Global Journal of researches in engineering
General engineering
Volume 11 Issue 7 Version 1.0 December 2011
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

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By Ojomo A.O., Ologunagba F.O . , Alagha S.A
Department of Agricultural Engineering Technology, Rufus Giwa Polytechnic

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GJRE- J Classification : FOR Code: 099902

EVALUATION OF A LOCALLY FABRICATED OIL SCREW EXPELLING MACHINE

Evaluation of a Locally Fabricated Oil Screw Expelling Machine

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I. Introduction

Groundnut (Arachis hypogaea Linnaeus), also Known as peanut or earthnut, is a member of Papilionaceae, the largest and important of the three divisions of leguminosae (shankarappa et al, 2003). Nature to South America, it originated between Southern Bolivia and Northern Argentina from where it spread throughout the world as Spanish explorers discovered its versatility. It was brought to West Africa from Brazil in the 16th century (Alonge and Adegbulugbe, 2005). It thrives well under a wide range of environmental conditions. The oil content of the kernels is between 45% and 55% depending on the variety (Woodroof, 1983; Young, 1982).

Groundnut has been identified as one of the leguminous species with the greatest potential for both food and industrial purposes in the tropical region of Africa (Milner, 1973). It can be processed in different ways to many products such as groundnut flour, groundnut milk, groundnut butter, sandwiches, paints, varnish, lubricating oil, soap, insecticide, furniture polish, leather dressings and many others. However, the concern of this paper is the processing of groundnut into groundnut oil and Figure1 shows a typical processing flow chart.

Processing or extracting or expressing oil from groundnut involves a wide range of traditional, mechanical, chemical and mechano-chemical methods (Ewaoda et al, 2008). The traditional method involves roasting and crushing the groundnuts into fine particles, after which the crushed mass is mixed with water and boiled so as to allow the oil to float. The oil is then skimmed off and dried by heating (Ajao et al, 2010). This method is time consuming, labour intensive, low output and low efficiency with lots of drudgery. The mechanical methods involve the use of screw and hydraulic presses (Asiedu, 1984). The screw press is more reliable than the hydraulic press, but is slower and produces less pressure. The hydraulic press is more expensive, needs more maintenance and risk contaminating the oil with poisonous hydraulic fluid. Generally, the mechanical methods have relatively higher operating cost than the traditional methods; however, they have higher efficiencies and are usually more adaptable for small and medium scale producers (Abubakar and Yiljeb, 1996; Adgidzi, et al 2006; Olayanju et al, 2004; NCRI, 1995).

The chemical method or solvent method is done either by continuous solvent extraction or aqueous extraction. This method is more appropriate for large – scale processing than small- or medium-scale processing because of higher capital and operating costs. However, there is the risk of fire and explosions from the solvents coupled with the complexity of the process (Davie and Vincent, 1980; Jaswant and Shukla, 1991). The mechano-chemical extraction involves using the cake from the mechanical extraction as a solute to which solvent is introduced to further release the oil held in the cells. Though this method is the most efficient, it is very expensive and time consuming. The various modern methods of processing are predominant in developed countries while the manual processing is still the norm in many developing countries despite the drudgery and low output (Maduako et al, 2006).

In Nigeria, some imported large-scale plants are replacing the small groundnut processing units, but due to high foreign exchange rate, the cost of such

Author: Department of Agricultural Engineering Technology, Rufus Giwa Polytechnic, P.M.B 1019 Owo, Nigeria
E-Mail: [α] Ojomooluyemisi@yahoo.co.uk
E-Mail: [β] francolog2@yahoo.com
E-Mail: [Ω] laghasake@yahoo.com

imported machines is clearly out of reach of the poor farmers. Therefore, the mechanical processing method using the screw press has been selected for this study and this paper reports the performance evaluation of a locally built oil screw expelling machine.

