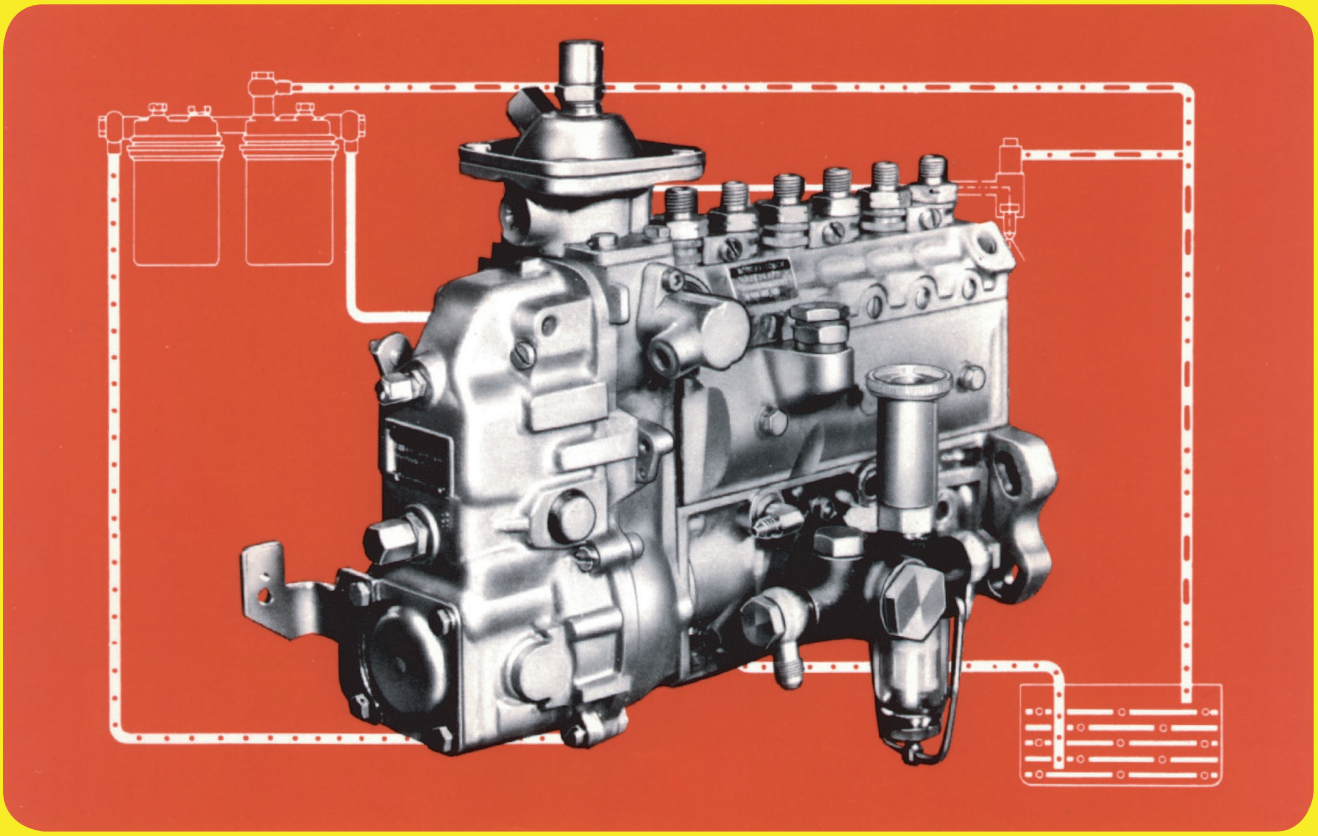
BOSCH

Module 4 (3)
MW - Pump Operation



Pre-Tech
Service Training

MODULE 4

MW-PUMP OPERATION

STPR MW 1
1/84

INTRODUCTION

This audio-visual program, **MW Pump Operation** is a part of Module 4 of PRE-TECH, **Pump and Governor Operation.** You should have completed Modules 1 through 3 before you begin this program.

This module consists of eight audio-visual programs. Each program has a separate review guide and exercise. You will be required to complete from one to all eight programs, depending on the program track that you have been assigned to by your instructor or supervisor. These audio-visual programs will introduce you to the theory of operation for several selected pumps and governors. This program explains **MW Pump Operation** in terms of distributing, pressurizing, timing, and metering of fuel.

PROGRAM OBJECTIVES: MW PUMP OPERATION

When you have completed **MW Pump Operation** you will be able to:

1. Describe how fuel, at supply pump pressure, enters the barrel.
2. Describe how and when delivery fuel pressure is developed.
3. Describe pump timing.
4. Describe pump phasing.
5. Describe how to adjust internal pump timing and phasing.
6. Describe pump metering.
7. Describe how metering changes.

SPECIAL EQUIPMENT

To complete this program you will need the **MW Pump Operation** audio-visual program, the appropriate play-back equipment, and this review guide. The different types of audio-visual presentations (formats) and the types of required equipment to view each format are listed below. Read the operating instructions for the equipment you will be using before attempting to view the programs.

Slide/Tape Format

You will need either an automatic slide/tape player or a manual slide projector and separate tape player. Side A of the cassette tape has inaudible pulses which trigger the advance mechanism of automatic slide/tape players. Side B of the tape has tone pulses which you can hear to indicate when you should advance to the next slide. Before you begin, be sure that you are using the correct side of the cassette tape for the equipment you are using and rewind the tape completely to be sure you are at the start of the program.

Filmstrip/Cassette Tape Format

You will need either an automatic filmstrip/tape player or a manual filmstrip projector and separate tape player. Side A of the cassette tape has inaudible pulses which trigger the advance mechanism of automatic filmstrip projectors. Side B of the tape has tone pulses which you can hear to indicate when you should advance the filmstrip to the next scene. Before you begin, be sure that you are using the correct side of the cassette tape for the equipment you are using and rewind the tape completely to be sure you are at the start of the program.

