A mechanically-actuated wave mattress

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Abstract

A polio victim who has been in a negative pressure ventilator ("iron lung") since 1950 was in need of an activated mattress to combat the hallucinatory effects of complete immobilization and to assist with body pressure distribution. A mechanical method was used to give the patient's mattress a moving wave form of vertical amplitude 50mm with a period variable from 50 seconds to infinity. His arms rested on separate supports which oscillated 180 degrees out of phase with the trunk support. The device is powered by a 12 volt electric motor operating through two mechanical reduction gear units. It differs significantly in design and purpose from pneumatic ripple mattresses.

Details of bed design

The bed consisted of a T-foam mattress of basic thickness 75mm laid on a base made of eight 5-ply wooden planks 12mm thick. The plan view of the planks is shown in Figure 1. The width of each plank (other than 1) is 216mm. Adjacent planks were hinged together by stapling 50mm wide seatbelt webbing to their upper faces along their common edges.

Beneath the planks a long carriage (Fig. 2) was made to oscillate horizontally with an amplitude of 216mm in the direction of the long axis of the bed. The carriage was supported on six polyurethane wheels with ball bearings (skateboard type wheels) which ran in two aluminium channels that served also as the main frame of the system. The carriage was provided with an array of similar free wheels on its upper face, and these supported formers or cams attached to the under sides of the bed planks (Fig. 3):

As the carriage moved back and forth the formers rode over the free wheels. The shape of the formers and the spacing of the wheels caused the planks to oscillate vertically with different phases. The effect was to make the wave form in Figure 3 travel to and fro at the same frequency as the carriage. The out-of-phase movement of the arm planks was achieved by providing these planks with their own.
formers and shaping them appropriately. For clarity the arm planks and their formers and wheels are omitted from Figure 3.

By reducing the depth of the formers towards the head of the bed the vertical amplitude was gradually reduced from 50mm at the foot and centre to zero at the shoulder line. This was necessary because the patient’s neck must remain centred in the diaphragm covering the iron lung aperture.

Plank 1 at the head end of the bed was bolted to brackets (Fig. 3) which could be moved up and down by the usual vertical control mechanism of an iron lung bed. Lateral movement of the foot of the bed was prevented by a fixed vertical plate which fitted snugly between two parallel plates mounted on the under side of plank 8. To ensure smooth operation the system of planks was kept under tension by a strong spring pulling plank 7 towards the foot of the fixed supporting frame (Fig. 3).

Driving mechanism

A 12 volt, 1800 RPM “pancake” electric motor was mounted on the frame of the carriage. Power was provided by a lead-acid battery located outside the lung.

Two reduction gear boxes were also mounted near the foot of the carriage, the first being an infinitely-variable-speed unit and the second a 53:1 reduction unit.

A crank of 108mm throw was mounted on the output shaft of the second drive unit. A connecting rod linked the free end of the crank to the foot of the main supporting frame. Rotation of the crank caused the carriage to oscillate longitudinally with the required amplitude of 216mm.

By moving a lever attached to the first gear box its reduction gear ratio could be varied. The lever was accessible to an attendant through a porthole in the side of the lung. Its use enabled the period of oscillation of the wave mattress to be varied from 50 seconds to infinity.

Upholstery and finish

At the patient’s request the thickness of the T-foam was increased beneath his knees, and was reduced beneath his sacrum to relieve pressure. A cut-out was made in the T-foam to accommodate a urinary bottle which was given an upward tilt by allowing its lower end to drop through a cut-out in plank 5 (Fig. 1).

The T-foam on the arm planks was separated from that supporting the torso to permit independent movement of these areas. A deep channel was formed in the T-foam of each arm support to ensure that the arms did not fall off the edges of the bed. The various pieces of T-foam were glued to the tops of the bed planks and upholstered with waterproof “60-40” cloth (60 per cent cotton, 40 per cent nylon).

The sides of the wave mattress were provided with shields of 20-gauge galvanized steel sheet along the whole length of the bed. A Terry cloth covering the upper surface of the mattress was attached by Velcro strips along its edges to similar strips riveted to the shields on both sides of the bed. This arrangement encased the mechanism and ensured that the patient’s clothing and bedding could not become caught in it. Figure 4 shows the completed unit.

Fig. 4. General view of the completed wave mattress, with Terry cloth cover lifted to reveal mechanism.

Conclusion

The system described differs significantly from pneumatic ripple mattresses in common use. It is a reliable method of providing a bed with a moving wave profile of variable period. It would be applicable to standard hospital beds, where the absence of the severe space restrictions of an iron lung would make it a relatively simple matter to design.

BIBLIOGRAPHY
