numbers of young, about one millimeter in diameter, were found on the rocks at Nobska Point. During the latter part of August and the early part of September, Veligers, all apparently of one species, were conspicuous in the surface skimmings ; these disappeared at about the time that the young *Littorina* were found.

Vermes. Mr. R. H. Johnson found *Bugula turrita* liberating embryos, even after the middle of the month.

Small specimens of *Nereis limbata* and certain allied forms occurred sparingly in the auftrieb. On the evening of the 30th *Autolytus* was still fairly abundant, and many of the females were carrying eggs in early stages of development. *Rhyncobolus* and *Diopatra* were not breeding.

Cœlenterata. With the exception of one or two minute forms, no Medusæ were found. *Gonionemus* was abundant in the Eel Pond, and specimens brought into the laboratory about the middle of the month extruded eggs. The greater part of these eggs did not reach the blastula, and none developed beyond this stage. Ctenophores *Mnemiopsis*, very conspicuous in late August, appeared in increasing numbers during September. *Obelia*, with a few ripe gonangia, was obtained on the 21st. *Pennaria tiarella* formed the bulk of the abundant hydroid-growths on the Fish Commission wharves, although a *Erudendium*, probably *E. ramosum*, was plentiful. Here and there small patches of *Plumularia tenella* were found. East Chop and Edgartown were visited on the 12th. At the former place there were few colonies of *Pennaria*, but a great abundance of *Eudendrium* and *Plumularia*. At Edgartown I did not find either *Pennaria* or *Eudendrium*, but *Plumularia* occurred in dense masses, which literally covered the submerged woodwork of the wharves.

At Woods Hole the colonies of *Plumularia* were small and sterile, while at the other localities they were large and provided with gonangia in the various stages of development.

The *Eudendrium* and *Pennaria* bore medusa-buds in all stages, and the latter species remained in fruit as late as the 21st, and perhaps later.

M. T. THOMPSON.

ECONOMICS IN MANUFACTURES.

ONE of the most difficult problems in practical economics, in the whole range of modern industrial systems, is that of securing a just and satisfactory method of insuring fair exchange of labor for capital or wages where large bodies of workmen are to be employed. Cooperation and innumerable plans of ' piece-work ' and 'profit-sharing' have been proposed, and none have, in practice, been found either in the abstract entirely equitable or wholly satisfactory to the employer as securing sufficient output from his always burdensome investments, profit on his sales, or a contented and fair-minded relation between himself and his employés ; nor has any system been found which fully satisfies the workman in either extent of total compensation, opportunity to secure compensation proportioned to his exertions and ability, or in abstract equity in distribution of profits.

One of the most promising of the later plans for a fair and honest and satisfactory distribution of profits and a very effective stimulus of the right spirit in both employer and employé was described, as a first experiment, to the American Society of Mechanical Engineers, some years ago, by Mr. F. A. Halsey, then or earlier manager of the Canadian Rand Drill Co., at Sherbrooke, Quebec, Canada. Mr. Halsey called his plan ' The Premium Plan of Paying for Labor,' and the title is indicative of its nature.*

The author of this system now reports the outcome of a considerable number of

* Trans. Am. Soc. Mech. Eng'rs ; Vol. XII.

experiments in its employment, some by important and famous manufacturers of various mechanical devices, from the steam-engine to the machine-tool. The following abstract is based upon his account of these later experiences, as given in the *American Machinist*, with extended tables of data and results.*

The plan has been in use eight years, and has come into use, in a number of establishments, sufficiently to give ample experience in is workings. Curiously enough, however, although devised for the benefit of the workmen, mainly and primarily, and invariably promising them gain, it has as invariably been received with suspicion and reluctance by them, and in at least one case has been opposed by the trade-unions of the place. In all but a single case, however, it has proved entirely successful in the accomplishment of its purpose—the promotion of the wage-earning power of the men and of the dividend-paying power of the establishment; sharing profits while stimulating ambition and increasing output. It gives the workman increased day's wages; it gives the employer increased output from his works, at reduced cost and increasing profits, shared with those who make them possible. The workman gains directly, day by day; the employer not only gains, directly, by increased output from the same number of men, but also indirectly and in an exceedingly important degree, often, through the increased earning power of his capital, invested in plant and in funds.