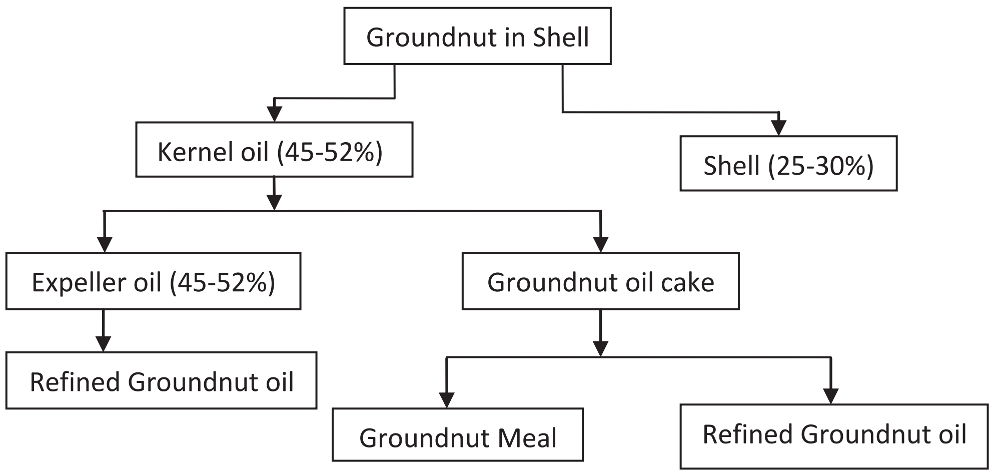

Fig. 1: Flow chart for processing of groundnut into groundnut oil. (Source: NCDEX 2010)

II. Materials And Methods

a) *Machine Description*

The machine consists of the feeding chute (hopper), expelling unit, discharge units, frame and prime mover. The feeding chute is pyramidal in shape and made of 5mm gauge galvanized iron sheet. The expelling unit consists of a screw shaft with a perforated barrel outer casing. The screw is divided into three sections; the feeding, milling and discharge sections as it tapers. The friction and pressure produced by the screw on the barrel causes the mass to heat up, thus facilitating oil extraction as the screw grinds and presses the fine mass against the expelling chamber. The oil flows through the perforation in the casing and is collected beneath the expeller chamber while the residue (cake) is extruded from the unit through the cake discharge outlet.

The frame supports the machine and is firmly fastened together with bolts and nuts to allow easy dismantling for transportation. The prime mover is a two (2hp) electric motor of 1400rpm speed with belt and pulley arrangement. Fig.1 shows a pictorial view of the oil screw expelling machine.

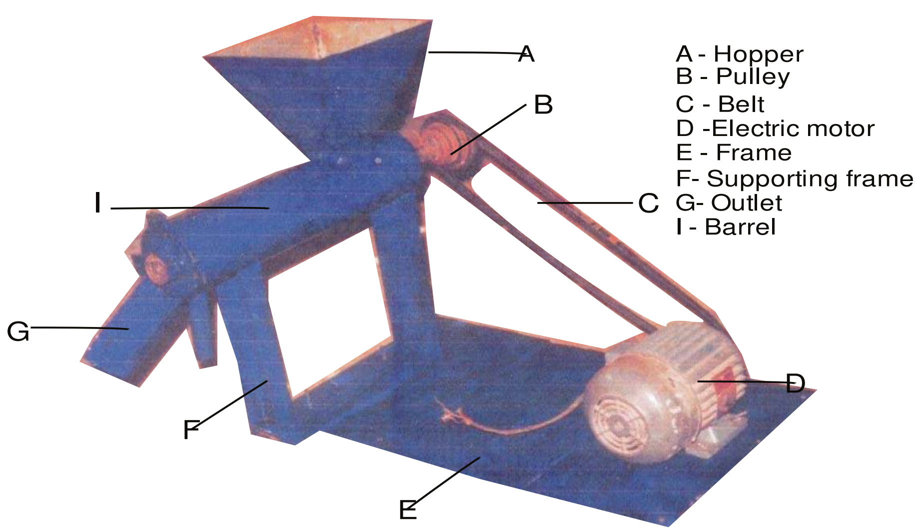

Fig. 1: Pictorial view of the Oil Screw Expelling Machine

b) *Economic Analysis*

The economic analysis of the machine was carried out as follows

i. *Machine Capacity*

a) Production Capacity = 48kg/hr (8 hrs per day operation) operating days per year = 300 days

b) Operating hours per year = 2400 hours

c) Production capacity per year = 115.2 tone/yr

d) Capacity Utilization = 85% of production capacity

e) Oil production per year = 97.92 tone/year

f) Power requirements per year = 0.8kwh x 2400h = 1920kwh

ii. *Cost of Production*

g) Cost of power consumed/year(#4.00/kwh)= #7680/year

h) Operators salary was assumed to be #12400 per Month for 2 workers; therefore the operators will collect #297,000/yr

i) Cost of fabrication of machine = #61,000 Electric motor inclusive.