Film/Tape Cartridge Format

Because of the variety of film/tape cartridge players available, we have not included instructions for this equipment. Be sure to read the operating instructions that come with the equipment you are using before viewing the audio-visual program.

If you have any questions about how to use the audio-visual equipment, see your supervisor or instructor.

SPECIAL INSTRUCTIONS

DO NOT use or refer to the review guide until you have finished viewing the audio-visual program or you are instructed to do so. The visuals in the program are produced in colors which present important information. The black and white reproductions of these visuals used in the review guide may not show the discrimination between these colors and, therefore, may not completely present the information from the color visual. In addition, the audio-visual program may have been revised with updated visuals which may not be reflected in the review guide. These changes in visuals will not alter the meaning or content of the information contained in the review guide.

Start the audio-visual program, **MW Pump Operation**, at this time. Sit back and let the colors, motion, and sound help you learn. When the program ends, turn to page 3 and continue as instructed.

NOTE

The audio-visual program will STOP from time to time when viewed using automatic playback equipment. These stops are included to provide an opportunity to review the information that has been presented to that point. When you are ready to continue, press the START button on the playback equipment.

REVIEW EXERCISE: MW PUMP OPERATION

Now that you have finished viewing the audio-visual program, complete this review exercise. If you have a problem answering any of the questions, use this review guide to locate the correct answer. The numbers following each question indicate the range of scenes where the correct answer can be found.

Fill in the correct word or words to complete the following statements.

1. The purpose of the MW pump is to _____ the fuel, _____ the delivery of the fuel, and to _____ the quantity of the fuel delivered. (6-8)

2. During delivery the stroke motion of the plunger serves to _____ the fuel. (15-17)

3. The measurement of plunger lift from bottom dead center to port closure is called _____ _____ _____ _____. (17-19)

4. Pump timing depends on when _____ _____ occur. (20-22)

5. When lift to port closure of number one cylinder is measured, it determines the _____ _____ of the pump. (23-25)

6. Lift to port closure is adjusted by adding or subtracting _____ under the _____ _____. (26-28)

7. Another term for setting internal pump timing for all of the plungers is _____. (29-31)

8. Plunger lift from port closure to port opening is called the _____ _____. (35-37)

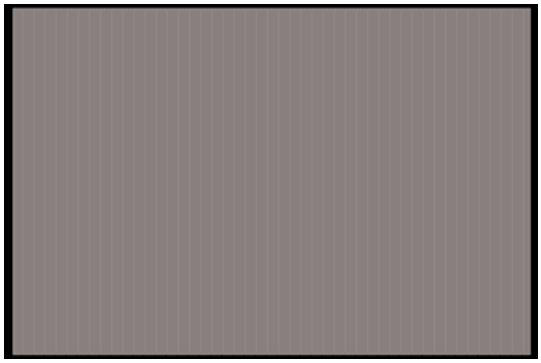
9. Port opening is controlled by the position of the plunger _____. (37-39)

10. When each plunger delivers the same amount of fuel per stroke you have _____ _____. (45-47)

When you have finished this exercise, review your answers. Then show the completed exercise to your instructor or supervisor. Have your instructor or supervisor record your progress on the Student Progress Sheet.

Go on to the next audio-visual program assigned to your program track.

1. FOCUS



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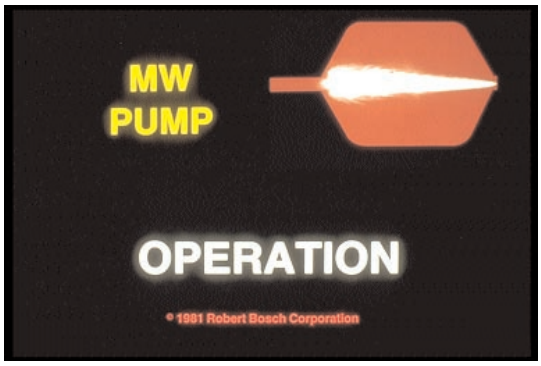

3.

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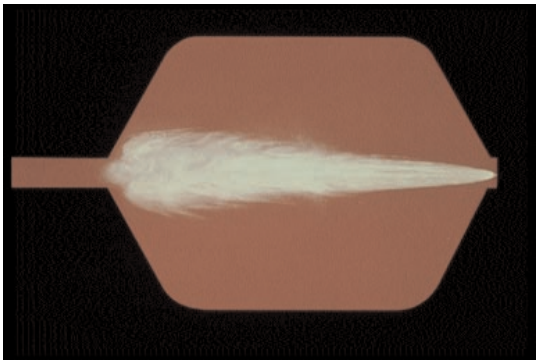
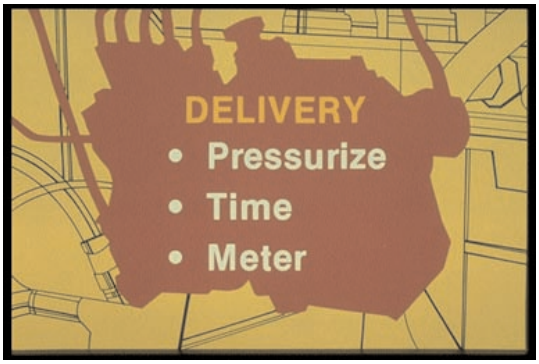
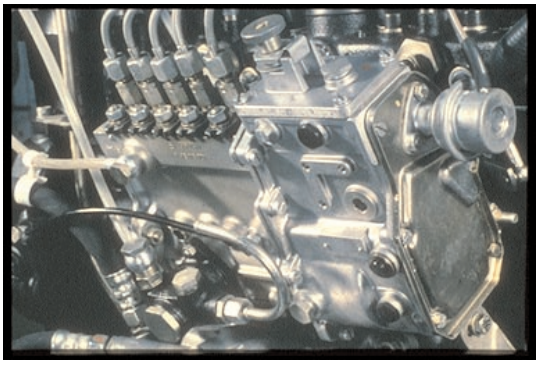


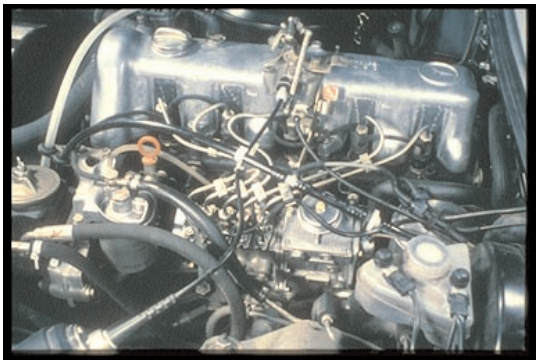
5. Delivery and injection of diesel fuel. This is what it's all about.



