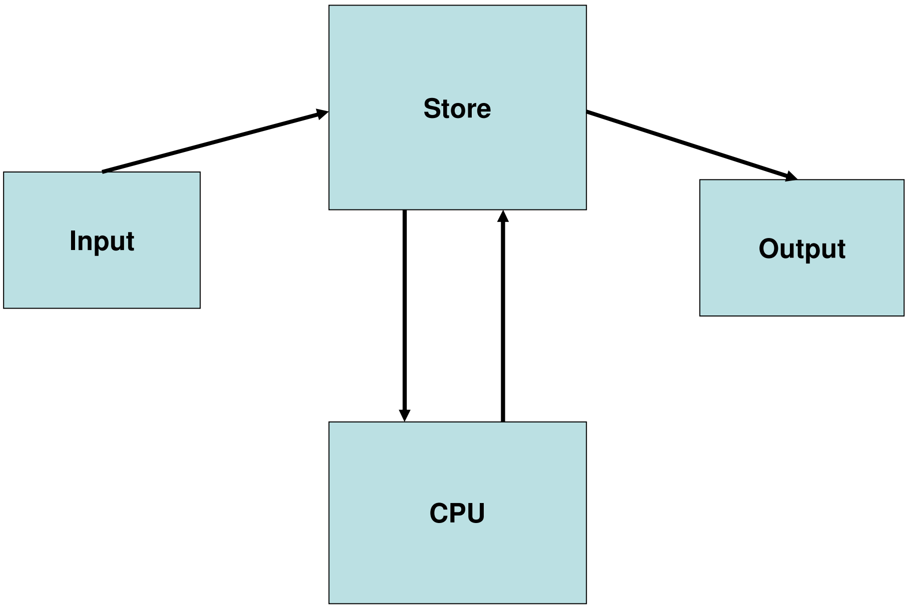
Glossary.

Basic concepts.
A general-purpose digital computer essentially consists of four sections, which are conceptually linked as shown below.



The ***input*** unit could be any device which represents alphanumeric symbols in a form suitable for their electronic processing inside the computer. The internal representation is most often based on the ***binary*** system, which requires only two symbols (conventionally represented as 1, 0). Information for computers of the 1950s was usually prepared on ***punched paper tape*** or ***punched cards***, which are then fed into the computer via a paper tape reader or a card reader. The presence or absence of a punched hole represents the binary states 1, 0.

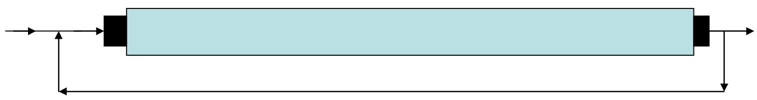
The ***output*** unit of a 1950s computer could be a ***teleprinter*** (a kind of electric typewriter), a ***paper tape punch*** or a ***card punch***.

The ***CPU*** or ***central processing unit*** is where the computation is actually carried out. It contains two sub-sections: an ***arithmetic and logic unit*** **(ALU)** and a ***control*** unit. During execution of a program the CPU fetches instructions one by one from the store and obeys them. In principle an *addition* instruction, for example, could require the CPU to fetch from the store the quantities to be added, then perform the addition, and finally return the answer to a designated location in the store. Many practical computers sub-divide the total addition process into three or more simpler steps. During computation, the CPU needs some temporary working space, each section of which is known as a ***register***. A register holds information as a string of binary symbols (abbreviated ***bits***). The ***accumulator*** is a special register whose main task is to hold the number resulting from each individual instruction immediately after it has been obeyed.

In computers of the early 1950s, the time taken to perform a single addition operation was usually a few ***milliseconds*** (10^{-3} seconds). Later developments achieved times of ***microseconds*** (i.e. 10^{-6} seconds). In 2012 the times are measured in ***nanoseconds*** (ie 10^{-9} seconds.

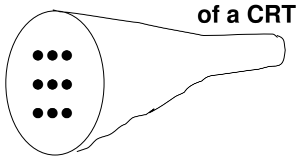
The ***store***, or ***memory***, is used to hold two types of information: firstly, the ***program*** or list of instructions prepared by the user; secondly, the ***data*** or facts which are required during the solution of a particular problem. A storage unit, capable of being 'written to' or 'read from' at electronic speeds, is crucial. Indeed it is, historically speaking, the main distinguishing feature of the modern computer, when compared with other aids to calculation.

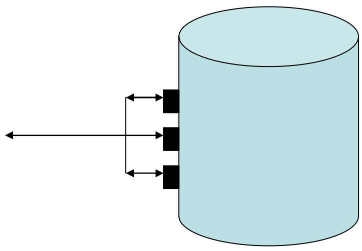
Early storage technologies: Delay lines, CRTs and drums.
One form of early computer storage depended upon the great difference in speed between electronic pulses and sound waves. Electronic pulses representing binary ones and zeros can be converted into pulses of sound, best though of as acoustic *shock* waves, by piezo-electric crystal transducers. In the 1950s the sound waves were often transmitted along a metal tube containing mercury, to be re-converted into electronic pulses by a receiving crystal at the remote end. This form of storage was called ***mercury delay lines.***



