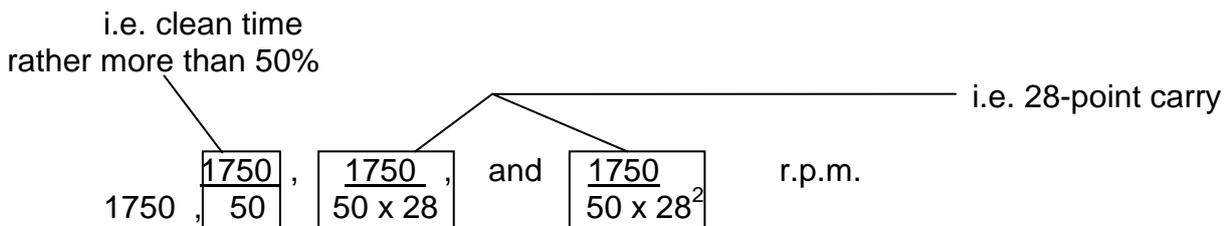


The physical shape of the bombe is roughly

The main body is divided into five decks, and the smaller part at the right into three. These latter contain (from top to bottom) : printer, brake, and motor-control relays and tubes. The lower deck of the main portion contains the main drive motor, the reversing motor, and the mechanical zero velocity switch. The depth taken up is about one foot.

The next deck is the largest - 30" deep - and houses the “E”(=ENIGMAS) machines and the gear system required to drive them.(1 bank, 16 enigmas) The sixty-four wheels are arranged in columns of four (for four wheel jobs), eight columns on each side of the bombe. All wheels move counter clockwise when the bombe is running “forward” with velocities respectively.



The gearing is direct from the very fast wheel to the next, but each of the other two transfers are through Geneva type systems. Brushes are solid and are wide compared to commutator segment gaps. (Brushes are stationary, commutators are on the wheels. The wheels are referred to as “commutators” at the Laboratory). The wiring from one brush-holder to another of the same “E” is permanent in the sense that 104 screws would have to be loosened to remove one brush holder, but a set of four brush-holders (i.e. 1 *enigma*) may be removed from the bombe by loosening twelve screws and removing four Jones plugs (i.e. 2 for input & output & 2 for *umkehrwalze*) - a two minute job. A clutch is provided to uncouple the slowest moving wheel (which is the left-most “E” wheel) for three-wheel operation. U wiring is in a lead between two Jones plugs, and is therefore changeable with no difficulty. *umkehrwalze* i.e. β or γ

In addition to the sixty-four “E” wheels, there are nine timing wheels. Four (*recording wheels*) of these keep the printer supplied with information as to the position of the various

wheels, and therefore run synchronously with the “E” wheels. Three are used to turn off sensing during transfer periods of the three slower wheels. Their velocities are

$$1750 \times \frac{26}{50}, \quad 1750 \times \frac{26}{50 \times 28}, \quad 1750 \times \frac{26}{50 \times 28^2} \quad \dots$$

These may be considered as having respectively 50, 28, and 28 segments, and as passing the same number of segments per minute as do the three faster wheels. Each sensing wheel must be in an “on” position before sensing actually takes place.

For the VF wheel	26 out of the 50 segments are “on”	}
For the F wheel	26 out of the 28 segments are “on”	
For the M wheel	26 out of the 28 segments are “on”	
While sensing is “on”		

Whilst sensing is “on” during running, one diagonal board column is examined for cold points i.e. non-energised. That cold points do not appear during passage from one segment to the next by the fast wheel is a result of bridging by the wide brushes. Sensing and input potential are thus left on for a full revolution of the fast wheel, and high frequency variations are avoided. (*i.e. circuit breakers only necessary on the slower wheels*)

When a cold point is found, the machine stops (in about 1/5 second), then reverses (for about 5 seconds) until it reaches the cold point position. The eighth and ninth⁽¹⁾ timing wheels are used here, in connection with a set of thyratrons, to stop the reverse movement at the correct position. The diagonal board is now examined, and the result printed if there is no contradiction. The main motor starts and the run proceeds. The total time from stop to start is nine or ten seconds. The machine stops at the end of the run, this being controlled by extra rings on four of the timing wheels. Total time is about twenty two minutes plus time for stops. The time for a three wheel run is fifty seconds plus time for stops.

The two decks above the main one contain the elaborate switches for connecting *enigma* machines to the diagonal board. The arrangement is such that each of thirty two Jones plugs (which are connected to machines) may be connected to any of twenty-six Jones plugs (which are connected to the diagonal board). (*i.e. auto-plugging of the 16 <*
inputs & outputs to the diagonal board)

The top deck is divided into seven sections, containing the various electronic and other automatic electric devices. (*sensing equipment*)

Each of the seven sections mentioned above, the printer, the motor control relay section, and the switch decks can be removed for replacement with no difficulty, since in each case the electric connection of the section to the rest of the machine is via Jones plugs. This has its obvious advantages in manufacture as well as in maintenance.

(1) *i.e. these wheels control the VF & F wheels of the enigmas*

Setting up a menu in preparation for running consists of the following :

1. Placing correct wheels on machine, in correct positions.

2. Setting thirty-two rotary switches, to connect the *enigma* machines to the diagonal board, or to turn off those not to be used. *These are by the enigmas*

3. Plugging diagonal board columns corresponding to menu letters to printer columns, except for one major chain column and one minor chain column. *i.e. Mammoth sensing by resistor board - but not during running.*

4. Plug "Primary" lead to one major column, and a printer lead to "Primary" plug, and a similar operation for a "Secondary" column. *inputs on two chains*

5. Set "Primary" and "Secondary" rotary switches to correspond to choices made in (4). *i.e. put current on input rows*

6. Plug "Neg" (input) lead to diagonal board. *i.e. choose searching point*

7. Turn on power, push start button.

The modification needed to make the bombe suitable for hoppity running is a re-wiring of brush holders *i.e. to make the R.H. wheel the slow wheel.* This would leave the machine unsuitable for three-wheel running. As yet no machine has been so modified.

Excerpt from letter from Cdr. Engstrum 30 August 1943.

I am enclosing a short write-up by Joe Bachus on the production Bombes. The complete write-up by Desch will not be in a finished state for some time. Until about two weeks ago we had a great many difficulties with the production models. These difficulties were tracked down and the principal sources of trouble seem to have been the brush bouncing and warpage on the high speed commutator. The difficulties were overcome by careful lapping and by building a heavier plastic base under the commutator segments. Twenty-five machines have been assembled and six machines have been running at Dayton. The building in Washington is now complete and the first equipment will arrive here on Monday. As soon as six are in operation here we will close down the operational aspect at Dayton.

Uncles separate for each enigma by wired or plugged Jones plugs.

Some were of the Mammoth type - i.e. only stopped for a story; and all had the complete stecker recorded.

Handwritten margin notes in the original text have been included above in italics.