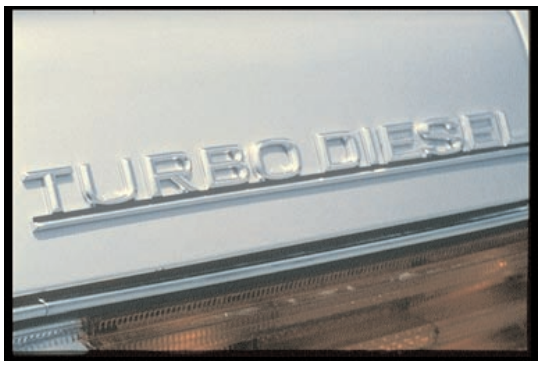
6. Delivery means — pressurize the fuel; time the delivery; meter the quantity. That's what you'll see here — how these three things are done . . .



7. . . . by the M-W pump, one of our popular in-line pumps. You'll be learning about servicing these pumps . . .

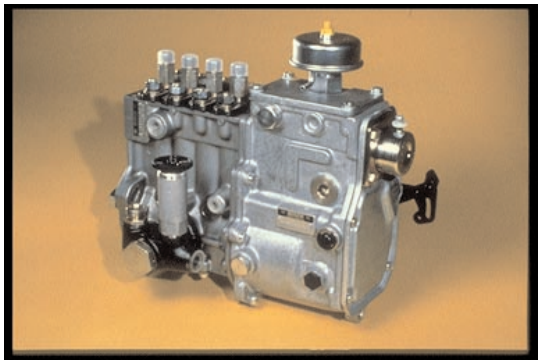


8. . . . used on Mercedes-Benz four-cylinder and five-cylinder diesels . . .

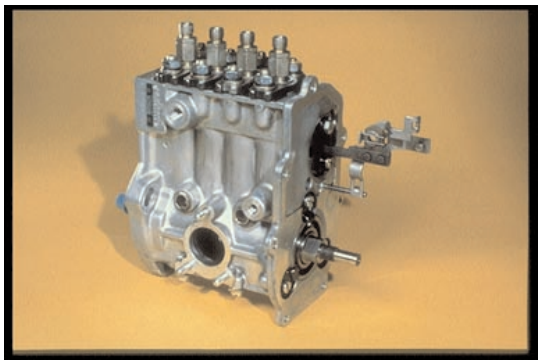


9. . . . on turbo diesels, which are setting new performance standards in diesel passenger cars . . .

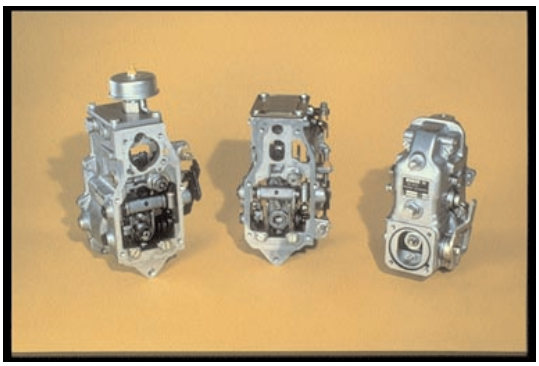
10. . . . on turbocharged and naturally aspirated engines in Volvo trucks, International Harvester equipment, and other marine and industrial applications.



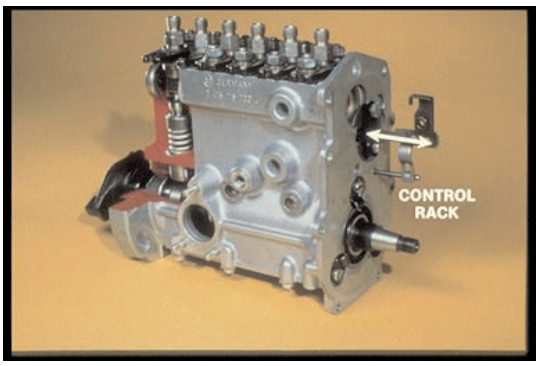
11. Yes, this pump gets around. And, when you finish this program, you'll know how it works and how to service it.



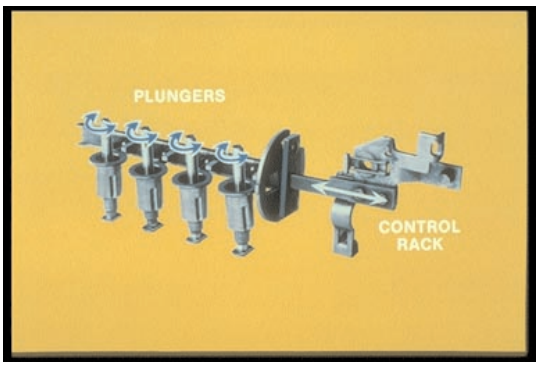
12. We'll concentrate on the pump in this program.



13. Other programs will cover the various governors. Whatever the governor type . . .

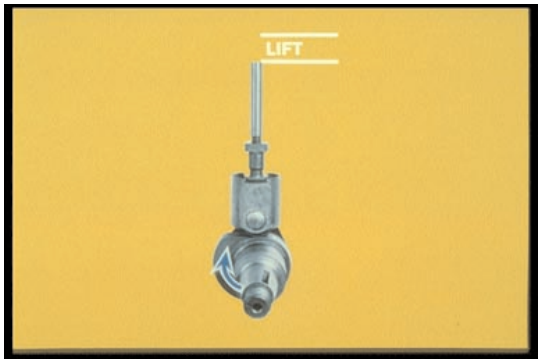


14. . . . each one manages the M-W pump by moving the control rack to meter delivery to the injectors. We all know that, when the rack moves . . .