Piece-work has not been wholly successful, and in too many cases the selfishness and greed of the employer, seeking to monopolize all the profit, compels the workman to accept a rate which makes his day's work no more profitable to him when working under high-pressure than when doing an ordinary day's work at fixed wages at such a rate that he can sustain that amount

* March 9, 1899.

of production indefinitely. Where properly adopted and adjusted, it is a vast improvement upon the older plan. Mr. Halsey's plan puts a premium upon increasing production, in such manner that both employer and employé are inevitably alike advantaged, and skill and industry and steady work secure proportional reward. It involves something of the principle of the common bargain by which a salesman is given a fixed and moderate salary *plus* a stated percentage on sales. Under this new plan the employer offers a workman a premium, perhaps ten cents, for each hour by which the production of a certain piece is reduced below that of the observed normal average or below an assumed period of time ; the day's wage being that of the time and place, as fixed by ordinary circumstances in the market, and without control, usually, by either party to the bargain.

Suppose that pay to be three dollars a day and an hour to be saved in a piece ordinarily requiring just a day's work for its production. The proprietor gains the hour and his thirty cents otherwise paid as wages for the hour ; he loses ten cents premium ; he gains in rate of output of the establishment, and so makes it possible to secure larger returns through more effective use of all other capital than the ' wages fund.' The workman gains his ten cents and the privilege of adding an extra hour's work on a new 'job.' Thus both parties gain. Had the premium been fifteen cents the money-gain would have netted both equal amounts, fifteen cents, per day. Thus, as in Table I., we sometimes actually find enormous gains possible through the ingenuity of the workman in finding ways of reducing time of production, as by increased personal activity, or by securing deeper cuts and higher speed of cutting, or less time in putting the piece in place or in replacing it by its successor, etc. The writer has known of a case in which the

cost of an important machine was reduced by such expedients from $250 to about $75.

TABLE I.—OPERATION OF THE PREMIUM PLAN.

1	2	3	4	5
Time consumed.	Day wages per piece.	Premium earned per piece.	Total cost of work = col. 2 + col. 3.	Workman's earnings per hour = col. 4 ÷ col. 1.
Hours.				
10	$3.00	$0.	$3.00	$0.30
9	2.70	.10	2.80	.311
8	2.40	.20	2.60	.325
7	2.10	.30	2.40	.343
6	1.80	.40	2.20	.366
5	1.50	.50	2.00	.40

Table II. is taken from the books of one of this establishments actually employing this 'premium plan,' and shows a gain of more than one half, in this particular instance, in time of production—in productivity, in fact—in the works, of just double wages for the workman, per piece produced, and a net increase in day's wages of eighteen per cent.; while the gain to the company was very much greater through its operation upon the interest and maintenance accounts.

In another actual case where the parts reported upon all belonged to a single contract, and comprised the whole contract, the gains of the workmen were 29 per cent. on the day's wages, 25 per cent. on the piece, and the time of production of each piece averaged a reduction of 63 per cent. These figures are astonishing; but they mark the enormous difference between the productivity of a man working under the old conditions of the day's-work plan, without incentive to either good work or to doing his best in continuous labor, and the premium-system, which is likely to give ambition, energy and productiveness to the most stolid. In this table Cases 41 to 44 are records made where both parties doubted the possibility of any gain at all One case was made by an apprentice boy and the standard was based on the work of an experienced workman. Another case gives illustrations of successive gains with practice on successive pieces. All illustrate large and equitably-shared gains over the old system of day's wages.

Everything depends, however, upon an equitable basis of inauguration. It is bet-

TABLE II.—RESULTS OF APPLYING THE PREMIUM PLAN TO MISCELLANEOUS WORK.

RATIOS OF TOTALS.

$$\frac{\text{New time}}{\text{Old time}} = \frac{44}{100} \qquad \frac{\text{New wages per piece}}{\text{Old wages per piece}} = \frac{50}{100} \qquad \frac{\text{New wages per day}}{\text{Old wages per day}} = \frac{118}{100}$$

RATIOS OF TOTALS WITH 46 OMITTED.

$$\frac{\text{New time}}{\text{Old time}} = \frac{76}{100} \qquad \frac{\text{New wages per piece}}{\text{Old wages per piece}} = \frac{88}{100} \qquad \frac{\text{New wages per day}}{100} = \frac{118}{}$$

Note that while this table deals with small parts it also deals with large lots. The ratios at the bottom compare the production of over 900 pieces by each method.