j) Cost of raw materials = #135000/tone

k) Net sale of oil produced = #270000/tone

m) Cost of grinding and processing groundnuts/hr = #0.36/hr

n) Cost of processing groundnut/annum N0.36 x 2400hr) = #1344

0) Total cost of production (g + h + j) = Raw materials used per annum

iii. *Profitability*

q) Total sales of oil (#270000 x 97.92t/yr) = #26438400/yr

r) Raw material/year = #135000 x 97.92t/yr = # 13219200/yr

s) Cost of production/year = (g + h+ r) = #13523880/yr

t) Gross profit before taxes = (q- s) = #12914520

u) Payback period =1year

c) Experimentation

Fifty kilograms (50kg) of groundnut was purchased in the market and prepared for the test. The preparation involves cleaning the groundnut by removing dirty and other particles and washing. The cleaned groundnut was milled to form paste. Three kilogram (3kg) was prepared for each experiment and each experiment was carried out in five replicates. The speeds of the machine were varied by varying the diameter of the pulleys. The diameters of the pulleys used for the experiment were 525mm, 600mm, 675mm, 750mm and 825mm corresponding to 730, 675, 600, 525 and 450rpm respectively.

At the end of each operation, the weight of oil expelled and mass of cake were recorded in order to evaluate the effect of machine speed on the machine feed rate, output capacity, efficiency, percentage of oil recovery and the mass of cake produced. The machine performance parameters were determined by using the following equations:

$$\text{Feed Rate} = \frac{\text{Mass of Paste}}{\text{Time taken/Unit operation}}$$

$$FR = \frac{M_p}{T} \quad \text{---------- 1}$$

$$\text{Output Capacity} = \frac{\text{Mass of oil expelled}}{\text{time of operation}}$$

$$Q_c = \frac{M_{oil}}{T} \quad \text{- ------- 2}$$

Percentage of oil recovery = $\frac{\text{Machine efficiency} \times 100\%}{45}$ (Oluwole et.al, 1989)

$$P_R = \frac{\eta_{oil}}{45} \times 100\% \quad \text{------------ 3}$$

Where:

45 = The oil content in kg per 100kg of groundnut (Wiemer and Korthalds, 1989)

$$\text{Efficiency} = \frac{\text{Mass of oil expelled}}{\text{Mass of Groundnut paste}} \times 100\%$$

$$\eta_{oil} = \frac{M_{oil}}{M_{GP}} \times 100\% \quad \text{----------- 4}$$

Oil yield = Mass of paste – Mass of cake

$$O_{yield} = M_p - M_c \quad \text{----------5}$$

III. Results And Discussion

The performance of the locally developed oil screw expeller was evaluated at the various machine performance parameters. Figure 2 through 6 shows the results obtained from the test carried out on the machine. Generally, from Figure 2, the feed rate of the oil expeller increased with increase in the speed of the machine. The highest feed rate for the expeller was at

87kg/h at machine speed of 690rpm. Also, from Figure 3, the output capacity of the machine increased with increase in the machine speed. The highest value of output capacity of 68kg/h was achieved at machine speed of 780rpm. Figure 4 showed that the mass of cake expelled from the machine also increased with increase in the speed of the machine. At machine speed of 750rpm, 2.5kg of groundnut mash was recovered. The efficiency of the machine increased with increase in the machine speed (Figure 5). The high efficiency of the machine at high machine speed may be attributed to the high rate of movement of the screw press against the expeller wall. The highest value of 67% and 65% for actual efficiency and predicted efficiency of were observed at machine speed of 600rpm. Figure 6 showed that at machine speed of 600rpm, the maximum oil of 1.8kg was obtained from the groundnut mash and further increase in speed of machine resulted in decrease in amount of oil expelled

IV. Conclusion and Recommendation

Performance test was carried out on a locally fabricated oil screw press. It was tested and found to be efficient in the expelling of groundnut oil. Generally, the performance parameters of the machine increased with increase in the machine speed. The machine is cheap, easy to operate and maintained because the parts can be locally sourced. It is recommended for small-scale farmers to process their nuts into oil which are hitherto sold as raw material at very cheap price.