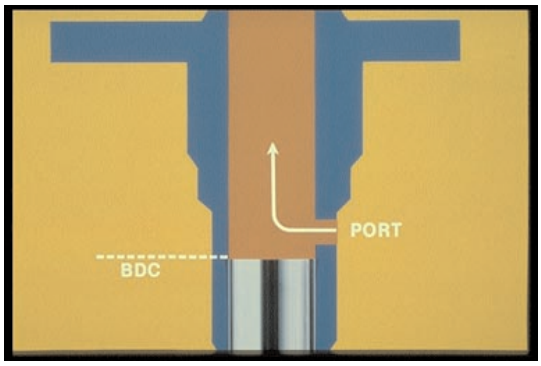


15. . . . the plungers are turned as the control rack moves the sleeves. The plungers can also stroke without affecting this turning motion.

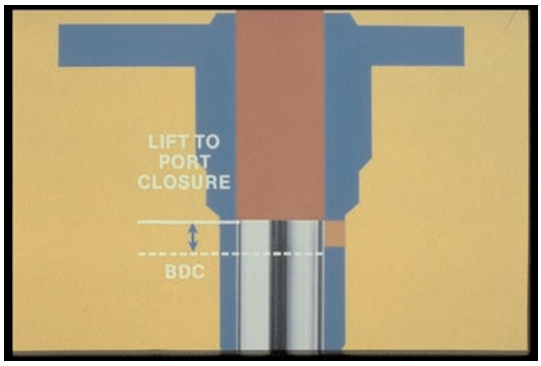
16. During delivery, the stroke motion serves to pressurize the fuel. That's what we'll look into first.



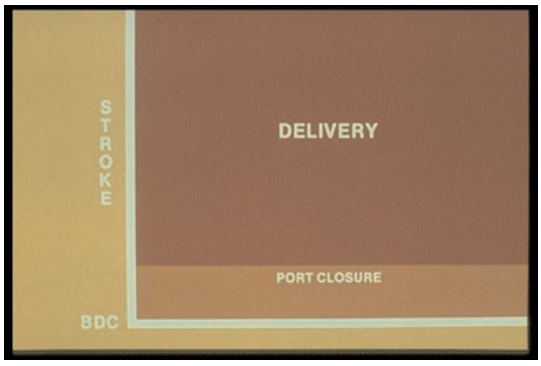
17. From bottom dead center, the plunger lifts as the cam lobe lifts the roller tappet. The down stroke is slower than the lift to insure good fuel intake.



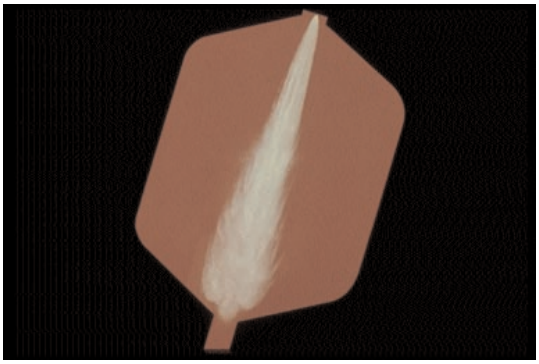
18. At BDC, fuel coming in through this port fills the barrel above the plunger. We'll show supply fuel in orange.



19. You may recall that lift to port closure is the measurement of plunger lift from BDC to close the port. After port closure, plunger movement pressurizes the fuel. We'll show that in red.

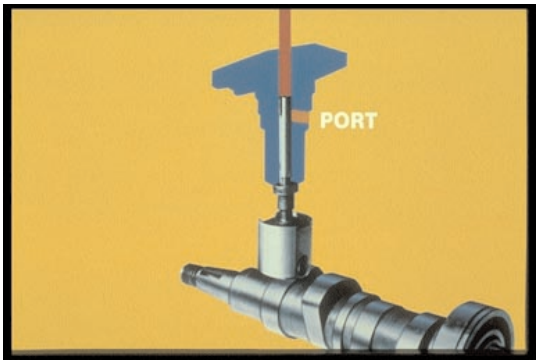


20. In the plunger stroke up from BDC, delivery begins after the lift to port closure. As a result of the high pressure stroke . . .

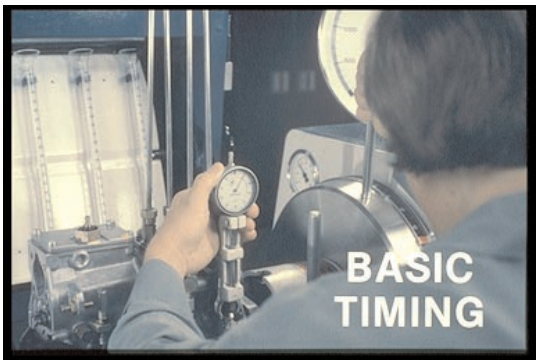


21. . . . at the cyliner head, fuel is delivered for compression ignition and the power stroke. So delivery depends on the pump's ability to pressurize the fuel. What else does it depend on?

22. Yes, delivery requires the pump to time the fuel injection. Timing depends on when port closure happens. Let's see how.

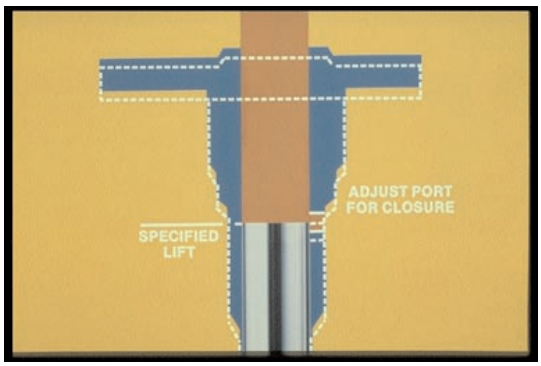


23. Here's the plunger being lifted, together with its roller tappet, to port closure and beyond. When lift to port closure of number one is measured, it determines the basic timing.

