In a chain hoist of any kind (where the word chain must be taken to include a hemp or wire rope), the first thing is to be sure of the chain or rope. If a chain be used, it should be of such strength that the ordinary load would not straighten the link out, even if it were cracked through. If wire ropes are used, there should be two, each capable of doing the whole work. The next point is the attachments. The author's experience is that more accidents arise from the breakage of the attachments than of the chain. The attachments should be considerably stronger than the chain, and, where practicable, should be tested with it.

Having secured a good chain and attachments, the next question is as to the safety of the mechanism by which the chain is hauled in, and the cage lifted. There is a certain risk attached to a chain or wire rope, which cannot be removed, but it will obviously depend upon the mechanism adopted whether other risks are super-added. The chain may be hauled in by machinery worked by hand, steam, air, gas, electricity, or water; but there is generally very little distinction to be drawn between the machinery used with the first five of these motive powers,—given the gear, it is simply a question as to what force shall drive it.

Accidents may happen to any of the mechanisms adopted, and some of the elements of risk, with these various sources of power, may here be mentioned

(*a*) Hand-power lifts are generally fitted with a brake apparatus, made up of several pieces, the giving way of any one of these would probably send the cage down with a run.

(*b*) The steam or air engine, in addition to the risk of breakage in the brake mechanism, is liable to breakage in the engine itself, and also in the gearing through which the power is usually transmitted, while the common practice of having clutches to throw the wheels in and out of gear adds a further risk of accident. Steam power is safer where worm gearing is adopted, and where steam is used for lowering as well as lifting, but this involves a great waste of power. In steam lifts there is also a considerable danger of accident from overwinding.

(*c*) The gas engine has all the risks attending the use of hand or steam power, and others besides, since, owing to the peculiar intermittent nature of its working, gearing is unsuitable for the first motion, and straps have to be used, which of all transmitters are the most dangerous. In a lift worked by a gas engine therefore, in addition to the necessary risk of a chain, there is the risk attending the use of driving straps and gearing in the working crab, and of brake gear, the possibility of overwinding, the comparatively long time occupied in starting and stopping, and also the extra strain on the whole of the mechanism due to the shock of the explosions.

(*d*) The application of electricity to hoisting is at present only in its infancy; but so far as attempts have yet been made to obtain motive power by this means, its application would appear to be subject to the same defects as the other methods that have been considered.

(*e*) Finally there remains hydraulic power; and it is obvious that one source of risk is at once removed by employing water-pressure, namely, that caused by the use of a brake apparatus, since in a hydraulic lift the descent is regulated by the speed at which the water used in lifting is allowed to exhaust. Water-power may be employed to haul the lifting chain through toothed gearing, or by means of straps, in which cases there still remain some of the risks inherent in the other systems, but by suitable arrangements all such mechanisms may be avoided, and the motive power may be obtained without in any way increasing the risk inherent to the use of a chain This condition of relative safety is only obtained by taking care that the pressure of water on the hydraulic ram is directly transmitted to the hoisting chain. If the power is so applied, any derangement of the mechanism would either mean the stoppage of the lift, or its gradual descent owing to the escape of water from the lift cylinder. In the possible case of a burst cylinder or pipe, the same condition would hold good; while the friction of the ram in the stuffing box would in itself perform the function of an automatic brake, in case of the too sudden escape of the contained water. The ram should also be provided with a positive stop, to prevent overwinding. The perfection of control obtained in hydraulic lifts is a further important element of safety. A single valve suffices for the control of all the motions of such lifts.

The form of hydraulic lift which most perfectly fulfils the above conditions for a chain hoist is that introduced by Sir William Armstrong and known as the Hydraulic Jigger. Figs. 3 to 6, Page 9 illustrate this, the simplest type of a high-pressure hydraulic chain lift. In Figs 3 and 4 the cylinder is horizontal, and the working pressure is therefore constant. There is a loss of effect in this hoist, in consequence of the weight of the chain being balanced when the cage is at the bottom, and unbalanced when the cage is at the top. This loss might be partially avoided by placing the cylinder vertical and making the ram work upwards, but this would involve balancing the ram, otherwise it would increase the risk of accident; for, if the cage got fast, and if the valves were open to the exhaust, the ram might descend without the cage, and the cage might afterwards become suddenly released and fall. The lifting chain is sometimes balanced by letting the cage carry a loose chain below, which is coiled on the ground when the cage is at the bottom, and which is picked up by the chain as it ascends.

Fig. 6, Page 9, is an illustration of a hydraulic jigger hoist suitable for moderate pressures. The ram A is inverted, and its weight partly balances the weight of the cage B. The chain C is attached at one end to the cylinder, at the other to the counterweights W. From the counterweights two wire ropes R are led to the cage, each being of sufficient strength to carry the weight The author's experience is that wire ropes are not so reliable as chains, and that it is desirable where practicable to use duplicate ropes. In this hoist it will be observed that, owing to the inverted position of the ram, there is a greater head of water at the end of the stroke than at the commencement. But, as the lift is constructed, there is no loss of effect from this cause; for, the chain being more than twice the weight of the wire ropes, this extra weight assists the ascent of the cage at the commencement of the stroke, and thus compensates for the variation in head of water.

The hydraulic jigger is not generally applicable except for high working pressures; and high pressure water is only occasionally available. Unfortunately therefore it is often necessary to depart from the beautiful simplicity of the apparatus. The best arrangement in such a case is to adhere to the hyd-