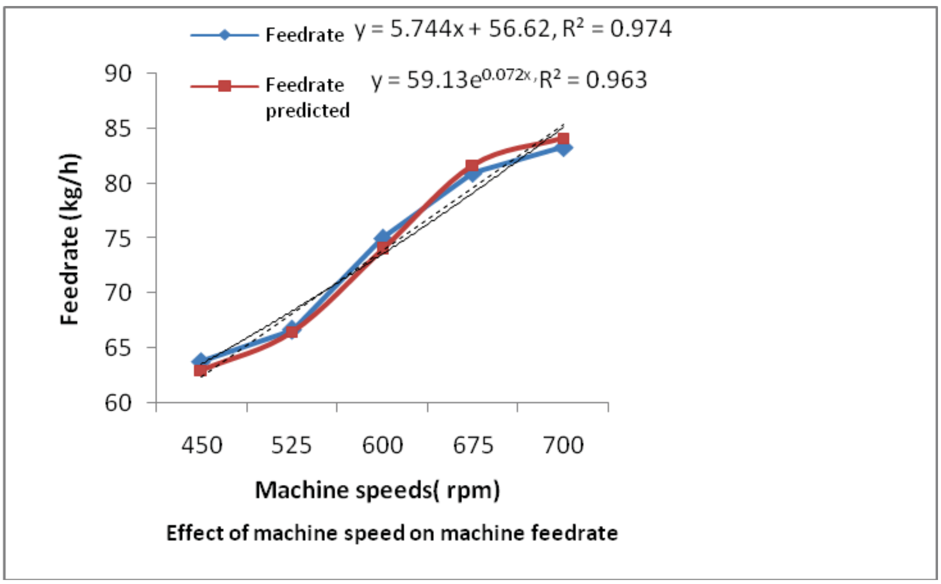

Figure 2: Effect of machine speed on machine feed rate

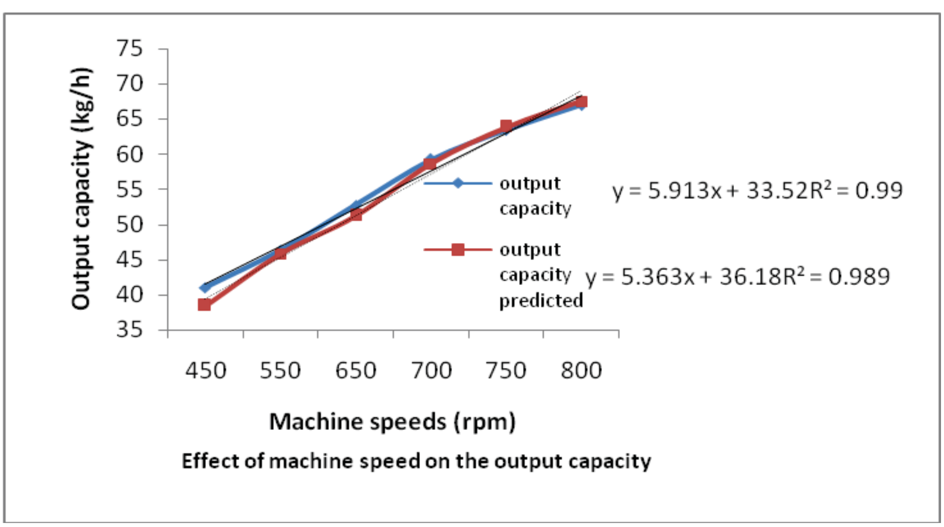

Figure 3: Effect of machine speed on the output capacity

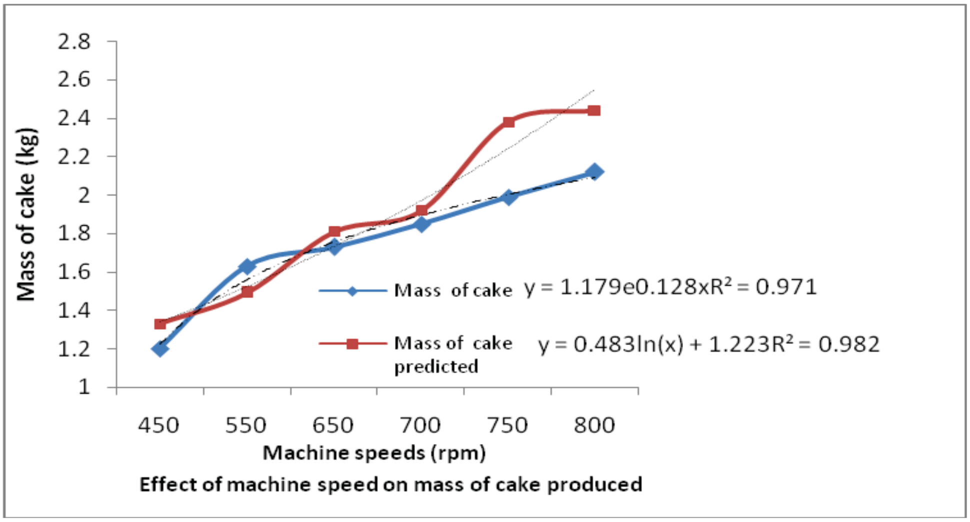

Figure 4: Effect of machine speed on mass of cake produced.