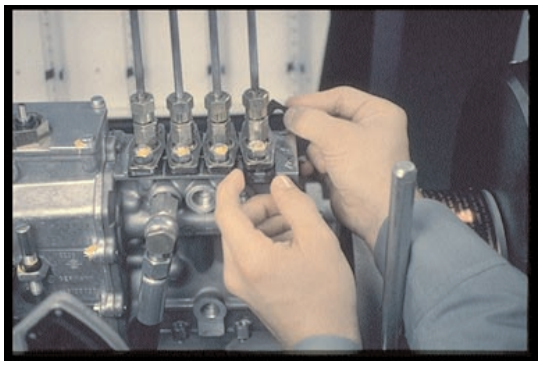


24. Checking basic timing answers the question "when" — when does injection begin?

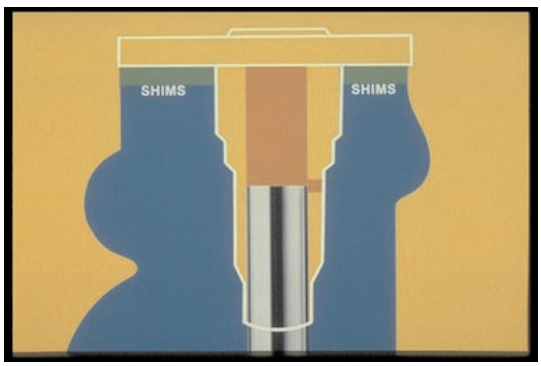
25. When we rotate the cam to a specified lift to port closure, we establish a zero check point for pump timing.



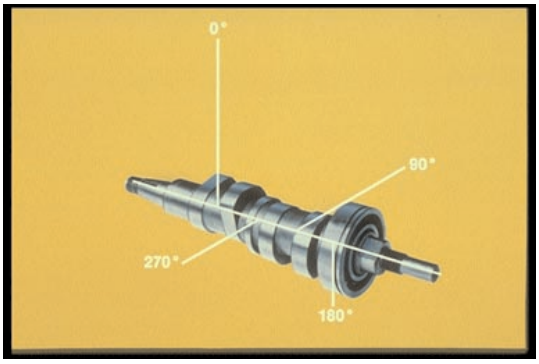
26. If, like this, the plunger does not port close at the specified lift, how do you adjust for port closure? Right, in the M-W, you move the barrel down.



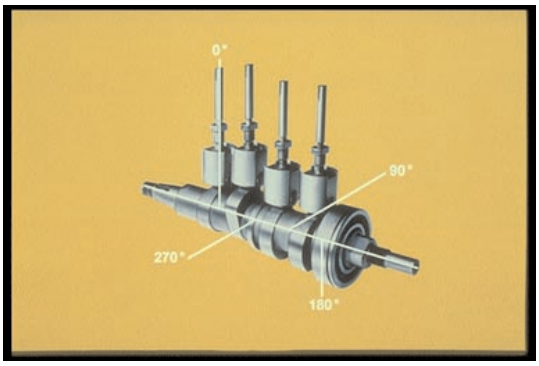
27. In this case, you change the shims under the barrel flanges to thinner ones, lowering the port.



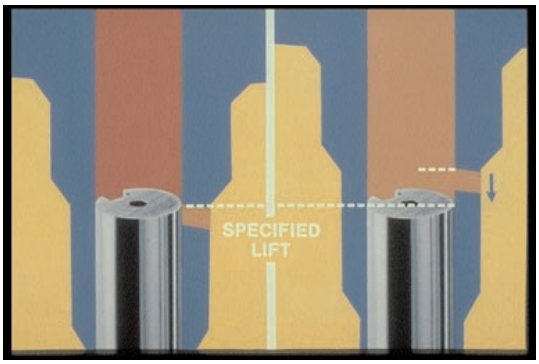
28. When the shims are too thick, like this, we don't get port closure at the specified lift. You can see why both shims for each cylinder must be the same thickness.



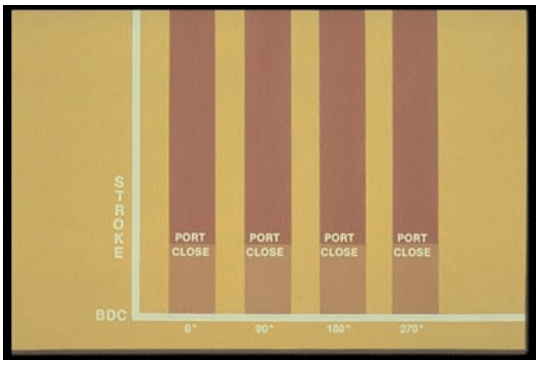
29. Once you've set port closure at number one and zero degrees, the other barrels must be shimmed to port close at equal intervals.



30. All plungers should work in phase to port close at equal intervals. We call this adjustment "phasing," or setting internal pump timing.



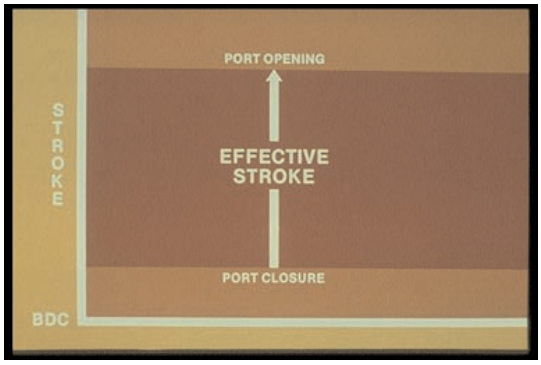
31. So, with number one shimmed to port close at the specified lift, each other barrel must be shimmed to port close when its plunger lifts the same amount, at equal intervals.



