soever. Second—We have the stop motion switch, which is operated by a travelling nut on an extension of the drum shaft, and stops the elevator at either limit of travel by means of a switch, which is practically a duplicate of the ear-switch. Third—The potential on the controller, which opens and cuts off current if the line voltage drops or whenever the slack cable or limit switches open. It is also operated by the ear-switch as heretofore described, and similarly by the stop motion switch. Fourth—The slack cable switch is usually located underneath the drum, and is opened mechanically whenever one of the cables becomes slack. This opens the potential switch circuit, stopping the machine. Fifth—Limit switches in shafts are so placed as to be opened by the car when it exceeds its normal limit of travel. They open potential switch circuit as before described, and act as a check on stop motion in case it gets out of adjustment. Sixth—Safety switch in car, which opens operating line, and hence potential switch, and shuts down elevator. This is for the benefit of the operator if car-switch should stick.

Where an emergency brake is used, safety switch operates this. Seventh—An auxiliary emergency brake is used on large machines, which acts when all circuits are opened from car-switch or main current fails. This gives increased mechanical braking at a time when dynamic braking action would fail. Eighth—Car safety, which is controlled by centrifugal governor and grips rails, stopping car at any predetermined speed.

The best form consists of a ball governor at top of the shaft, which grips governor rope at excessive speed. Governor rope is attached to car by a spring plug, which pulls out readily. A second rope is fastened to governor rope and then wound round the drum of the safety plank. When the governor rope is gripped, this rope unwinds the safety drum, and by means of right and left screws and toggle joints or wedges forces jaws of safety together until they cramp the rails hard enough to stop the car.

The governor sometimes operates a switch to stop the motor before grips go on. Ninth—An air cushion is sometimes used as a last resort, if everything else fails. Tenth—Slow-down switches in shaft are often used. They may automatically cut in an auxiliary shunt, winding on the motor as the car nears the upper and lower landings, so that limits of travel are approached at slow speed.

Although so many safety devices are required, they are comparatively simple in themselves and positive in operation. The general cause of accidents is the abuse of or neglect to care for them. Of course, you all know that trouble and accidents have occurred on all makes. It may be worth while to discuss them briefly and the means of prevention.

In the first place, there are a great many contacts about the controller of an electric elevator, and it is essential that they be kept clean and in proper adjustment. Contact pieces that have to carry heavy current should have ample bearing surface, and where such contacts are used to break currents they should have auxiliary carbon contacts, between which the final break and consequent arc occur.

In the controller of which I have spoken copper discs are used and set loosely on their spindles, so that they rotate during operation, and constantly present new surfaces to the contact pieces. A judicious use of emery cloth will keep these in order for a long time. Knife contacts, however, are very bad. I remember one time when I was called in to investigate an elevator accident. The controller was a cheap solenoid affair, with a double lever arrangement. The car rope turned a shipper sheave, which moved a lever and threw in the main switch, which in turn connected the solenoid and started the motor, the solenoid gradually cutting out the resistance. The switch blades happened to get bent and passed their clips, making a poor contact. The arcing set up fused the blades solidly to their clips, and the operator could not pull hard enough on shipper rope to release them.

The car came on down to the bottom, and as soon as the ropes slacked the mechanical slacked cable device was brought into play. This merely threw a clutch into gear with a pinion, meshing with a rack on the same old lever, and, as the switch blades still refused to let go, the gear was stripped of its teeth, the lever bent and the controller board smashed. The main line fuses blew out at this point and saved the rest of the wreck.

There were two bad features in that elevator: knife contacts and a mechanical slack cable device. The remedy prescribed was a new and better controller. Great care should be used to keep wires from becoming crossed or grounded, as almost any combination of circuits can be obtained by grounding wires, and it is impossible to foretell the result.

I know of one case where an armature grounded and a sudden flash occurred clear across the commutator. The startled attendant grabbed a fire bucket and threw its contents on the motor. It put out the fire, but it pretty effectually put the motor out of business and cost a new armature.

Another thing: If you disconnect the field terminals, be sure to get them back right. If you get the series field in opposition the motor will surely run away. Even a loose connection in the field circuits may cause trouble.

It is well to remember, too, that the ear is overbalanced for the sake of economy, and if you jack the brake off while making some repairs, and at the same time have the main switch open, the car had better be at the top of the shaft; otherwise it will soon get there, and it might not stop at the roof.

A great many accidents in which people have been hurt have been due to the car over-running the lower limit and breaking the counter-weight ropes at the top of the shaft and dropping the weights on the people below, when they would not otherwise have been hurt. This is easily prevented by having the weights securely bolted together by through bolts.

Sometimes hoisting ropes break and the car safety fails to operate. This cannot occur with a good governor, kept in proper condition. It would seem superfluous to say that all moving parts should be kept clean and well lubricated, and yet most of the wear and tear and a great deal of trouble is due to just this lack of attention. All the cables, but particularly the hoisting ropes, should be carefully inspected frequently, and if the wires of the latter show signs of cracking the ropes should be discarded. If they show wear on one side, observe how they lead from drum to sheave, or in case of B.D. ropes, from drum to vibrator. See that the vibrator shaft is so clean and well lubricated that the vibrator follows easily and does not lag behind, pulling the ropes off to one side.

I will touch on just one more point. The electric elevator in small buildings offers marked economy over other forms. No steam plant has to be run for its benefit, and it uses power only when it is in operation, and then proportionately to the load carried. With average load, it takes only the power required to overcome frictional and motor losses. In general, you might expect an automatic residence elevator to use about 1.6 k.w.h. per car mile, and a big passenger machine for a large office building about 3 k.w.h. per car mile.