and assist chemists and medical research workers in their humane endeavors, for in this field no less than in others the laborer is worthy of his hire. No one familiar with the situation in this country in the early days of the war can fail to understand the seriousness of the present attack upon chemotherapeutic research.—Frederick A. Mason, College of Technology, Manchester. *The London Times.*

SOCIETIES AND MEETINGS

THE NORTH CAROLINA ACADEMY OF SCIENCE

THE twenty-ninth annual meeting of the North Carolina Academy of Science was held at Duke University, Durham, on May 9 and 10. Papers were presented before the general section of the academy on Friday morning and afternoon. Following the presentation of papers and the business meeting on Friday afternoon, Duke University served the academy a picnic supper on the new Duke campus. Friday evening the retiring president, Dr. J. B. Derieux, professor of physics at State College, gave his presidential address on "The Corpuscular Theory of Radiation and the Wave Theory of Matter." After this an informal reception was given the academy by Duke University. Saturday morning the academy met in the following sections: General section, chemical section, mathematics section and physics section. Seventy-seven papers and five exhibits were on the program. (Abstracts of most of them and complete papers of several will appear in an early number of the *Journal of the Elisha Mitchell Scientific Society.*)

The executive committee reported the election of thirty-four new members during the year and the reinstatement of four former members. Dr. F. P. Venable, professor of chemistry of the University of North Carolina, was made an honorary life member as a token of appreciation for his services to the academy, to science and to his state. Dr. Venable has been a member of the academy since the year of its origin, 1902, and is this year retiring from active duty after fifty years' service at the University of North Carolina (professor of chemistry, 1880–1900; president, 1900–1914; professor of chemistry, 1914–1930). Two hundred and twenty-eight registered at the meeting.

Mr. Calhoun Pruitt, a student of the Monroe High School, was declared the winner of the High School Science Prize, a silver loving cup, for the best essay presented by a high-school student. Essays for 1930 were confined to the fields of chemistry and physics.

The officers elected for the year 1930–31 were:

GENERAL ACADEMY

President, W. F. Prouty, University of North Carolina.
Vice-president, P. G. Ginnings, Greensboro College.
Secretary and treasurer, H. R. Totten, University of North Carolina.
Executive committee, the above officers and F. A. Wolf, Duke University; Bert Cunningham, Duke University; W. L. Porter, Davidson College.
Representative to the A. A. A. S., W. C. Coker, University of North Carolina.

CHEMICAL SECTION

Chairman, T. A. Bigelow, Duke University.
Vice-chairman, A. J. Wilson, State College.
Secretary-treasurer, H. D. Crawford, University of North Carolina.
Councilor, L. G. Willis, State College.

MATHEMATICS SECTION

Chairman, W. W. Elliott, Duke University.
Secretary, E. L. Mackie, University of North Carolina.

PHYSICS SECTION

Chairman, A. A. Dixon, State College.
Secretary, W. E. Speas, Wake Forest College.

The thirtieth annual meeting of the North Carolina Academy of Science will be held at State College, Raleigh, in the spring of 1930.

H. R. TOTTEN,
Secretary

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A BELT PAPER KYMOGRAPH WITH A THREE SPEED GEAR SHIFT

THE recent appearance in SCIENCE[1] of an article describing a commercially built kymograph with a multirange gear shifting device has prompted the writer to describe a kymograph provided with a speed reducer and a gear shifting device which was built by junior and senior college students in mechanical engineering.

For more than a decade the writer has been interested in belt paper kymographs and has frequently studied published diagrams as well as observed those in operation. Therefore, about four years ago when called upon to design an electrically driven belt paper kymograph it was thought best to construct the machine as herein described.

[1] Porter, Roy and Vianey, "An Electric Kymograph," SCIENCE, 71: 41, January 10, 1930.