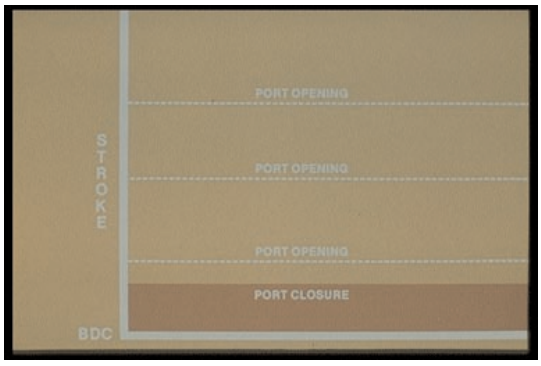
32. We want to set our timing to port close at the specified lift and at regular intervals. A good job of pump timing . . .

33. . . . delivers these kinds of results for good engine performance.

34. You've seen that delivery means to pressurize and to time the fuel injection. Let's see that it means to meter the fuel delivery.



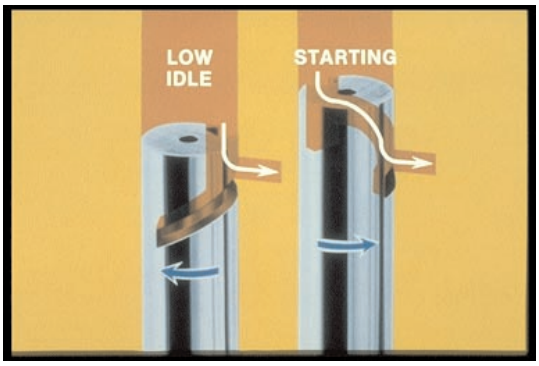
35. You may remember that the quantity of fuel delivered depends on the effective stroke – the plunger lift from port closure to port opening.



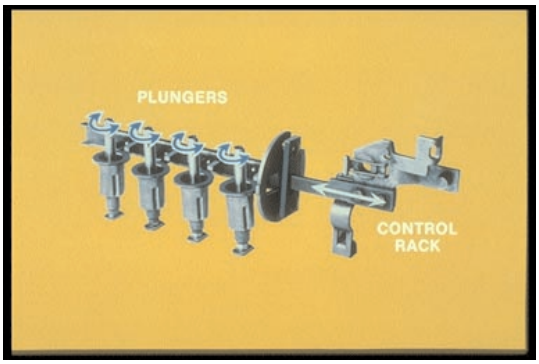
36. How can port opening be changed to change the effective stroke from port closure? How can each plunger deliver the precise quantity of fuel required?

37. Right, by changing port opening, when the plunger helix uncovers the port. At port opening, pressure falls to supply pressure, shown in orange. With no delivery pressure, injection stops at the cylinder.

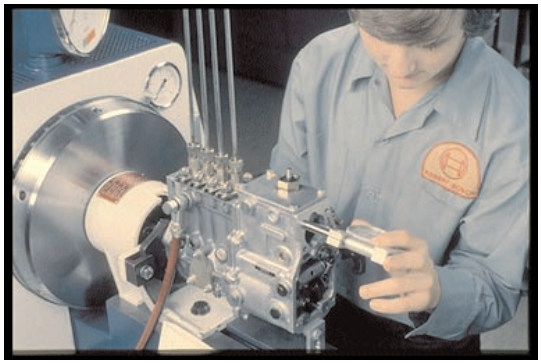
38. On the left, you can see that, when the helix uncovers the port sooner in the stroke, less fuel is delivered. In comparison, when the helix uncovers the port later in the stroke, more fuel is delivered.



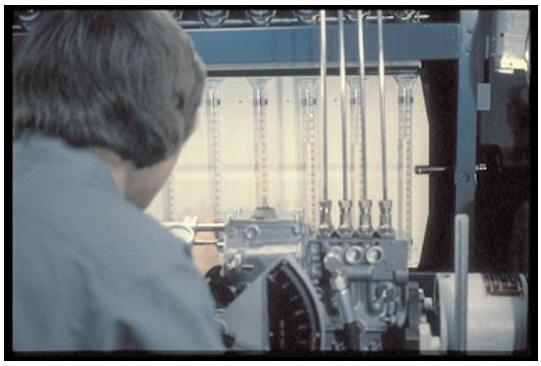
39. Compare a plunger at low idle, turned for less fuel and a shorter effective stroke to its position for starting. You can see how this longer effective stroke delivers more fuel.



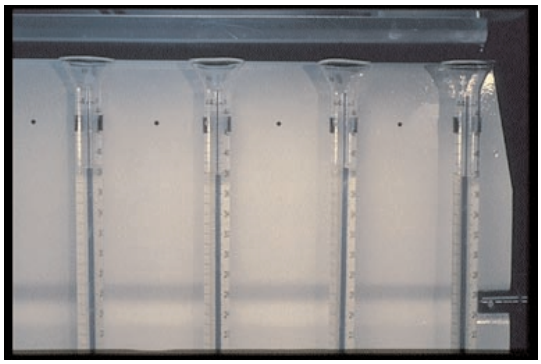
40. This brings us back to the rack — the rack which turns all plungers in their barrels. The position of the rack determines the position of all plungers.



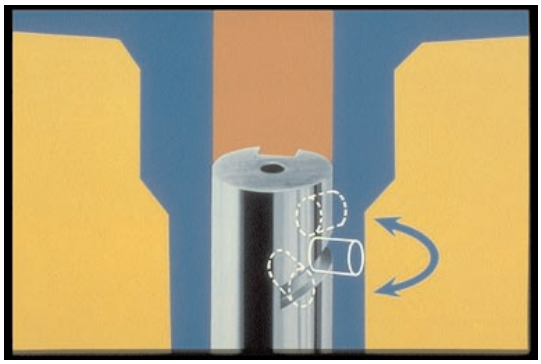
41. When you measure rack position, you are setting the position of each plunger helix in its barrel.



