

## The Pringle and Kirk four-bar crossed linkage and the "safety-knee"

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### Introduction

Historical literature on prosthetics is not large compared to other specialities, and there is relatively little written about the men at its origins. It is worth recording some of these men and their times.

Alexander Pringle (Fig. 1) was born at Bessbrook in Northern Ireland in 1880, where his father was the manager of a large spinning mill. His two brothers became doctors, but Alexander escaped to become an engineer, serving his apprenticeship in Belfast and



Fig. 1. Alexander Pringle.

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Manchester. He was also lucky to have two sisters who married into the Mackie family, which owned a large textile machinery manufacturing firm in Belfast, that still exists today. As was fashionable in those days, he sailed for the United States in 1911, to be employed by GEC, and subsequently the Revere Rubber Company. This was a time when America was forging ahead with mass production methods, and young Alexander learned engineering from the floor up. His expertise came to the attention of James Mackie when he returned home in 1913. There was a whiff of war in the air, and he was engaged to reorganise the tool-room of the family firm in Belfast on American lines. He did this with remarkable success and in the 1914-1918 war Mackies played its part in making munitions.

It was at this stage that fate directed Alexander Pringle into an involuntary interest in prosthetics. There was at that time an eminent and successful, if eccentric, surgeon known as 'Surgeon Kirk' in Belfast (Fig. 2). Surgeon Kirk was invited to London in 1917 to discuss the problems of the amputees from the dreadfully mutilating war in Europe. He was not impressed by the artificial limbs provided at that time, and decided to change the situation. On returning to Belfast, he berated his friend James Mackie on the poor contribution engineers were making to the suffering imposed on limbless soldiers by the munitions they were manufacturing. There is little doubt that James Mackie's conscience was pricked, and he donated the part-time services of his best man, Alexander Pringle.

### *The P & K arm*

Surgeon Kirk and Alexander Pringle started by designing an artificial arm. In just over a year, they researched, designed, tested prototypes and were in mass production with their P & K



Fig. 2. Surgeon T. Kirk.

artificial arm. Undoubtedly, most of the expertise lay with Alexander Pringle (James and Orr, 1983).

Patent No. 114,220 (1918) related to their hand with a 'four finger' grip (Fig. 3), produced by a cable pulling through a 'D' shaped spring by

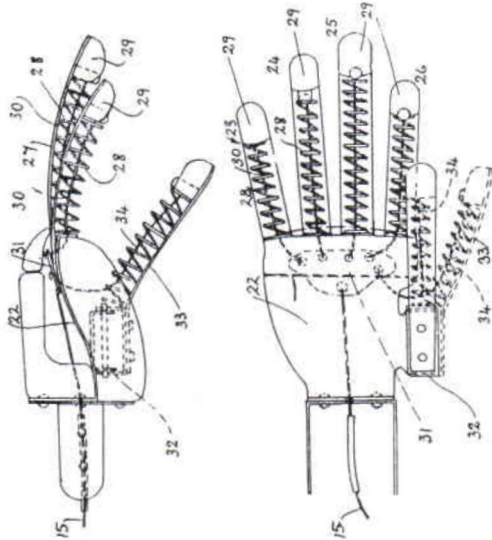


Fig. 3 The P & K hand. Patent no. 114220.



Fig. 4. Sergeant Major Cox,

means of a ratchet lever at the wrist. There were three other patents relating to upper limb prostheses.

They were lucky to have as one of their first patients a Sergeant Major Cox (Fig. 4) who lost his arm in France in 1918. A fine looking military man, with a waxed moustache, who became adept with his P & K arm, he could use a hammer, doff his hat, grip a glass of water, and even lift a boy seated on a chair. He was a natural choice to head their sales team. Pringle and Kirk were in business. Their first contract was to supply 500 artificial arms to the Ministry of Pensions for limbless ex-servicemen. The P & K Artificial Limb Company was born with headquarters in Belfast, and branches in Glasgow, Southampton, New York and Melbourne.

#### *The 'safety-knee'*

Pringle did not rest on his laurels, and carried on with his prosthetics research, turning his attention to the lower limb, no doubt because there were 41,000 ex-servicemen with lower limb amputations.

Until the 1920's the common form of knee joint was a simple hinge. In 1921 an advertisement appeared in the newspapers which read:

'Something new in Artificial Limbs.'

'The knee joint automatically locks every time the weight is taken on the artificial leg.'