Simple representation of a mercury delay line store

Simple representation of a CRT store





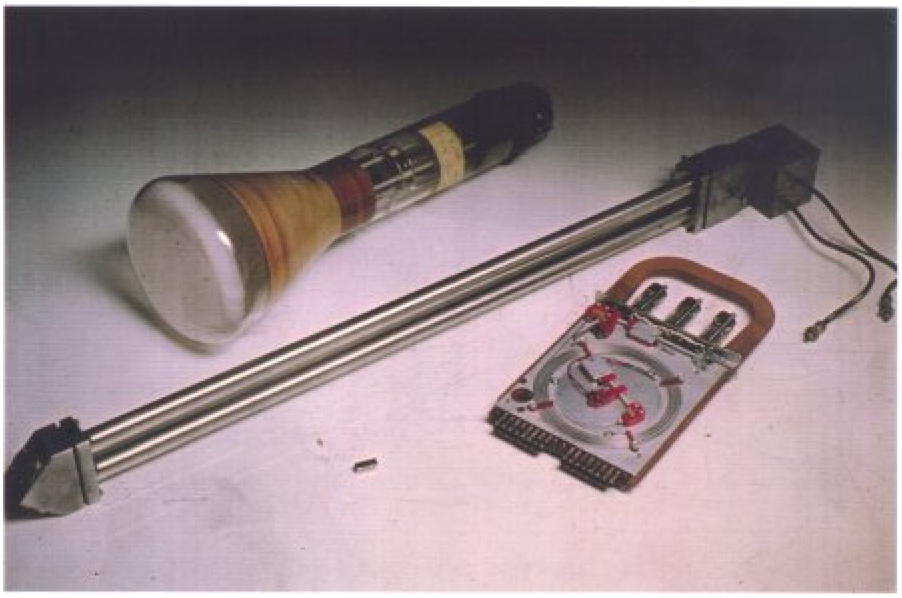
Simple representation of a magnetic drum store

Another form of delay-line memory used the magneto-strictive properties of nickel. The magneto-strictive effect enabled electronic pulses to be sent as acoustic shock waves along nickel wires. ***Nickel delay lines*** were more robust and cheaper per bit than the mercury delay line technology. The nickel delay lines were also more robust and more reliable than CRT storage (see below), but more expensive per bit.

Each sound wave took about one millisecond (one thousandths of a second) to travel along a tube of mercury about 5 feet (1.5m) long. If electronic pulses were produced every one microsecond (a millionth of a second) inside the main computer, then about one thousand such pulses, when converted to sound, could be ‘stored’ as they travelled slowly along the tube of mercury. Since the train of pulses travelled serially, one after the other, a programmer might have to wait some time before a particular binary digit emerged from the delay line and became available for use. Much ingenuity was exercised in reducing ‘wait times’ associated with serial access.

In a ***cathode ray tube (CRT) store***, a focused beam of electrons causes a glowing spot on the inner phosphor coating of a glass screen at the far end of the tube. At the same time, the area of the spot acquires an electrostatic charge from the electron beam. The charge gradually leaks away but can be re-generated by external circuits. The presence or absence of a charged spot at any particular place on the screen can also be detected by external circuits, via capacitive coupling to a metal plate on the outside of the tube face. A pattern of many spots can be ‘written’ onto the screen and can be detected or ‘read’ by the external circuits.

Each spot, or the absence of a spot, can be made to represent a binary digit. Other schemes, such as a focussed/defocused spot, or a dot and a dash, were also used to indicate binary ‘zero’ and ‘one’. By deflecting the CRT’s electron beam, each spot in an array of spots can be quickly scanned or ‘addressed’. The access-time is independent of the physical position of the spot. When used for computer storage, CRTs were known as ***Williams tubes***, or ***Williams-Kilburn tubes*** (after their inventors). By the end of the 1950s, Williams tubes had been superseded by storage systems based on small torroids (ie rings, or cores) of ferrite material. ***Core stores*** were cheaper per bit, more reliable, and had much faster access-times.



The upper left device in the photo is a CRT *Williams-Kilburn* storage tube from a Ferranti Mark I computer. In the centre is a mercury delay line from an English Electric DEUCE computer, where acoustic signals are transmitted down one tube and reflected back along the other tube. At the right is a package from a Ferranti Pegasus computer containing a nickel delay line register.

In addition to delay lines, CRT systems and ferrite core stores, there was also a need for a cheaper, more robust, storage technology capable of holding much large volumes of data. One way of providing this was via magnetic ***drum stores*** or ***disc stores***.

Electronic pulses can be made to record sequences of binary digits on a magnetic surface. The problem is how to read back these digits at high speeds. If a spinning disk or drum is coated with magnetic material, recording and reading heads can be placed close to the spinning surface and binary information can be 'written to' and 'read from' the surface. This is similar to the technology used in a modern computer's hard drive. The total storage capacity of a drum depends on many factors but mainly on the dimensions of the drum, the number of individual tracks of information arranged round the periphery and the closeness of adjacent bits in a track. Early drum stores were relatively ponderous pieces of equipment but they did provide relatively economic storage.

For more information …

For illustrated accounts of both the technology and the programming of 1950s computers, see the relevant sections of the book *Early British Computers.* This book is conveniently available on the web: http://ed-thelen.org/comp-hist/EarlyBritish.html