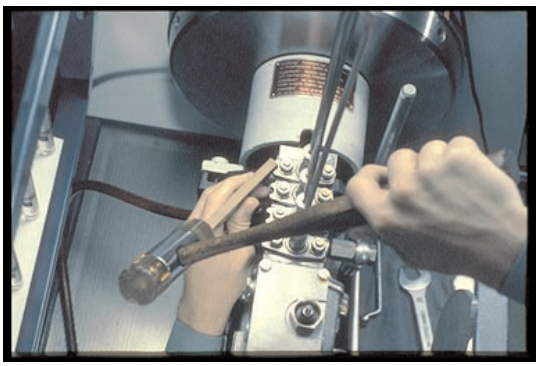
42. For any specified rack position, each plunger should produce a specific delivery.



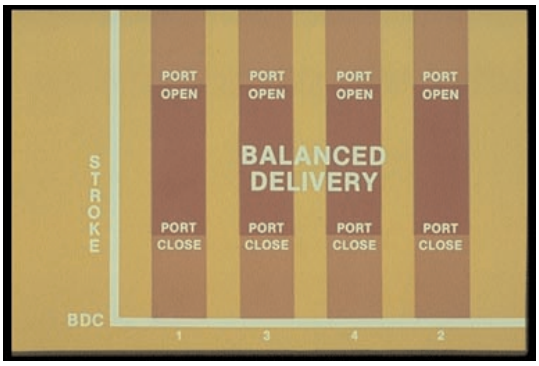
43. Fuel delivery is specified within limits; you're allowed a certain amount of "spread."



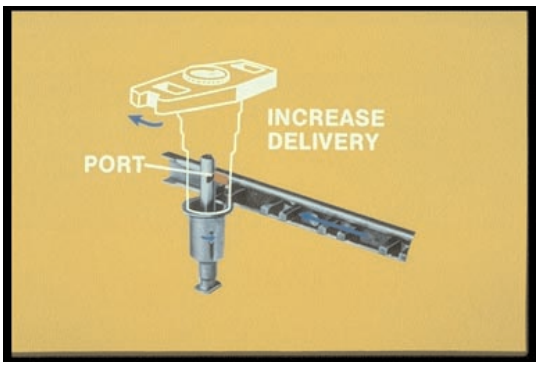
44. Notice how turning the port in relation to the plunger helix will change the fuel delivery by changing port opening. This changes the effective stroke. How is the port turned?



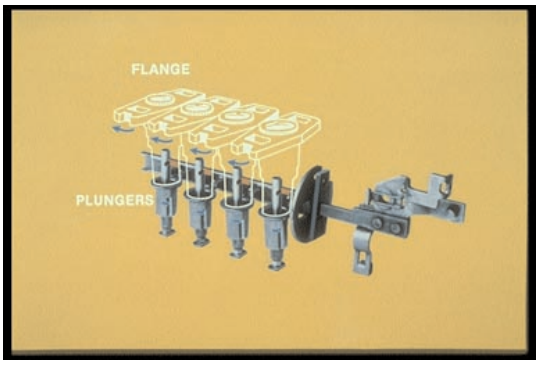
45. By turning the barrel. Turning the flange turns the barrel and so, turns the port, an integral part of the barrel.



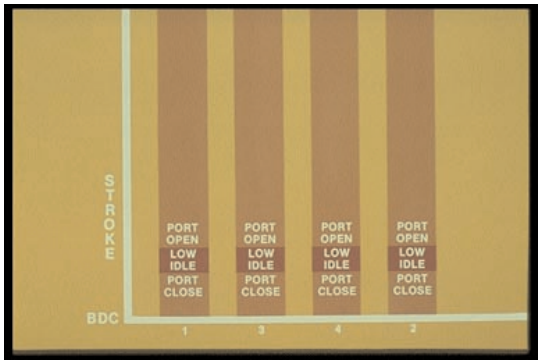
46. This is "balanced delivery," with the least spread. In turn, you can see how each plunger is port closing with the same lift, and how it is port opening with an equal effective stroke for equal delivery.



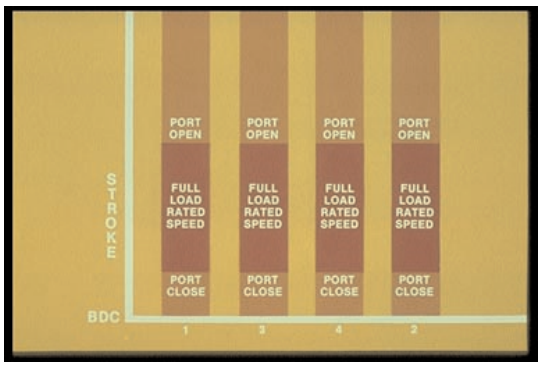
47. Let's see if we can put it all together. In calibration, to increase delivery, turn the barrel and port this way in relation to the plunger helix. In operation, the rack turns the plunger the other way in relation to the port.



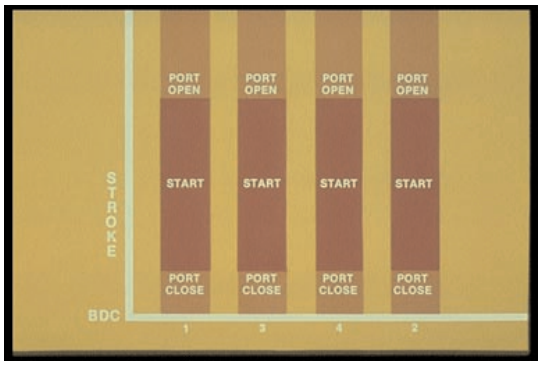
48. Think of it this way – turning any barrel and port changes that cylinder's fuel delivery. On the other hand, moving the rack turns all plungers the same and so, changes the delivery to all the cylinders. When you've balanced and calibrated a pump . . .



49. . . . port openings will terminate the effective strokes sooner at low idle for low fuel delivery. Compare this . . .