In other words, the 'safety-knee' had arrived, by courtesy of Pringle and Kirk.

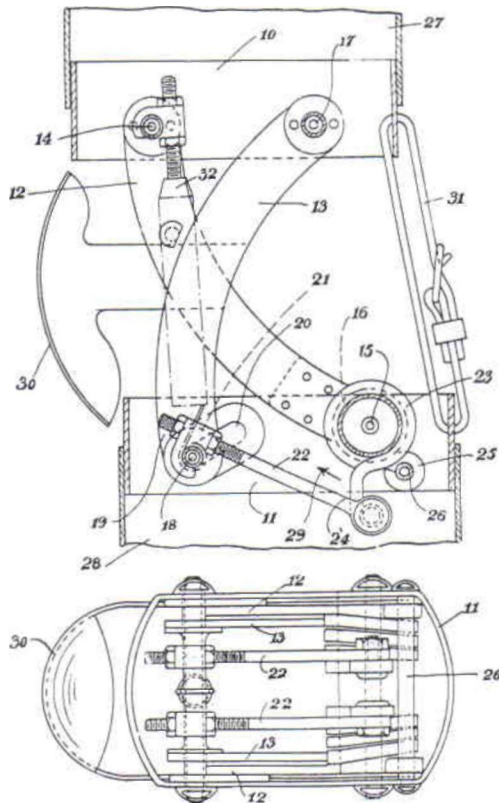


Fig. 5. The safety-knee. Patent no. 184511

Patent No. 184,571 (1922) was taken out for this device. The engineering drawings show the locking device acting on a crossed four-bar linkage, with a cosmetic knee-cap (Fig. 5). The Patent states:

'It has already been proposed to construct a knee joint comprising cross links. It has also been proposed in relation to other types of knee joints, to construct the joint with spring frictional means for automatically locking the joint under pressure of the wearer, the spring means re-enacting to release the frictional locking action when the pressure on the limb is relieved. It is however novel to combine a knee joint of cross-linked construction with spring action frictional means for automatically locking the knee joint under pressure of the person wearing the limb, the spring means re-acting to release the frictional locking action when pressure is relieved.'

Patent 150,901 (1920) shows a limb construction using a lattice-work. It said:

'At elbow, wrist, shoulder, or knee or other joints the crossed links connecting the cross frames or rings may be pivotally connected with the cross frames or rings, and be free to move relatively to each other so as to allow the structure to be moved in such manner as to simulate the movements of a human joint.'

It would seem that he was moving towards a 'four-bar' linkage of the 'crossed' type, although 'open' linkage is now more common (Radcliffe, 1970).

The present Pringle family well remember that one of the prototypes of the 'safety knee' failed, the wearer had an unfortunate gait pattern, and was subsequently arrested by the police for being 'drunk and disorderly'.

Pringle became Managing Director of the P & K Arm Ltd. in Belfast, and Surgeon Kirk continued with his wide interests. Kirk firmly believed, in a time when antibodies were the vogue, that dried serum from elderly cows and horses was the answer to infections and other ills. Were you honoured to have tea with him at the Royal Victoria Hospital in Belfast in the 1920's, your sandwiches might well taste gritty from the powdered serum put there for your benefit. Pringle assisted in the project by inventing a motorised 'pill making' machine which was installed in a bedroom of Kirk's elegant home. Private patients visiting the house were disturbed by the vibrations of the machine, and it was christened 'the flying bedstead'.

Competition in the prosthetics field was fierce in the 1920's and Pringle and Kirk were better inventors than business men. P & K Arm Ltd. slowly failed, Pringle returned to James Mackie and Sons Ltd. in 1937, no doubt to prepare for the next war, and P & K Arm Ltd. closed.

Pringle was a brilliant engineer. A quiet and thoughtful man who retired in 1949 to take up gardening, archaeology, geology and bee-keeping, and died in 1959. Kirk was an enthusiastic surgeon and a colourful character, who retired in 1938, and died in 1940, probably of boredom, for he was an energetic man. Three P & K arms remain in the Rehabilitation Engineering Centre at Musgrave Park Hospital in Belfast as a reminder of Pringle and Kirk.

Belfast is well known in this day for an unruly element in its population. It should not be forgotten that it is a University City and a seat of learning. Not least, it is the home of the Ferguson tractor, John Boyd Dunlop's

pneumatic tyre, the 'hover-jet', the four-bar crossed linkage, and the 'safety-knee'.

#### Acknowledgement

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