COMPOUND HARMONIC MOTION APPARATUS.

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This apparatus has given excellent satisfaction, as we may judge from the accompanying figures produced by it.

There is nothing new in the method of suspension, but the mechanical device for tracing the figures and making them permanent, I believe, to be entirely new. I would be pleased to know if anybody has ever made use of it before.

FIG. 1.

The apparatus consists of a sixty-pound cannon ball suspended from the ceiling by two brass wires. A convenient clamp that holds the wires firmly and securely together determines the ratios of vibrations. The clamp is of such construction that it will never allow a wire to escape and yet allows full freedom of motion up or down when the screw is slightly opened. A hole is drilled into the bottom of the ball and this filled with a plug of

soft wood. Into this is driven a ten-inch piece of brass tubing just large enough to allow a pencil to slide up and down very freely, Fig. 1, but without any undue side motion. If necessary a thin collar may be put on the pencil so as to fill the tube. The pencil is notched near the point and a trigger attached to the

FIG. 2.

end of the tube prevents the pencil from falling, and releases it at will, when the ball has the proper motion, thus avoiding irregular and oscillatory tracings as long as the ball is wobbling. The pencil, Fig. 2, is released when the motion of the ball is entirely steady. It is also advisable to do this when the two motions are more or less in turning phase; that is, when the ball is moving very slowly.

The figures are traced by the pencil on smoked paper. A soft pencil will trace very slight figures on white paper, and this I tried first; but the paper I use in

connection with our seismograph gave me a new idea.

The seismograph records the motions of the earth on a belt of smoked paper eight inches wide by thirty inches in length. These papers are smoked over a broad lamp and are made to pass over the smoking flame by means of revolving cylinders. When the figures are traced on the paper, the carbon is fixed by dipping the paper into a solution of shellac. This gives you figures that can be kept for reference and that show side by side the changes produced by a change of phase.

The way I get the ratios is this. I first count the exact number of vibrations per minute of the whole pendulum. After this I calculate the number of vibrations per minute required to

get the ratios wanted. Then I sit alongside the pendulum, make the short end oscillate at right angles to the long swing, and lower or raise the clamp until I get the number of oscillations wanted. This may take from ten to fifteen minutes. The oscillations are best counted by holding a thin wire in your hand and allowing the ball to touch it at every turn, thus leaving your eyes free to follow the second hand of your watch.

For each ratio I measure the height of the clamp above the ball and record it. Once this is done, any ratio can be had without loss of time by simply moving the clamp to the required height. Care must be had to raise the paper according to the height of the pendulum, which varies as the clamp is moved up or down. If the pencil has to fall too far, the point may be broken or blunted. Instead of smoked paper, smoked glass may also be used. The smoking must not be too thick, otherwise the lines will not be smooth. The even and uniform smoking of paper or glass is a matter of experience.

Different authors that use a similarly suspended pendulum as an illustration of compound harmonic motion, tell you to take a funnel full of sand; or fix a point on the lower end of the ball and cover the floor under it with fine sand, so that the point may trace the figures into it. This sand must be made concave, so that the point will touch everywhere evenly. Tyndall, in his eighth lecture on sound, describes another form of the same pendulum where he used a hair pencil to trace the figures on a glass

plate covered with white sand. But his system of producing the compound motion kills the amplitude too rapidly. Last year a friend of mine used a chemical separating funnel containing a colored liquid the flow of which was regulated by means of a stop-cock.

If one examines the construction of this apparatus he will see that the sliding of the pencil up and down the brass tube overcomes the difficulty of tracing a figure on a flat surface with an instrument that moves in a curve above it. The friction of the weight of the pencil against the paper; and that of the point on the paper and of the side of the pencil against the tube is so slight that the heavy ball will lose its amplitude very slowly. The trigger that holds the pencil is made from the same brass

wire as the suspension. It is made in such a way that the long ends will pass on either side of the brass tube when raised and stay there, so as not to cause extra friction by pressing against the pencil. The pictures show clearly the two positions.

If the ball be suspended by a single wire it will in the same way trace the figures of simple harmonic motion.

I hope this will prove interesting to some of the readers of *SCHOOL SCIENCE AND MATHEMATICS*. Later on I may describe some other simple apparatus that I have found to be very efficient for the illustration of first principles.

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During the first two or three weeks of September the campus of a college looks more like a railroad freight terminal than a quadrangle of a seat of learning. The campus is a vast jungle of trunks, suitcases, bags, and furniture. Every available wagon in town is pressed into service. A Princeton student saw the possibilities in an express company managed by students and catering entirely to their own fellows. In 1905, the Princeton Express Company was organized by a senior who was working his way. He hired a wagon and called for five "huskies" to act as assistants. Over forty applied for the job. He paid \$2.00 a day and a man cleared from \$20 to \$30 before college formally opened. The enterprise is now making a handsome profit for the president and officers of the company. At the end of the college year in June there is a repetition of the freight terminal scene, and the Students' Express Company reaps another harvest.—*Review of Reviews*.