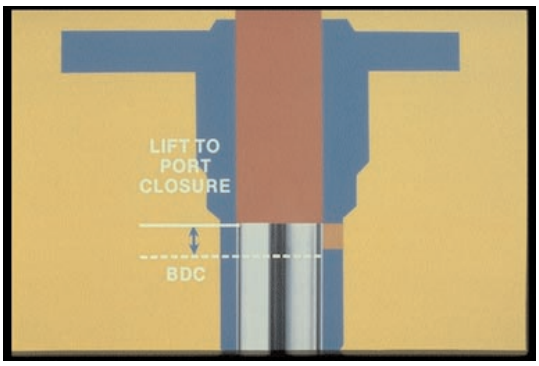
50. . . . to rated speed, where later port openings and longer effective strokes deliver more fuel to each cylinder.



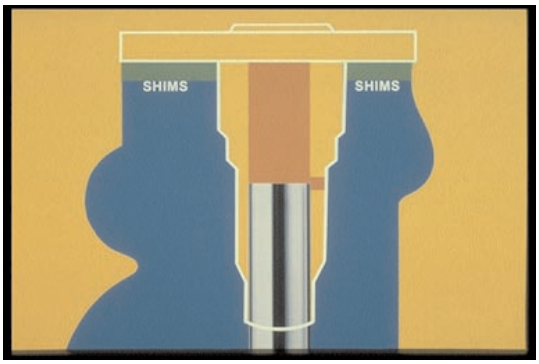
51. And compare it to starting, where the latest port openings give the longest effective strokes for the greatest fuel delivery. What are the results of such balanced delivery?

52. When fuel metering is correct, the results — hold it! Do these results look a little familiar? Right, good metering and good timing are both important for good engine performance.

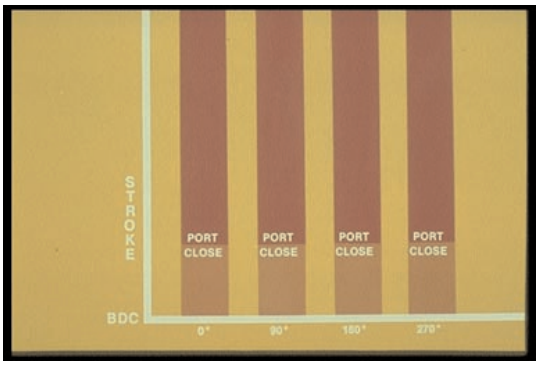
53. In this program, you've seen that pump delivery involves three jobs: to pressurize the fuel, to time the injections, and to meter the quantities delivered.



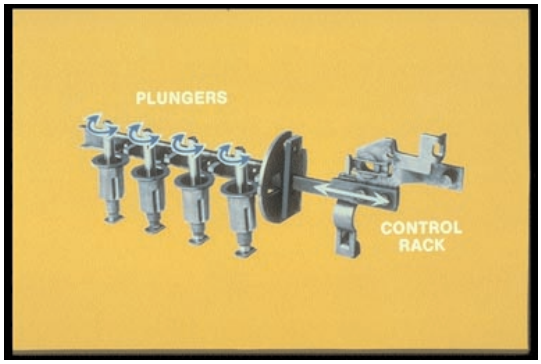
54. Pressurize the fuel after lift to port closure.



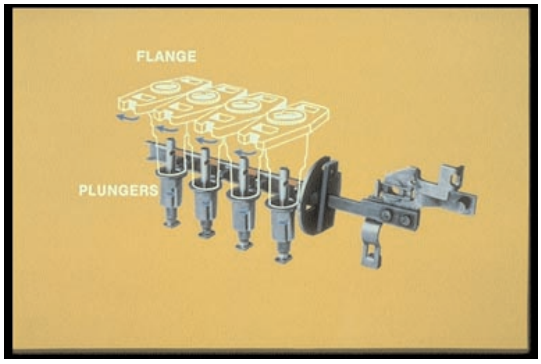
55. Lift to port closure adjusted by shims.



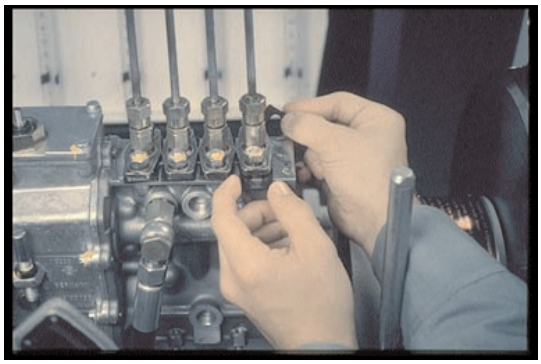
56. With port closure of number one shimmed to a specific lift, adjust shims for port closure at equal intervals for correct internal timing.



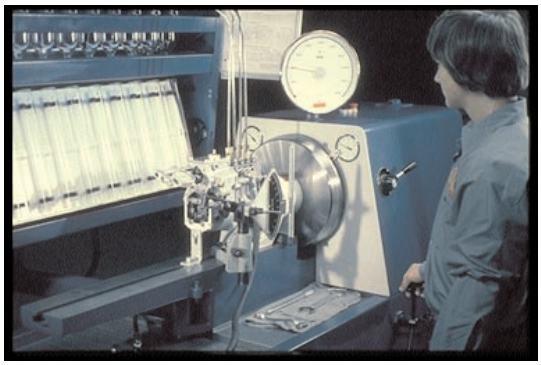
57. And you've seen how the pump meters fuel – how the rack turns all plungers together . . .



58. . . . how the flange turns the individual barrel and port in relation to the plunger to adjust the metering.



59. Your understanding of these operating principles . . .



60. . . . will help you in your servicing of the M-W pump . . .

61. . . . brought to you by Robert Bosch.

REVIEW EXERCISE ANSWER PAGE: MW PUMP OPERATION

1. presurize, time, meter
2. pressurize
3. lift to port closure
4. port closure
5. basic timing
6. shims, barrel flanges
7. phasing
8. effective stroke
9. helix
10. balanced delivery