# XLVIII AN EXCELLENT INEXPENSIVE CONSERVATION OF MOMENTUM APPARATUS.

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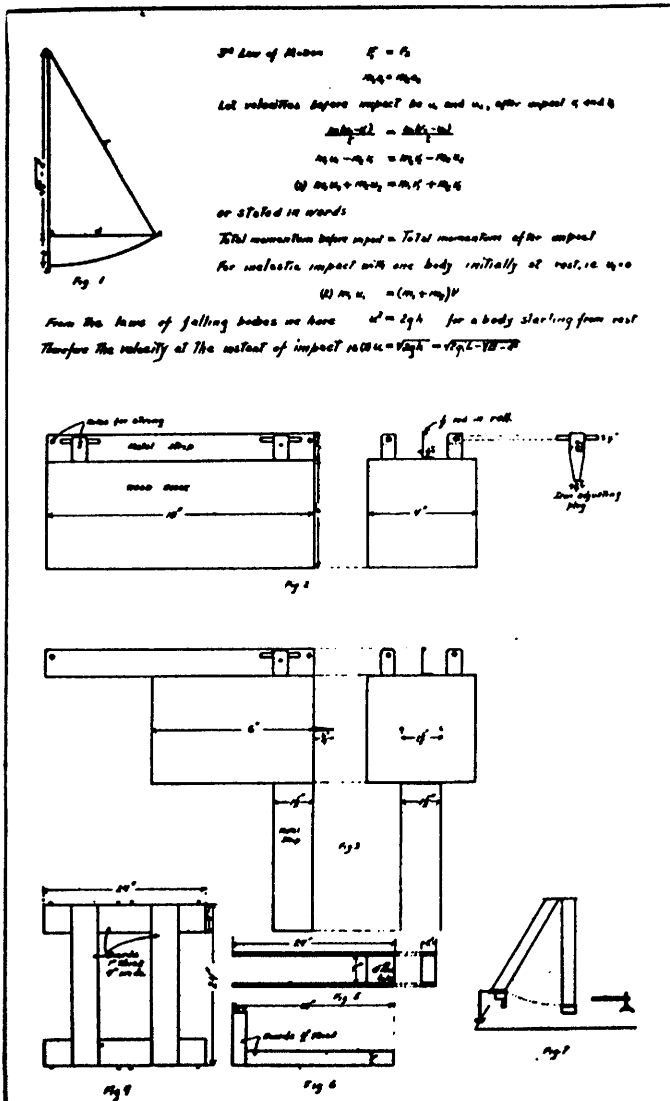
Every school in which physics is one of the subjects taught, should possess apparatus for studying conservation of linear momentum. The principles underlying its use are of fundamental importance and the mathematics involved in a complete understanding of the principles has been covered in high school algebra and geometry, by the average high school senior. The chief difficulty in dealing with this law in the laboratory has been the high price of the type of apparatus offered by the scientific supply companies. And when once obtained, the apparatus was found to be very heavy and inconvenient for the average laboratory, very difficult to adjust and very inefficient in the hands of the average student. In order to meet these difficulties I did some experimenting at the University of Oklahoma during the summer of 1924. Dr. Wm. Schriever, also of the University of Oklahoma, suggested that I try large wooden blocks suspended from the ceiling. The increased dimensions would reduce the error made in the measurments and by using four suspending strings for each block the adjustments could be made very simply but very accurately. Having set up a rather crude apparatus I was happily surprised to find that good results could be obtained easily; the measured momenta before and after impact differed by less than one percent. Only five measurements were necessary for the case of inelastic impact with one body initially at rest: the length of the pendulum, the mass of each block, and the horizontal distances through which the blocks swung before and after impact.

The apparatus, as made in the shop of the physics department, is shown in detail in the drawings. Fig. 1 is a diagram to accompany the derivation of the equations to be used. Equation (3) gives the method of finding both $u_1$ and v of equation (2). In order to measure the horizontal distances swung by one block before impact and by the two blocks together afterwards, a level table, a meter stick, a square (Fig. 6) and a support for a paper rider (Fig. 5) were used. Fig. 7 is a miniature of the arrangement just before the block is allowed to swing. The first d is measured under these conditions and its value substituted in equation (3). This will give the velocity of the small

## PLATE X.




**Impact Apparatus for Studying the Law of Conservation of Momentum.**

block as it strikes the other block. The metal points in the small block hold the two together after impact. The metal strips below the small blocks shove a paper rider along the support as the two blocks swing up the arc together. The second d is measured from the right edge of the metal strips below the small block when the two blocks are stuck together and hanging at rest, to the position of the rider after the first swing. This d substituted in equation (3) gives the V of equation (2). L is measured from the axis of support at the ceiling to the eyelets in the metal strip on top of the blocks. This should be the distance and not necessarily the length of the supporting strings.

The plan of the large block is shown in Fig. 2 and that of the small block in Fig. 3. The metal strips were the same for both blocks and were made out of galvanized iron with a roll at the top to stiffen the piece and a half inch bent over at the bottom as a means of fastening the strip to the block. The strips were nailed to the blocks. The large block had four adjusting plugs and the small block, two. These tapered plugs are set in tapered holes in top of the blocks. The supporting string from the ceiling passes thru the eyelet to the plug. A slight turn of one plug would throw that corner of the block to one side. Turning all the plugs would raise or lower the block. By this means the two blocks were easily and quickly lined up.

Fig. 4 shows a frame that was permanently fastened to the ceiling. Loops in the ends of the supporting strings are put over the nails in the sides of this frame. There are eight nails in each frame and four of these nails and four strings are used to support each block. A good quality of string was used. The frame was made larger in order to increase the stability of the block and the sensitivity of the adjustment.

This apparatus has been found to be extremely satisfactory. The cost would be very little even if a person paid for having all the parts made, but with a few tools and materials that can be found around almost any shop, the whole apparatus can be made in a few hours. We recommend its use wherever a laboratory experiment on conservation of momentum is desired. A variation of the experiment of testing the law would be to measure the velocity of a rifle bullet fired into the blocks with the strips below. In this case $m_1$ is the mass of the bullet, $u_1$ the velocity to be determined and V is found as before by measuring the horizontal distance swung after impact and substituting it in equation (3).