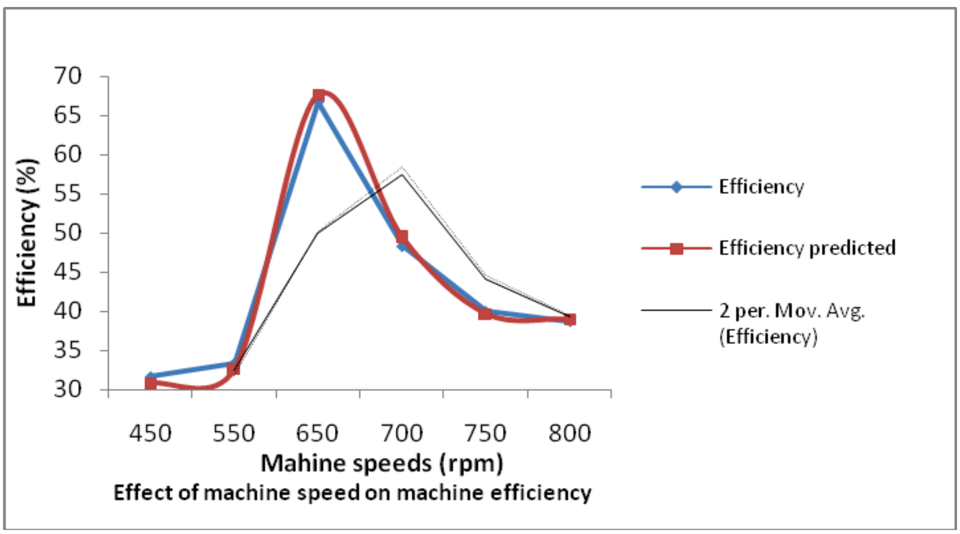

Figure 5: Effect of machine speed on machine effeciency

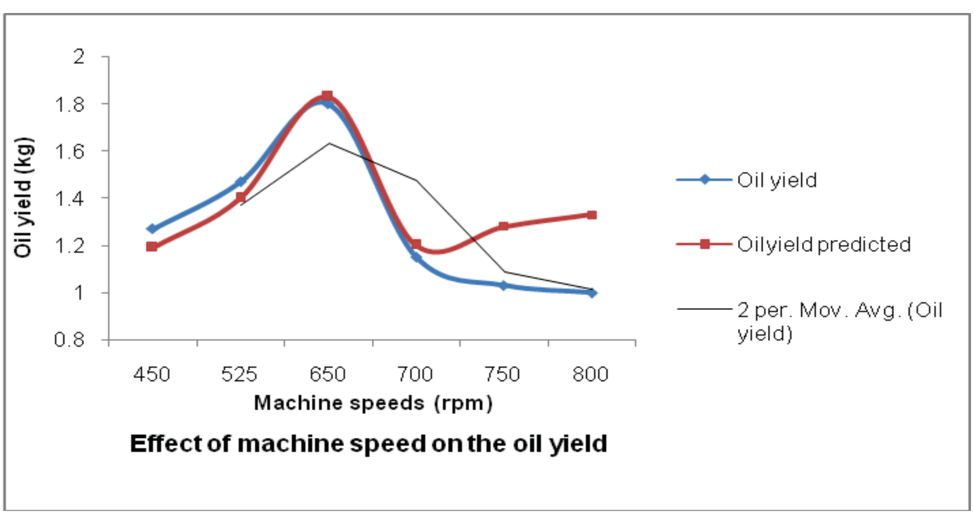

Figure 6: Effect of machine speed on the oil yield.

References Références Referencias

1. Abubakar, S.Z. and Y.D. Yiljep. 1996. Design and development of a groundnut Kneader.Proceeding of the Nigerian Society of Agricultural Engineers (NSAE). Vol. 18 pp 245-250.

2. Adgidzi, D. Dauda, S.M. and O.O. Emeruwa 2006. Development of an oil expeller.Proceedings of the Nigerian Institution of Agricultural Engineers. Vol. 28. pp 88-93.

3. Ajao, K.R., Ajimotokan, H.A., Olaomi, J. and H. Akande. 2010. Design and development of a groundnut oil expelling machine. Journal of Agricultural Technology. Vol. 6 (4). pp 643-648.

4. Alonge, A.F. and T.A. Adegbulugbe. 2005. Some physical properties of groundnut (Arachis hypogeal. L). Journal of Agricultural Engineering Technology. Vol. 13 pp 35-41.

5. Asiedu, J.J. (1989) Processing tropical crops: a technological approach. Macmillan Education Ltd. Houdmills Basingstoke. pp 124-143.

6. Davie, J and L. Vincent. 1980. "Extraction of vegetable oils and fats" in Hamilton, R.J. and Bhati, A. (Ed). Fats and Oils, Chemistry and Technology. Applied Science, London pp 123-134.

7. Ewaoda, M.O., El-Okene, A.M.I. and D.D. Yusuf 2007. Effect of Kneader configurations of a motorized groundnut oil-extraction on extraction time. Proceedings of the Nigerian Institution of Agricultural Engineers. Vol. 29 pp 145-151.

8. Jaswant, S and Shukla, B.D. (1991). Post harvest technology of oil seeds. Technology mission on oil seeds. Central Institute of Agricultural Engineering, Bhopal, India.

