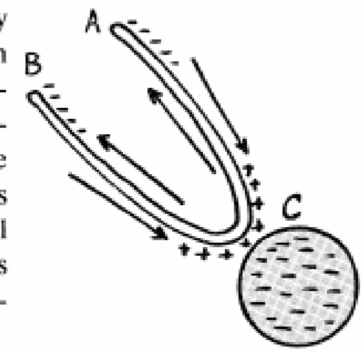
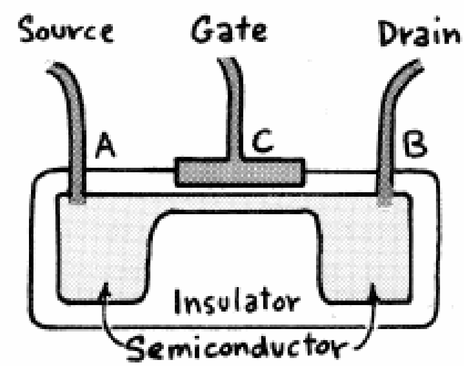
ANSWER: ELECTRIC PIPE

The answer is: a, even though it might seem that the electrons would be pushed back by the negative charge on **C**. The problem comes from picturing the wire as an empty glass tube through which little balls called electrons flow. That picture is misleading. If it were correct the answer to this question would be b. But in fact, the current in the wire will be as if **C** were not present.

What happens is that the electrons in the wire shield the inside of the wire from the influence of **C**. It happens like this: Consider only the wire and object **C** without the presence of **A** and **B**. Positive charge is induced in the part of the wire near **C** while negative charge is induced in the part of the wire away from **C**. This induced charge distribution sets up an electric field in the wire that exactly balances the field due to **C**. This happens by a momentary electron flow in the wire until the net electric field in the wire is equal to zero. Then further flow is nil unless an additional potential difference is established; which happens with the introduction of **A** and **B**.



Of course there must be enough free electrons in the wire to allow for a redistribution of charge to offset the effect of **C**. But suppose there are not enough free electrons in the wire. Then the wire could not be completely shielded from the effect of **C**. In practice there are always enough free electrons in a metal wire, but there are semiconducting materials like germanium which have relatively few free electrons. This situation is taken advantage of in the making of an electric valve called a *field-effect transistor.* The device allows the flow of a few electrons to be stopped by the presence of other electrons and works as is shown in the sketch: A semiconductor bridge joins two metal wires. Normally, electrons flow from the source wire across the semiconductor bridge to the drain wire. However, if another piece of metal called the *gate,* which is very close to but not touching the bridge, is made negative it repels electrons in the bridge. That stops the current and closes the valve.



Were the bridge made of copper this electric valve wouldn't work because the top of the bridge would get positive enough to shield the material below it from the negative charge on the gate. But in a semiconductor there are not enough free electrons to make the top of the bridge sufficiently positive to shield itself.

The idea of the field-effect transistor was developed in the 1920's but wasn't put into practice until the 1960's. There is another type of transistor called a *junction* or *bipolar* transistor. That type is described in most physics books.