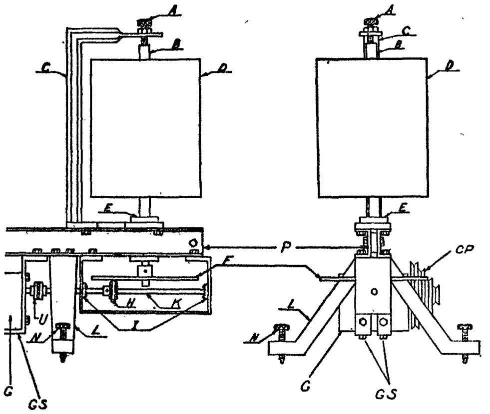

FIG. 1

The frame consisted of two 1 x 2 inch channel irons, Fig. 1, *P*, placed in parallel position and supported by cast-iron legs. To this frame was firmly bolted the head drum bracket, *C*; but the tail drum bracket was arranged so that it could be moved back and forth upon the frame and firmly fixed at any desired position by means of a wing nut. These drum brackets were made sufficiently large that they would accommodate an 8 x 10 drum or two 6 x 6 Harvard drums. The general arrangement of supporting legs, *L*; head drum, *D*; friction drive, *H* and *F*, and the gear box *G* may be noted in Fig. 1, which shows both side and end views of the chief mechanical parts.

The friction drive was chosen because of its simplicity and elasticity. A 7 inch brass disk, Fig. 1, *F*, mounted upon the vertical drum shaft *B* just below the frame is caused to rotate by friction of a leather or fiber wheel *H* which is mounted upon the horizontal power shaft *K*. After learning that the friction disk must be slightly rough and that the leather wheel should be at least two inches in diameter no further trouble was experienced. The power shaft *K* terminates distally in the universal joint *U* by which it is attached to the output shaft of the gear box. As the first kymograph operated satisfactorily still others were made with but slight modifications.

Since these kymographs were driven by a 1/20 h.p. motor operating at 1125 r.p.m., it was necessary to reduce the speed 2,000 times between the motor and the friction drive. In the early model this was accomplished by means of worm gears alone. Learning that the flexibility of the machine was reduced to zero the writer set about to find some type of gearing which would allow rapid changes of speed as well as increase the general flexibility of the machine as a whole. This was accomplished by means of a gear box shown in Fig. 2, which not only contains the reduction gears but also a three speed gear shifting device as well. In Fig. 2, *A* represents a 1–1 set of spiral gears; *C*, a 50–1 worm gear set, and *H* a 20–1

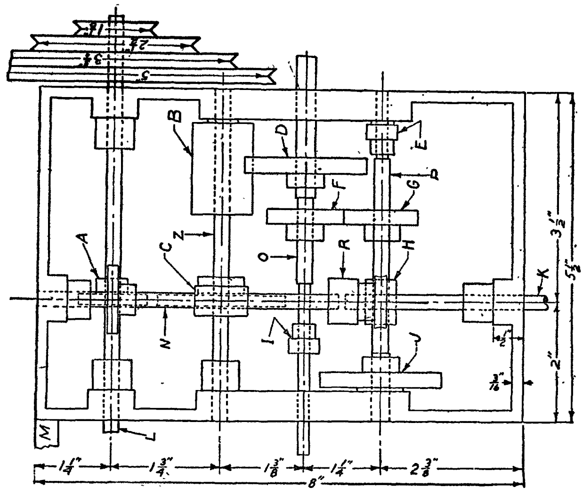

FIG. 2

worm gear set. The various other gears, *B, D, E, F, G, I* and *J*, are all of 24 pitch, but *B* is only one half the size of *D*, which in turn is four times the size of *E*. *D* has 48 teeth; *F* and *G* both have 20 teeth.

Therefore, as the wheels stand in Fig. 2, intermediate position, the speed reduction is 2,000–1. If pressure were put upon the right end of the movable shaft *O*, the wheels *F* and *G* would be thrown away from each other into a neutral position. Further pressure would cause the wheels *D* and *E* to engage and then the speed would be reduced only 500–1, high speed. On the other hand, if pressure were applied to the left end of shaft *O* the wheels *F* and *G* would be thrown out of contact and into a neutral position, but still further pressure would cause wheels *I* and *J* to mesh and the speed would be reduced 8,000–1, low speed, since *I* and *J* are the reverse of *D* and *E*. The lever for shifting gears and the devices necessary

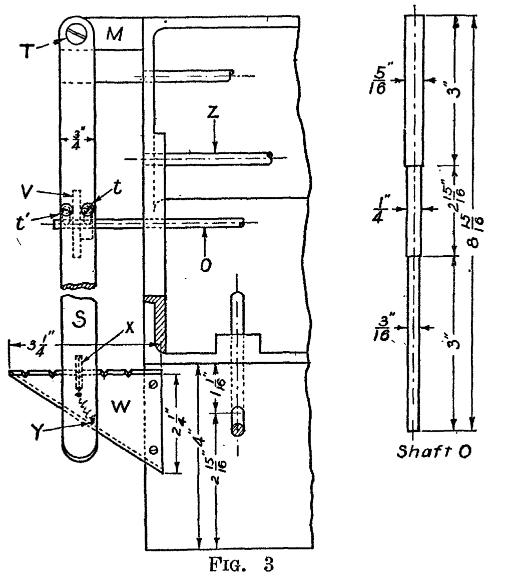

FIG. 3

for retaining the gears in the position desired are shown in Fig. 3. The use of a four stage cone pulley adds further flexibility.