NATURE OF WORK.	Operation	DAYS WORK PLAN		PREMIUM PLAN		Old wages cost per piece	New wages cost per piece	Old wages per day	New wages per day
		Time per piece	No. of pcs. in lot	Time per piece	No. of pcs. in lot				
		Hours		Hours					
41. Long T-shaped piece cast-iron..	Chuck, Drill & Ream	.125	300	.089	300	$ .0275	$ .0258	$2.20	$2.82
42. " " larger size cast-iron	" " " "	.178	200	.112	200	.0492	.0317	2.20	2.84
43. " " " " "	" " " "	.275	100	.175	100	.0605	.0533	2.20	3.06
44. " " largest " " "	" " " "	.366	100	.183	100	.0805	.0624	2.20	3.41
45. Cast-iron wedge..........	Plane	3.5	2	3.25	4	.805	.792	2.30	2.44
46. Box-shaped casting..............	Oblique planing	56.	1	21.	1	14.00	6.25	2.50	2.98
47. Cast-iron wedge................	Plane	3.75	2	2.62	4	.825	.727	2.20	2.76
48. Small pulleys, cast iron........	Chuck Drill & Ream	.18	100	.13	100	.045	.0417	2.50	3.20
49. Spindle steel	Grind 3 sizes	.6	50	.36	50	.144	.09	2.40	2.50
50. Small head stock	Mill 3 operations	.45	50	.32	50	.1237	.0925	2.75	2.90
Totals	....	65.424	......	28.239	......	$16.1604	$8.1664	$24.45	$28.91
Totals omitting 46	....	9.424	......	7.239	......	$2.1604	$1.9164	$21.95	$25.93

ter for the employer to be liberal in estimating the time-rate rather than with the premium-rate. Excessive premium-rates are apt to result in too large expectations to be fully met in the long run. From one-half to one-third the saving are usual premium-rates, and probably one-third to the workman and two-thirds to the firm best brings out a permanent and satisfactory adjustment which, if found inequitable, can generally be easily readjusted to a correct figure. In one machine-tool works the premium-rate is thirty-six per cent. and is found satisfactory to both sides. The higher premium-rates, however, should be paid for manual labor, as in blacksmithing, and the lower to power-tool work, as at the lathe or the planer or the milling machine. Undoubtedly every establishment, and every department of labor, from floor-sweeping to book-keeping, has its own peculiar best rate. In all cases the result may be expected to be a largely increased output of the works, a greatly increased earning power on the part of the men, and decreased costs of production with increased dividend-paying power for the holders of the capital. "Wisely administered, the plan will do more to settle the wages-question than anything else that has been suggested," and the wages-question is to-day the burning question in the economics of manufacturing.

R. H THURSTON.

SCIENTIFIC BOOKS.

Analytic Functions. Introduction to the Theory of Analytic Functions. By J. HARKNESS and F. MORLEY. London, Macmillan & Co. 1898 8vo. Pp. xvi + 336.

The appearance of the present work is a very pleasant sign to friends of the modern school of mathematics in England and America. It indicates that the movement which set in some years past with us in this direction has been steadily growing; that the theory of functions is no longer the property of a few bold and rest-

less minds, but has already descended to the masses. The present work may very happily serve as a text or reference book to a first course on the theory of functions in the senior class of any of our better universities. The theory of functions of a complex variable may be viewed from two standpoints. One was taken by Cauchy and Riemann; the other by Weierstrass. The methods of Cauchy and Rieman are more natural and intuitive; those of Weierstrass more abstract and lend themselves more easily to a rigorous treatment of the subject. The authors have chosen the methods of Weierstrass.

Roughly speaking, the subjects treated in the first 100 pages fall under two heads:

1. The geometric representation of complex numbers, the conformal representation afforded by

$$y = \frac{ax + b}{cx + d}$$

and the first properties of rational functions.

2. Topics which lie at the foundation of the calculus.

The treatment of the first group of subjects is admirable. In regard to the second is seems to us that the authors have attempted the impossible. The theory of function in common with the calculus rests on certain notions, such as that of number, limit, continuity, extremes of functions, etc. These subjects are very imperfectly treated in English works on the calculus, and our authors have thus found it advisable to give some account of them in the present volume. The amount of space at their disposal was very limited, and they have, therefore, been obliged to be excessively concise. This has been carried to such an extent in the chapter on number, Chapter I., that the subject, so it seems to us, will be utterly incomprehensible to the student.

We cannot understand why, if it is worth while to say anything about irrational numbers, the arithmetical operations upon them are passed over in absolute silence. Until the terms sum, product, etc., are defined they have no meaning.

Chapter VI., which treats of limits and continuity, suffers severely on account of the brevity of Chapter I. In this chapter it is important to establish the existence of certain