qualities needed to become a Tunnelling Operative.

Explore the Tunnelworks AR app or use your teacher's guidance to help complete the challenges below. You may also need to use your wider research skills.



Challenge 1: Personal Protective Equipment

For each piece of equipment, suggest a reason for its use.

Equipment	
Safety helmet	
Steel-toe cap boots	
Carbon monoxide detector	
Eye protection	

Challenge 2: Designing PPE

Look at the team photograph above. All Tunnelling Operatives wear a high visibility tideway jacket as part of their personal protective equipment. From your knowledge of tunnelling, PPE and the photo above, consider five specification points that should be considered for the design of these jackets, explaining your answers.

1) _____

2) _____

3) _____

4) _____

5) _____

Challenge 3: Lee the Tunnelling Operative

Explore the *Tunnelworks* AR app and read about Lee's experience of being an apprentice Tunnelling Operative. Suggest two personal qualities that would be useful for working for Tideway in this role.

1) _____

2) _____