All the gears used, except wheel *B*, may be readily secured from nearly any machinery or model maker's supply house. Wheel *B* has 24 teeth at 24 pitch with ¼ inch hole and 1½ inch face. This wheel was obtained from the Boston Gear Works.

SUMMARY

1. Herein has been described and illustrated a belt paper kymograph, electrically driven, and provided with a three speed gear shift.

2. By the use of this gear shift the operator may instantaneously change the speed of his paper from intermediate to high speed which is four times faster or to low speed which is four times slower.

3. By the arrangement of gears here shown no clutch or clutch lever is needed, and the operator may readily alter the speed by the use of either hand.

4. Although this gear box may appear somewhat complicated and difficult to construct it was built by junior and senior college students in mechanical engineering.

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SPECIAL ARTICLES

SURFACE TENSION BY THE RING METHOD

SINCE surface tension determinations are made frequently by chemists and physicists, and especially by biologists and in the industries, it is important that the quantity measured shall be the surface tension itself and not some other force. Of all the methods which are applied the determination of the pull on a ring is the most often used, as is evidenced by the fact that in one biological laboratory sixty thousand such determinations were made in a period of five years. The wide-spread popularity of this method is probably due to the ease with which a ring of platinum or platinum-iridium may be cleaned, and the resultant rapidity of the measurement, since all that apparently needs to be done is to put the ring in contact with the surface of a liquid, and to determine the force needed to pull it away from the surface.

Although what has been called the "ring method" has been so widely applied, it is a surprising fact that *until four years ago there was no ring method for the measurement of surface tension,* since all that was determined was the pull on the ring, which is related to the surface tension in a way that was before that time unknown. Thus in "International Critical Tables" nine experimental methods for such measurements are listed, but a ring method is not included, since the procedure which had been designated by this term did not supply even one single measured value of surface tension for these tables.

The failure of the ring procedure was due to the fact that the theory had not been developed with sufficient completeness, though an excellent beginning had been made by Cantor,[1] Lohnstein,[2] Lenard,[3] Tichanowsky,[4] MacDougall[5] and others. Since, however, their equations are not extremely simple, and moreover apply only to rings of such dimensions as make them impractical for use, it was customary to neglect their theory, and to calculate the surface tension from the entirely incorrect equation

$$\gamma = \frac{P}{4\pi R} \quad \text{(incorrect)} \qquad (1)$$

in which P is the maximum pull in dynes as determined by a balance, R is the mean radius of the circular ring and γ is the surface tension in dynes per centimeter.

In 1926 Harkins, Young and Cheng[6] demonstrated that a correct value of the surface tension is given by the expression

$$\gamma = \frac{P}{4\pi R} \times F \qquad (2)$$

Since $P = Mg$, in which M is the mass in grams indicated by the balance, and g is the gravitational acceleration, this may be written

$$\gamma = \frac{Mg}{4\pi R} \times F \qquad (3)$$

That the equation (1) generally used is entirely incorrect and does not give the surface tension at all is shown by the fact that in our experiments the value of the factor by which this must be multiplied to give the surface tension has varied from 0.72 to 1.45, or it exhibits a variation of 100 per cent. The most harmful and absurd fallacy in this connection is the statement which appears so often in connection with this incorrect equation: "It may be true that it does not give the proper absolute values, but of course it gives the correct relative magnitudes." This is entirely untrue,

1 Cantor, *Wied. Ann.*, 47: 399, 1892.
2 Lohnstein, *Ann. Physik*, 25: 815, 1908.
3 Lenard, *ibid.*, 74: 395, 1924.
4 Tichanowsky, *Physik. Z.*, 25: 300, 1924; 26: 523, 1925.
5 MacDougall, SCIENCE, 62: 333, 1926.
6 Harkins, Young and Cheng, SCIENCE, 64: 333, 1926.