9. Maduako, J.N., Saidu, M., Mathias, P and Vanke, I. 2006. Testing of an engine-powered groundnut shelling machine.Journal of Agricultural Engineering Technology. Vol. 14. pp 29-37.

10. Milner, H.G. 1993. Traditional extraction of oil from Nigerian foodstuff. Heinemann Education Books, Ibadan, Nigeria.

11. NCDEX 2010. Groundnut oil. National Community and Derivatives Exchange brochure, Mumbai,India.

12. NCRI. 1995 "NCRI Develops Vegetable Oil Extractor" National Cereals Research Institute Newsletter 11(1) pp 7.

13. Olayanju, T.M.A., R. Akinoso and O.M. Oyeku. 2004. An investigation into the machine parameters of some vegetable oil expellers. Proceedings of the Nigerian Institution of Agricultural Engineers Vol. 26. pp 387-393.

14. Oluwole, F. A., Aviara, N. A. and Papu, E 1996. Performance Evaluation of a Spindle Press for Oil Extraction. Proceedings of the 4th International Conference of the Nigerian Institution of Agric. Engineers Vol 25 213-218.

15. Shankarappa, T., Rober, E.R. and N. Virginia. 2003 World Geography of Groundnut. Distribution, Production use and Trade. Available at http://www.lanra.anthro.uga.edu/peanut/knowledge database (October. 2010).

16. Wiermer, H. and Korthals 1989. Small Scale Production of Oil Seeds. Friedr Vieweg and Sohn Vertags GmbH Bramschiveig Germany

17. Woodroof, J.G. 1983. Peanuts production, processing and products. 3rd AVI publishing Inc. Westport Connecticut. USA.

18. Young, T.S. 1982. Field Crop production in Tropical Africa. MacMillan publishers, New York